# CLIMATE ACTION PLAN

*In awareness of the common*

*achievements and the responsibility*

*towards future generations*

Climatestrike Switzerland
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# Executive Summary



# Introduction

## The Challenge

In 2015, Switzerland, together with almost all other countries in the world, signed the Paris Agreement, which obliges the contracting parties to limit global warming to well below 2 °C compared with pre-industrial times (1850), with efforts to stay below 1.5 °C. The IPCC special report from 2018 made It quite clear, that the 1.5 °C target is of the utmost importance if we do not want to slide into an un-stoppable feedback-loop of warming beyond human control. With our current course, however, we are heading towards a warming of 4 °C or more, which would lead to catastrophic consequences such as famines, water shortages, more frequent and stronger storms and forest fires, wars over dwindling resources, rising sea levels and other environmental disasters.

In August 2019 the Federal Council has set the target to reduce Switzerland's net carbon emissions to zero by 2050 which is not only insufficient but completely rejects the scientific reality. It is delusional to believe that we could stay within our carbon budget with this goal.

According to the IPCC, the atmosphere can absorb, calculated from end-2017, no more than 420 Gt of CO2eq if we want a 66% chance of staying below 1.5 °C. Since around 42 Gt of CO2eq is emitted globally every year this budget is expected to be used up in less than eight years as of 2021. A linear reduction of GHG starting this year would lead to net zero worldwide until the year 2035.

Given that affluent nations carry more historical responsibility and have more financial capacity, they must decarbonize faster and financially support poorer nations to do so. Consequently, a country like Switzerland must reach net-zero GHG emissions at the latest by 2030. Figure 1 visualized this challenge. The figure compares the business-as-usual GHG reduction to the net-zero goal by 2050 of the Swiss Government and the necessary net-zero goal by 2030.

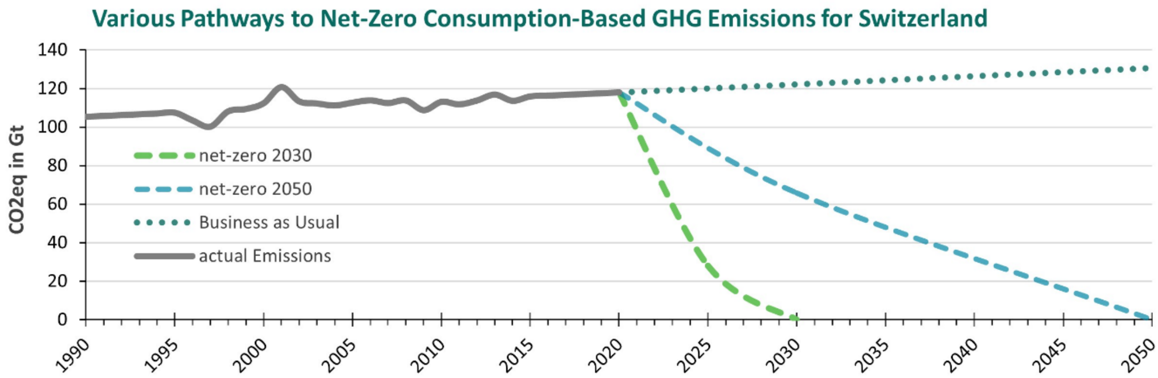


*Figure 0-1 Various pathways to net-zero consumption-based GHG emissions for Switzerland.*

# What is the CAP?

The CAP is an ongoing project aiming to find a joint solution to the climate crisis today and create a common vision for our society of tomorrow. It does not claim to be a flawless master plan. We tried to be as comprehensive as possible, but the CAP also tolerates a certain degree of overlapping or slight contradiction between different measures. Nevertheless, the most important measures have been worked out in great detail.
We discuss a very broad selection of possible policy measures. Which exact combination of policies would be best in terms of impact and social feasibility would need to be further studied. We may also have missed out on some excellent measures despite everything. The target of 1.5 degrees and net zero by 2030 for Switzerland remains non-negotiable. But we are always keen to discuss the path to reach this goal. We simply cannot afford to take too long. Some of the measures in the plan can be implemented immediately from 2021. And they must be.

The CAP is addressed to the people. We want to take all parts of society on the journey to search for the right solutions with us. The different actors in the emitting sectors, other instances in our society and individuals are invited to give feedback, make new suggestions for policies and join the project of initiating a just transition for climate ambition. We therefore also expect criticism towards the plan to be constructive instead of polemical so that we can actually move forward together instead of getting lost in ideological trenches. We are open for improvement suggestions.

# Aim of the CAP

Many have questioned the feasibility of net zero by 2030 and have criticized the target as unrealistic or even dangerous. The CAP is an answer to those criticisms. It presents pathways to reach this goal in a technically feasible and societally just way.
Since the very first school strikes for climate, schoolchildren have also been repeatedly criticized for demanding a safe future without developing solutions to this existence-threatening crisis themselves. Even though it is tantamount to state failure that this task is left to students after institutional politics has failed to address it properly during three decades, we had no other choice in the end but to deliver the policy measures which the Swiss parliament should have passed before most Climate Strikers were even born.
Our plan shows that with existing technologies and within a democratic structure, it is possible to implement net zero by 2030.

# Who wrote the CAP?

The Climate Action Plan was written collaboratively by young Climate Strikers, scientists and experts from various different fields with an elaboration budget of CHF 0. All experts volunteered their time and contributed in their private capacity. The policy recommendations were developed in twelve topic related working groups. This plan is in every way a collaborative project of dozens of people. Therefore, we do not see the sometimes heterogeneous form and content as a weakness but rather as a strength.

# How to Read the Plan

The whole CAP comprises over 300 pages split into 12 chapters containing a total of 138 policy measures. The executive summary should provide a good overview of its content while remaining rather unspecific. Readers can then delve deeper into certain points or into individual chapters which interest them. In the summary the sources are not indicated for reasons of readability and clarity. The detailed Climate Action Plan is to be seen as the source of the executive summary. In the detailed version the external sources used are indicated. The entire plan can be viewed on www.climateactionplan.ch.

# The Project Continues

The CAP needs to be discussed with as many people as possible (for example within Climate Assemblies). With outputs from constructive discussions we expect to collect a variety of ideas worth thinking about and develop them into new concrete measures. For us it is important that also the people working in the fields where change is needed, are part of the discussions.

Building up from this CAP we already plan to release a second version of it. This second version should include the criticism from the population and new ideas that came up. All together we hope to give the next version a broadly supported base and make a more accurate and more visionary plan to overcome the climate crisis and to shape a future we all want to live in.

# List of Contributors

The following list includes all contributors to this plan. Their naming, as well as that of their organization or institution, does not directly imply support for the political content of the plan, but should disclose the knowledge base and expertise on which the plan is based.

We want to thank all those who sacrificed their valuable time and energy for this project from the bottom of our hearts.

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# Vision – A Message from the Future

Many people think we will live on like we are today forever. But reality is different. There will be big changes anyways. We need to choose. Either we decide passively for a world full of suffering and problems or engage actively for a world full of regeneration and solutions. We now want to show you one possible future.
Imagine waking up in the morning and stepping out of your front door on a summer day. You are breathing in clean and fresh air. You are looking around and although you live in a big city, you see many trees and plants that seem to embrace the buildings around you painting the city in their different colors and keeping it cool. You listen to the birds and the insects humming around you, but you do not hear the loud noise of the planes that you were used to hearing at first when waking up. Normally you go to work by bike. Ten years ago, you were working as an assistant engineer at Zurich airport. When the Corona crisis hit the world, planes were grounded, and you feared to lose your job. Later many planes never got back in the air because of climate mitigation measures. But at that point there was no need to be afraid of becoming unemployed anymore. There was the possibility to get professional retraining to work in many different other fields, you could choose from, that are compatible with an ecological future. In the beginning it was hard to change the work you were used to, but when you started working as an engineer for technologies that take CO2 out of the atmosphere you felt enlightened and saw much more sense in your work and also it was a new challenge. In the long run the retraining was a great opportunity. A colleague of you had similar experiences. He wanted to do something completely different because he was fed up with sitting in front of a computer the whole day long. He decided to retrain in the field of agriculture and now he is organizing a big permaculture farm, working in and with nature the whole day. He feels much better and healthier now. Further he is happy to return to the countryside where he grew up. There are many permaculture farms or farms with other methods that do not need any fossil fuels but more human power, creating jobs and working together with nature rather than against it. Because these techniques are more efficient as well, we need to import much less food from other countries. Because of regulations meat and fish are now rather rare. There were many people complaining about it in the beginning but now people got used to it and there were many medical studies showing significant decreases in cardiovascular diseases.

Not only the food we eat makes us healthier but also the way we travel. Memories of your holiday last spring make you smile. You made a three weeklong bike journey together with your daughter and your partner, who came to Switzerland as a climate refugee after fleeing from locust plague in Somalia. Biking can now be done safely as the car-free streets do again belong to the pedestrians and bike drivers. Social life expanded into the streets and the squares; people are talking to neighbors they did not care about before. Getting to know other cultures no longer requires emitting large tons of greenhouse gases. All bigger cities in Europe can now be reached by fast, modern and affordable night trains and a high-speed rail network. Your daughter is already talking about all the countries she wants to explore once having grown up.

The energy for the night train network comes from the solar panels all over the place: from big solar farms and from all rooftops.
The solar panels have even new designs nowadays so that they look like normal facades and roofs but just have the benefit to produce energy. Your electricity bills have gotten less and less expansive as you were producing more and more of your own energy.

When you think back to the times before the government started to act, you sometimes observe yourself shaking your head thinking about how blind you were back then for the crisis we were facing. When you got interested in the topic and informed yourself better, you started to see the urgency of the crisis we are in, the changes that were done, seemed just logical. In general, many measures brought significant changes to people's lives. The twelve month long parental leave allowed you and your partner to build up a close relationship with your daughter without having to worry about anything else. You started to like thinking about ways to change our way of life and making it better and happier in many ways. You started getting more involved in politics yourself and you were not the only one. When change came and people knew about the science behind the climate crisis, everyone wanted to get involved and to decide how this new world should look like, which is now much easier with only six working hours per day.

It is not only Switzerland that has gone through enormous changes in the last decades.  After the Corona pandemic there was a huge wave of changes all over the world and it was almost surreal how countries learned to work together and help each other because of the simple need for collaboration to get out of the climate crisis we are in all together.

Driving through a forest on your way to work you smile and you are grateful for the people fighting for this ecological revolution – that is how some people call it and all the people that made the ideas reality to protect you from the crisis. You are grateful for them having made the right choice.

# Chapter Summaries

## 1. Cross-sectoral Policies

[Read the full chapter]

The climate crisis is in its complexity and scope an unprecedented challenge for humankind. It requires fundamental changes in all areas of the social, political and economic system, and this in the shortest possible time.
While the other chapters of the Climate Action Plan deal with solutions in specific emission sectors, this chapter takes care of all policies that are of great importance for several areas. For, just as the underlying problems are often rooted in different sectors, some solutions are useful for different sectors. The cross sectoral policies therefore cover a broad spectrum, ranging from taxes to financing instruments and sales platforms. Like this, the chapter aims to restructure the buildings sector and, at the same time, create a huge new workforce for the transition to net-zero in all other areas. It will drastically reduce consumerism and simultaneously create the basics for a more circular economy. And not only will it propose bold changes but also outline the instruments needed to finance them. What all cross sectoral policies have in common is that they take an across-the-board approach and propose particularly fundamental changes.

# 2. Mobility

[Read the full chapter]

## Ground Transport

Over the last decades, ground transport got faster and faster. On the one hand, people cover longer distances with no effort. On the other hand, energy use and the emission of GHG are enormous. Thus, in Switzerland, traffic accounts for 32% of all GHG emitted inland. The private car has shaped our landscapes, our communities and how and where we live and work. The immediate availability of goods by a mouse click is about to change our cities and the way we consume fundamentally. No step back in time, but a step towards mobility that serves people and saves the environment is desperately needed.

**Strategy:** The goal in ground transportation is a traffic revolution with a substantial reduction of the motorized traffic volume in Switzerland. The remaining vehicle fleet will be electrified or decarbonized. The use of sustainable means of transport (biking, walking, public transport) rather than individual motorized traffic will be highly encouraged by the policies concerning ground transport. Imagine fresh air (less pollution), healthy people (more activity), lively and green surroundings where people meet (more space for social interactions).

**Supporting policies:** The reallocation of existing infrastructure, referring to private motorized transportation, will enhance the traffic revolution. Moreover, the concept of smart multimodality will lower the barriers to switching from a private car to a joint system, to bike, foot or public transport. Thus, a close-mesh of carsharing offers and a hub-system has to be established. At multi-modal hubs the different means of transport are merged, in order to realize an efficient and convenient transfer. In order to break the vicious circle of road building and increase in road traffic, the financing of planning and extending the national road network will be suspended.

To reach net-zero by 2030, private motorized mobility must be reduced drastically. Hence, a steering levy will be introduced dependent on vehicle weight and driven distance per year. An adjustment of speed limit will be added to reduce the energy consumption of cars. On the other hand, climate conscious forms of mobility, such as infrastructure for pedestrians and bikes, will be supported and prioritized. Hence, biking to work will become safer, faster and due to the tax deductions more attractive. Cities will become car-free, giving more space and fresh air to people. By 2025 the sale of internal combustion engines is prohibited and by 2030 fossil fuels as well as fossil electricity will be reduced to zero. At the same time, gross vehicle weight and maximum power for passenger cars will be limited to 1.5 t and 100 kW.

## Aviation

Today people seem to know destinations abroad better than the beauty that lies in front of their door. Flying less, does not mean to stop the adventure. A new form of tourism has to be established that includes the way to the destination as part of the journey. Discovering foreign cultures will get even more exciting, whilst being rare and special. When it comes to business trips, a replacement by video-conferences does not only serve the environment but means less stress and more time for other things.

**Strategy:** Given that aviation is entirely reliant on fossil kerosene today, and there are no technological alternatives to liquid fuels, emissions reduction can be achieved in two ways: synthetic fuels generated from renewable energy or a reduction in aviation altogether. Replacing fossil kerosene with synthetic fuel is the most promising long-term path. Unfortunately, today's quantities of kerosene can most likely not be replaced with synthetic fuels before 2040, and even that would be a very ambitious project.
To reach the 2030 net-zero goal, and without relying on negative emissions or compensation, there is no alternative but to avoid all fossil kerosene by 2030 and therefore drastically reduce use of aviation. To avoid a hard cut and encourage synthetic fuels, we envision a quota system leading up to a ban of fossil kerosene by 2030.

**Supporting policies:** We propose additional policies to ease the transition and make it more socially fair and acceptable. The first is a dismantlement of any tax breaks and subsidies for aviation, such as tax-free kerosene. Flights that are easy to avoid, such as short-haul flights, private jet flights and other forms of luxury aviation should be banned. We consider specific instruments like a Frequent Flyer Tax and a maximum limit on aviation emissions. Further, non-CO2 heating factors must be compensated. Finally, we want to see active support for the modal shift from aviation to alternatives, however, it is important to only support the shift and not consumption itself. To complement these measures, we propose some general efficiency measures that could reduce emissions by a few percent on their own.

**Social impact:** This means that most jobs in the aviation industry will gradually disappear. Generally speaking, climate action means, that many industrial branches will disappear as new sustainable businesses appear. As the current economic system relies on growth and is ill equipped to deal with shrinking enterprises, this could mean that many workers lose their jobs and become unemployed. This is why governments need policies to support the workers caught in the transition to an economy compatible with the climate goals. Accompanying measures will be taken to support professional reintegration.

**Possible concerns:** One might worry that the proposed measures will simply cause people to take flights from airports in neighboring countries. However, we expect that other countries will also implement similar policies, and if not, Switzerland needs to lead by example. The same holds for economic disadvantage because of less flights in and out of Switzerland.

Another concern is that people instead will take their cars with internal combustion engines (ICE) to travel to other countries. This issue might be solved by supporting alternatives like high-quality train networks as well as by increasing the tax on gasoline and benzine.

## Waterborne Transport

Traffic is not only caused by bringing people from A to B. The transportation of goods takes up a big share in the traffic sector. Therefore, the way we consume and the journey our goods take plays a crucial role in the discussion about the mobility sector. By only focusing on inland traffic, we do not get the whole picture. Both travelling abroad and importing goods have to be included. Thus, water transport is looked at besides air and land transport, even if on the first glance it seems to be neglectable in a landlocked country like Switzerland.

**Strategy:** There should be a decrease of goods imported by ship, and the goods that are imported should follow ecological and social standards. Moreover, it is crucial that consumers have the possibility of taking well-funded buying decisions. And last but not least, the same rules that apply for private cars need to apply for private ships.

# 3. Buildings & Spatial Planning

[Read the full chapter]

In 2030 our vision of a climate-neutral future has brought people together and brought them closer. Moving closer together - which was initially unfamiliar to some and had to be learned again - has proven to be extremely enriching. This movement closer together does not only convey meaning in the face of the existential crisis situation and thus brings joy, but also changes the quality of how we meet. In the future our daily life will be much less marked by the often loud, ruthless, and rushed drive than it is today and rather be a life based on closeness, neighborly help, solidarity-based organization, and resilient local social relationships. The distances will be shorter, the exchange more meaningful. We will have learned to listen and to share needs. And we will be sharing much more: whether it is knowledge and skills in neighborhood organizations, whether it is a drill and a bike for carrying loads in sharing-centers and loan centers, whether it is experiences and deliciously smelling apple pies in the neighborhood café. Of course, we will not have been able to create an ideal world free of disputes, problems or contradictions, but one in which we work together to find innovative solutions, not only technically, but also socially, organizationally and culturally. Together, we will have created the conditions for a social coexistence that, in the energetic sense, favors a life that is frugal, i.e. "sufficient". Our buildings will have been converted to be climate-neutral, our cities will give us more space for staying, exchange, play and leisure on site and in the streets, which will have been more extensively greened to provide cooling. Our villages will have also rediscovered and developed their potential. They will actively contribute to our climate-neutral life, especially by taking advantage of the lower density - whether for the production of vegetables, fruit and food or the solar roof harvest. In many ways, we will have oriented ourselves on what many people have already successfully tried out: more solidarity and less competition. More joint action without suffocating in complete social control. We will have once again appropriated much of what was once left to anonymous markets: from solidarity-based agriculture to cooperative or non-profit housing - through which we will find an efficient, space-saving use of our living space - all the way to using traffic-calmed streets as common property, as our "living rooms" outdoors, which we will maintain together. All this will be liberating and beneficial. It is going to be a joy to be part of a human society - with our own competences.

In order to achieve this vision, the focus is on a number of key objectives in the field of buildings and spatial planning. With regard to buildings, the primary goal is to work with the existing building stock instead of continuing the previous growth. The retrofitting rates have to be increased significantly in order to make all buildings carbon-neutral. With regard to spatial development the potential of the existing space has to be activated in such a way that it enables a climate-neutral social life. Since a moratorium on new buildings is planned in the chapter on cross-sectoral policies, the goal of "climate justice" is also a big priority in the area of housing policy.

# 4. Industry & Service Sector

[Read the full chapter]

The industry sector causes emissions firstly due to the consumption of fossil fuels and secondly to industrial processes that emit CO2 and other greenhouse gases. The most fossil fuel intensive sectors are cement production, chemistry and food processing, which together account for over 90% of these emissions. Only in the case of high-temperature process heat (above 120 °C) is it currently not possible to replace all applications with renewable heating systems, as CO2 is sometimes indispensable for the process.
Most emissions related to industrial processes come from cement production and the consumption of hydrofluorocarbons for cooling and air conditioning units. Meanwhile, the service sector contributes mainly through heating emissions as well.
In the past few years, emissions in Swiss industry have fallen, mainly due to the outsourcing of CO-intensive activities. In other words, they have not really been reduced, but merely relocated.

The instruments that are currently trying to cover this sector are highly insufficient in their effectiveness. The Swiss Emission Trading System (ETS) has so far created hardly any incentives for emission reductions according to the Swiss Federal Audit Office. Also, the target agreements, with which major emitters can exempt themselves from the regular CO2-levy, do not lead to more emission reductions, but rather subsidize business-as-usual.


In order to become compatible with a climate-friendly and safe future, the industry and service sector need to take their responsibilities and decarbonize rapidly. We finally need to be able to consume the products and services we need without worrying that our consumption is fuelling the climate crisis. At the same time innovation of sustainable technologies and materials and their implementation must be promoted.
The transformation of this sector relies heavily on certain broader policy measures which are covered in other chapters of the CAP. The most important ones are the moratorium on new infrastructure, the

prohibition and replacement obligation on fossil heating systems, the general greenhouse gas pricing and the border carbon adjustment.

In addition to those, we propose seven sector-specific measures. Firstly, we propose a ban on the production, import and use of products using synthetic substances with a Global Warming Potential (GWP) > 50 (meaning they are 50 times more climate damaging than CO2). For applications that are not able to get clearance for new substances on a short term, such as medical applications, a levy of 500 CHF/t CO2eq is charged.
Secondly, all companies that produce additional direct emissions that are not already covered by the other sector policies have to develop and regularly update net-zero action plans to fully decarbonize. By 2030 all net-zero action plans need to be implemented, otherwise their operation license is revoked. For the implementation of uneconomic measures both financial and technical support for process and product innovation can be provided. At the same time, a Net-Zero Technology Program should help companies achieve measures which lack technical feasibility today. In order to achieve a quick diffusion and because the fight against the climate crisis must be a joint effort, patent protection of these new technologies will be limited.
Furthermore, the Swiss ETS is adjusted to be in line with the 2030 net-zero target. Beyond 2030 it will be transformed into an efficient market-based instrument to finance negative emissions technologies (see chapter on negative emissions) to neutralize the unavoidable residual emissions left for certain key materials and goods.

# 5. Energy Supply

[Read the full chapter]

It is foreseeable that the decarbonization of the energy system, even with consistent efficiency and sufficiency measures, will lead to an increase in electricity demand, for example through the transition to electromobility and the use of heat pumps to supply heat to buildings. Because almost every other country will face a similar situation in the coming years, our goal should be to cover our additional electricity demand entirely with domestic renewable energy (RE).

Assuming a decline in mileage due to efficiency and sufficiency measures in the mobility sector and an increased renovation rate in the building sector we expect an additional electricity demand of 32.3 TWh per year by 2030 which is an increase by almost 50% compared to today's electricity generation. Further expansion of renewable energy after 2030 will be necessary to phase out of nuclear energy.

Exhausting the full development potential for hydro energy and biomass as well as half the efficiency potential in power usage and a third of the wind power potential until 2030, 16.4 TWh remain to be covered by photovoltaics on roof areas, facades and other existing infrastructure.

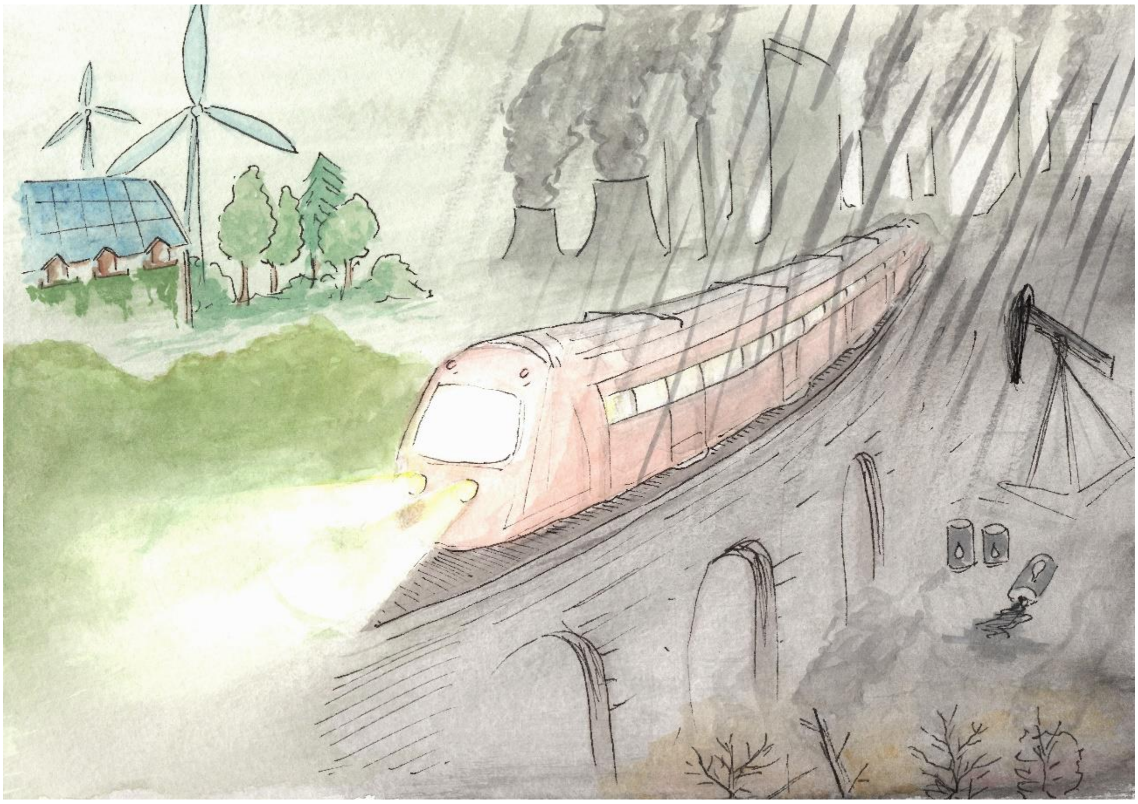
If no or insufficient measures are taken in the buildings and mobility sector, the demand to be covered will be correspondingly higher. However, even this demand can be met by domestic PV installations. Consequently, complete decarbonization is left solely as a matter of will rather than technological feasibility.
This also applies for storage (both short- and long-term), where the necessary technologies like different types of batteries, pumped and electrothermal storage, compressed air storage or power-to-gas, are already well known and applicable at scale. A forced expansion of PV systems in the mountains and wind power would further reduce the seasonal storage requirements.

By decarbonizing our energy system, we additionally make ourselves independent of oil and gas imports on which Switzerland has spent 252 billion over the last 40 years. In the future, this added value can remain at home and instead of flowing abroad can finance thousands of meaningful jobs in the renewable energy sector.

We propose a total of eight policy measures to foster renewable energy and storage capacity additions as well as to adapt the electricity tariff system to future production regimes. The centerpiece consists of a cantonal electricity certificate trading scheme. The scheme requires cantons to supply an annual quota of renewable electricity based on the canton's population size. Certificates can be traded between cantons that surpass their designated target and cantons that fail to do so. The scheme is a simple tool to incentivize cantons to scale up their renewable energy generation while offering them the flexibility to decide how to do so considering their different potentials and conditions.

Secondly, building owners - whether public or private - are obligated to build solar PV installations on their roofs within 10 years if their roofs are deemed suitable. The size of the installation needs to be adapted to the size of the roof not to own electricity needs. It thus accounts for the fact that we need to rapidly scale up the solar PV capacity to achieve the 2030 target and that the potential for rooftop solar PV installations is very high in Switzerland. The solar PV electricity generation is remunerated in a cost-covering way so that homeowners obligated to build a solar PV installation do not incur additional cost. The policy is financed through an increase on the existing consumer surcharge for renewable energies. Additional financing options (e.g. interest-free loans) may be provided by the cantons, the federal government or mandated finance institutes, such as cantonal banks, a green investment bank, or a climate fund.

These two policy measures are supported by six accompanying measures: Competitive auctions for power purchase agreements for large-scale RE installations, a simplified and shortened permitting process, a support program to train additional personnel, an abandonment of grid charges for storage technologies, an active promotion of open-space solar PV and a new electricity tariff structure.



# 6. Agriculture & Food System

[Read the full chapter]

Agriculture is a main emitter of greenhouse gases (6.08 Mt CO2eq per year., 15% of the total emissions of Switzerland) and thus a strong contributor to the current climate crisis. At the same time, agricultural production is highly vulnerable to climate change, particularly in the developing world. We see huge potential for Switzerland to render its agricultural production, food consumption and trade of agricultural commodities environmentally and socially more sustainable.

We envision a food system that can supply present and future generations of all people in Switzerland with enough healthy, nutritious and sustainably produced food while guaranteeing a high degree of food self-sufficiency.

## International Environment

The upsurge in international agricultural trade has turned tropical forests, pastures and meadows into croplands, threatens biodiversity and significantly increases carbon-intensive international transport. Switzerland strongly relies on agricultural imports, including palm oil and animal feedstuff. About the same amount of CO2eq produced in Switzerland is produced abroad for agricultural related imports. Additionally, Switzerland is both a hub for international agricultural commodity trade and home to many international agricultural corporations (headquarter or branch office in Switzerland).

Switzerland must necessarily be held accountable for any negative side effects its consumption patterns entail in the realm of environmental protection, human rights and labor standards abroad. The Swiss government should revise both planned and existing trade agreements that cover agricultural products so that they adhere to strict and enforceable environmental and social standards. Further there should be a ban on the production, usage and speculation of agrofuels majorly produced from edible crops and thus undermine global food security. Also, Swiss-based international agricultural corporations must democratically elaborate plans to outline how it intends to cut down its emissions and Swiss trading companies must legally commit to only buy and sell agricultural products whose production and distribution inflicts minimal possible damage upon the environment. Additionally, speculation with agricultural commodities and food needs to be banned.

## Consumption

What we consume, depends on different aspects. It depends among others on our knowledge about the product and its background, it depends on what is available at the food retailers and on the price of the product. To ensure a sustainable diet and reduce food waste we elaborated different measures that can change our consumption patterns. Among these measures are an adjustment of industry norms to have less food rejected even if its quality is high, food labelling and pricing according to the environmental impact of it, education measures, the support of sustainable alternatives for animal sourced food and a cross sectoral nutrition strategy developed by different departments within the Swiss government (FOPH, FOAG, FSVO and FOEN).

## Production

Over the past years, Swiss farmers have undertaken considerable efforts to comply with several challenging regulations that seek to render agricultural production more sustainable. However most environmental targets are not met and technical solutions currently available are insufficient to cope with the needed target. It is necessary to address environmentally and socially unsustainable domestic agricultural production structures.

It is particularly the livestock breeding (about 85% of all emission in Swiss agriculture), the abundant use of fertilizers and fossil fuels combustion that contribute to the climate crisis. The limitation of the livestock population to locally available feedstuff and limited imports of animal sourced food could reduce GHG emissions from food consumption in Switzerland by more than 50 percent and contribute to healthy diets. Ruminants should be fed from grasslands only and feedstuff imports should be abandoned. Cropland should be used to produce food directly edible by humans. Agricultural production should primarily be guided by the ecological framework conditions (climate, soil, feed no food, topography etc.) as well as the efficient production of sufficient and healthy nutrition to reach a high degree of food self-sufficiency.

Agricultural soils must be managed sustainably in order to assure a long-term production potential. Soil carbon must be preserved or enhanced. To further address the issue of overfertilization Swiss agricultural policy must enhance nutrient use efficiency, i.e. the amount of fertilizers applied should meet the plants´ demand for macro- and micro-nutrients. A national cap for synthetic fertilizer application in Switzerland (e.g. ammonium nitrate) would help realize this overarching objective. Finally, the standard mineral oil tax should be extended to agricultural machinery to mitigate CO2 emissions that are produced from the combustion of fossil fuels in agricultural production. Switzerland must also empower its farmers and agricultural workers both economically and legally. Jobs in agriculture must be amenable to the Swiss labor law. Consultancy and training in environmentally sustainable agricultural production and alternative income sources in agricultural zones should be promoted in order to support those farmers that embark on the envisioned transformation process of Switzerland´s agricultural sector and/or grapple with short- and medium-term loss of earnings caused thereby.

# 7. Negative Emissions

[Read the full chapter]

## Introduction

NETs (negative emission technologies) capture CO2 from the exhaust gases of processes that are difficult to substitute or extract CO2 from the atmosphere - this can be done purely technically or throughout plants. Many of these technologies are already being tested and used today. However, the resulting negative emissions are infinitesimal. Nevertheless, there are huge potentials for the safe final storage of CO2 - according to the IPCC report SR 1.5 certainly 2000 Gt, with current annual emissions of less than 40 Gt CO2. The safety of these deposits is assumed to be very high. The necessary technologies and reservoirs to remove CO2 in large quantities from the atmosphere already exist today.

Furthermore, the necessity of NETs is undisputed in order to limit global warming to the 1.5°C Celsius foreseen in the Paris Climate Convention. Thus, all 90 climate scenarios collected in the IPCC Report SR 1.5, which are compatible with the 1.5 degree target, require negative emissions on a large scale, with a start between 2020 - 2030. In addition, almost all current climate scenarios are based on the fact that massive amounts of CO2 will be removed from the atmosphere in the second half of the century in order to stabilize global warming.
Nevertheless, NETs do not allow "business as usual" under any circumstances, since CO2 removal and storage is expensive and energy-intensive - NETs should therefore be reserved for emissions that are difficult to avoid. Examples of such areas are aviation, agriculture and cement production. NETs are therefore not an alternative to reducing emissions, but a practically indispensable supplement.

## Technologies

This is a brief description of the seven NETs examined and their storage options, followed by an overview of the corresponding potential, costs and side effects (figure 2).

- **Direct Air Capture and Storage**
  With Direct Air Capture, CO2 is extracted from the ambient air by means of technical equipment. The CO2 thus extracted in Switzerland is safely stored (sequestered) in the earth's crust. Switzerland is expected to have a capacity of 2.68 Gt. The storage of CO2 in soil has been carried out for 40 years, so far about 0.26 Gt CO2. It is considered very safe.
- **Bioenergy Carbon Capture and Storage**
  By burning biomass (e.g. plant waste, wood residues, etc.), heat or electricity can be generated and the CO2 emitted from the exhaust gases can be stored in the ground, as with DACCS. This allows carbon to be removed from the carbon cycle and safely stored.
- **Carbon Capture and Storage in Industry**
  In industrial point sources such as waste incineration plants or cement production, CO2 can be filtered out in a targeted manner due to its high concentration and stored in the ground as with DACCS.
- **Enhanced Weathering**
  In the process of Enhanced Weathering, crushed mineral rocks are distributed on fields. By crushing the rock, it reacts more quickly with the CO2 bound in the rainwater - its natural

weathering process is thus accelerated. Washed into the sea via water, the CO2 is stored there as carbonate rock for a long time. This process thus also counteracts ocean acidification.

- **Reforestation, afforestation and enhanced usage of wood**
  Through reforestation, targeted planting of the forest and increased use of wood in buildings, up to 3 Mt CO2 can be stored annually.
- **Vegetable carbon**
  It is also possible to convert fast-growing plants, or waste from food production, into vegetable carbon under great heat and then store it in the soil. The waste heat can be used directly or converted into electricity.
- **Soil Carbon Sequestration**
  Changes in agricultural land use can also increase the carbon content of soils, which would also improve soil quality.

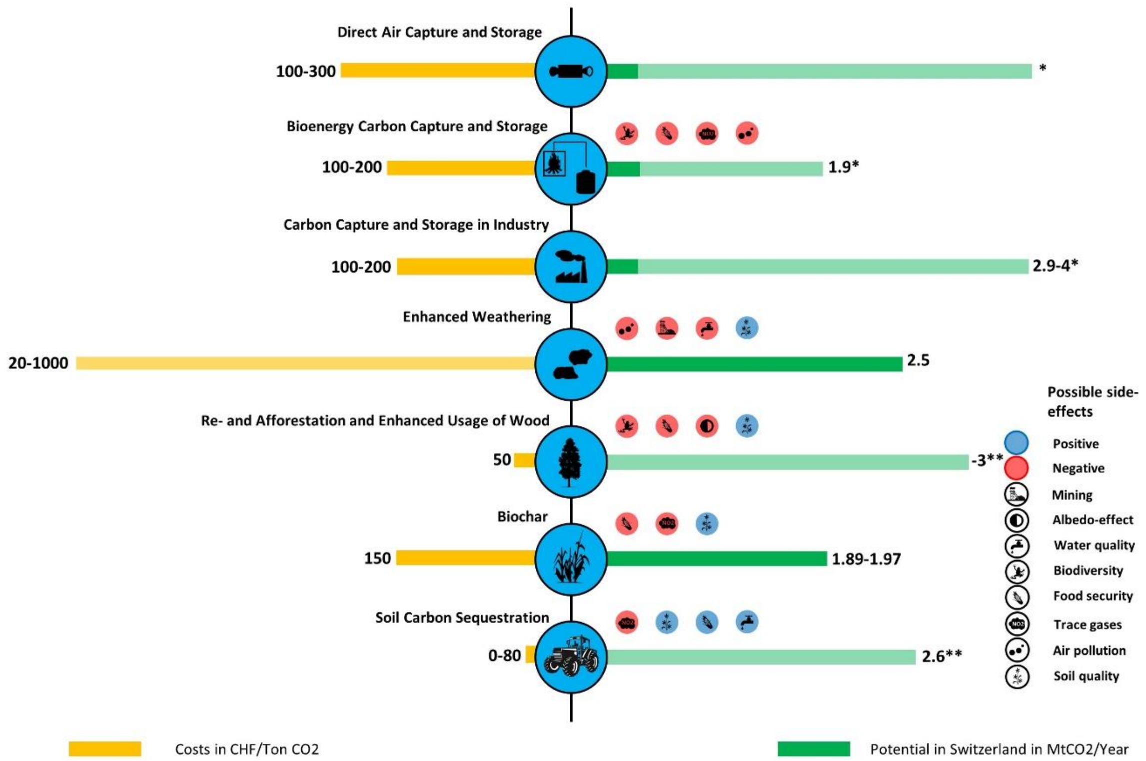



*Figure 0-2 Potential and costs of different NETs in Switzerland*

## Politics

Today the price for NETs is two to three times higher than in the overview above. However, due to the technological learning curve and the increased use, the price would decrease significantly. In order for NETs to enable net zero greenhouse gas emissions at the lowest possible cost in 2030, it is therefore essential that they are used, expanded and promoted now. Any further postponement of NETs places an additional burden on future generations and Switzerland would be less able to compensate more than its domestic emissions at the global level if this were necessary. However, since the emission of greenhouse gases into the atmosphere is currently practically free of charge, there is no economic incentive today to remove CO2 from the atmosphere. Accordingly, without determined political support, NETs will not be available quickly enough to have the required significant impact on Switzerland's CO2 balance.

# 8. Financial Sector

[Read the full chapter]

The Paris Climate Convention obliges countries to bring their financial flows into harmony with the objectives of the Paris Climate Convention. (Article 2.1.c of the Paris Convention).

Financial intermediaries help the oil industry to raise capital, which in turn helps it to remain profitable despite competition from renewable energies. Today, with the adoption of the Paris Climate Change Accord and thanks to alternative renewable energy sources, the fossil fuel business should not be as profitable in future - but it is valued and treated as such by financial intermediaries. This contrasts with the concern that many of these securities are stranded assets and that the global economy is heading for a carbon bubble. The market is not simply neutral. Risks are wrongly assessed by the financial market, because many financial institutions have not built up any expertise on the climate crisis internally and therefore assess risks related to fossil fuels too low. The opportunities offered by alternative investments are also misjudged. Many financial institutions have long denied their responsibility to the climate and society. Financial intermediaries are not only passive vessels through which money flows, they can actively control where the money goes and therefore have a great responsibility and obligation. Unfortunately, very few financial institutions do this.


The Swiss financial center, especially Zurich and Geneva, are among the most important in the world and Switzerland is one of the world's most important asset managers*. Our financial center therefore has particularly strong leverage in international climate policy and the global economy. This is an opportunity for Switzerland to reduce its foreign emissions and a duty to the world, because if we do not do so, the whole world will never be able to achieve the Paris targets. It is in keeping with the polluter-pays principle to demand action from the Swiss financial center and regulators now. Compared to the ECB, the comprehensive reforms of the EU regarding Sustainable Finance and the proactive measures of the Bank of England, Switzerland is the bottom line of Europe, especially with regards to the size and importance of its financial center.

When talking about Sustainable Finance, the credit side is often neglected in comparison to the investment side. A few big banks have many capital investments abroad, but smaller banks, such as cantonal banks, mainly grant loans in Switzerland. Here, too, banks are not only passive vessels through which money flows, they can also actively lend money. On the financing side in general, more focus on climate related risks can be done by domestic banks.

In summary, it can be said that the financial center has the power to drive forward the transition of our entire economy, both here in Switzerland and globally. And with great power comes great responsibility, as is well known.

The measures discussed in Chapter Finance use the following instruments:

**Divestment:** Capital is withdrawn from emission-intensive parts of the economy, such as oil companies.
**Investment:** Capital is directed specifically into climate-friendly sectors or companies that are necessary for the transition of the entire economy to a carbon-neutral economy.
**Engagement:** If CO2-intensive companies are not able to drive change internally, they will not be able to survive on the market in the long term. It is preferable that the management in these areas actively approaches the change on its own initiative. However, management is often reluctant to face the facts and develop new strategies. Shareholders can actively exercise their voting rights and influence to drive internal change in such parts of the economy.
**Transparency:** A major problem is the lack of transparency about the climate-damaging effects of financial flows or information about financial flows in general. Customers, both private and institutional, are not well informed and cannot make conscious decisions, even if they want to invest their money climate consciously. Such information and transparency provide the basis for informed customers to express their demand for sustainable financial products. This information also provides the basis for science, which can only make meaningful analyses in this way.

# 9. Economic and Political structures

[Read the full chapter]

The inherent logic to pursue profits – through the externalization of social and environmental costs - in a competitive global economy has led to a correlation between economic growth (that reflects profits) and GHG emissions (that reflect environmental externalities) at a global scale. Green growth suggests that we can continue growing the production of goods and services in a capitalist system while reducing environmental externalities of production. As discussed above, there are limits to this approach – due to the need to remain competitive and to generate profits, and due to the fact that even a service economy cannot be fully dematerialized. An alternative approach to green growth as a solution to the environmental crisis is the absolute reduction of the quantity of produced and consumed goods and services in a given period of time. This is usually called a degrowth economy, whereby degrowth entails the dematerialization of the economy through controlled shrinking of economic activities that require material inputs, such as fossil fuels, cement, metals and minerals, chemicals, rare earth elements, etc. Degrowth is impossible in capitalism as we know it, since capitalism is built on the pursuit of aggregate economic growth.
As Figure 0-3 shows, Swiss economic growth (expressed through the indicator GDP) has been substantial, while the Swiss CO2 emission footprint – expressed in consumption-based emissions – actually outstripped GDP growth. In other words, instead of decoupling economic growth from the GHG emission footprint ("green growth"), we see here a development that even outstrips recoupling. Consumption-based GHG emissions have grown faster than economic growth. In sum, we have seen neither green growth nor degrowth so far in Switzerland.

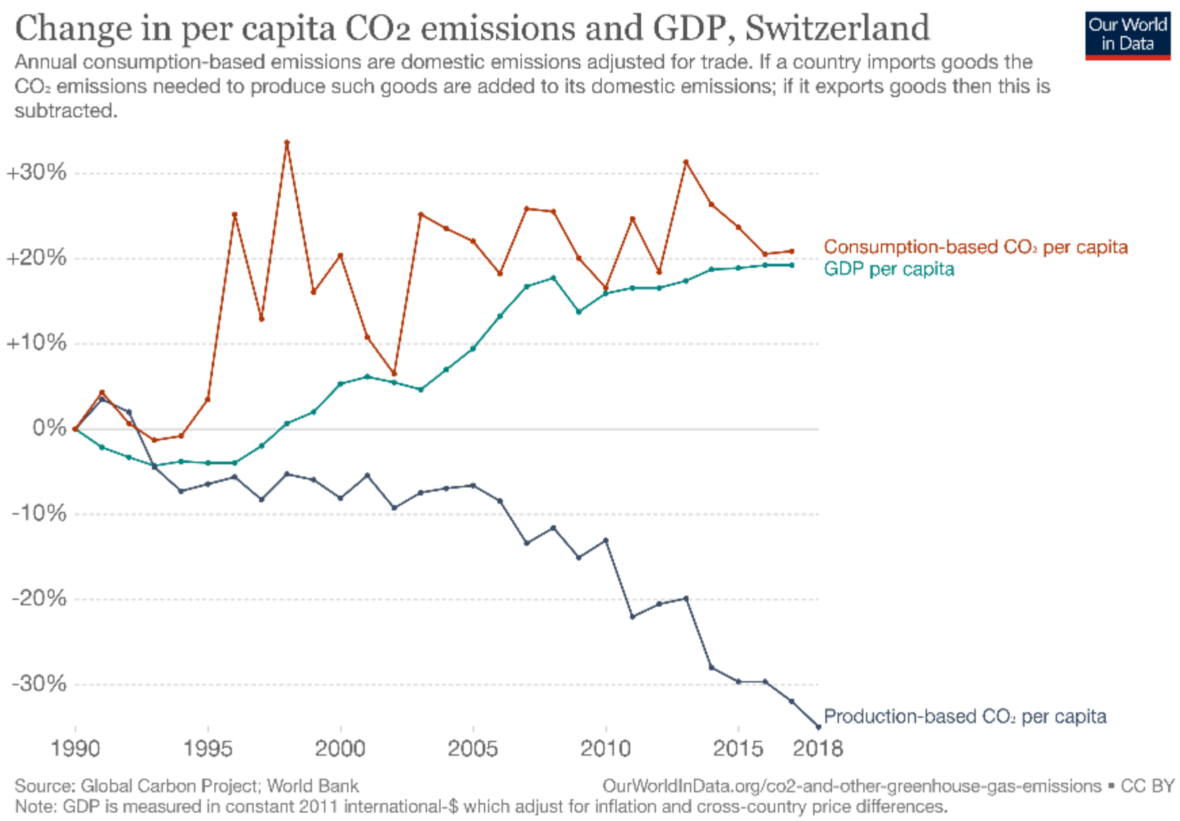



*Figure 0-3 Change in per capita CO2 emissions and GDP, Switzerland*

In the little time that we have to achieve net 0 GHG emissions by 2030 in order to remain within 1.5 degrees Celsius, the Swiss material economy (as measured with the GDP metric) would have to shrink in absolute terms so that the remaining carbon budget is not used up before 2030. The main challenge ahead is to dematerialize the economy by decoupling economic activities from the present and future welfare of people so as to stop growing our material throughput and consume less goods (most of which we do not need for our well-being), all without leading to an economic collapse. A set of regulations, including bans on certain goods, will be necessary to eliminate undesired economic activities at a large scale and quickly. Yet there are important political economic structures that would need to be overcome. Most importantly, an alternative is needed to offer people material well-being without the necessity to work in industries that fuel the climate crisis but fund state welfare and retirement programs through their productive activities. Only a labor that is liberated from the need to participate in the generation of perpetual economic growth can act as an agent of change towards a radical transformation of the economy to meet the 1.5°C climate target.

Several policies are needed to ensure a just transition towards a decarbonized economy. The Public Program for Green Jobs (ProGJ) is created to guarantee and support the establishment of new jobs in climate-friendly sectors such as the construction of renewable energy plants. It establishes support structures for workers in those sectors that need to be deconstructed such as the aviation industry. Furthermore, a network of local climate workshop in each municipality is founded. Their purpose is to provide equipment for loan, offer repair services and organize further training and courses. Climate workshops support households, municipalities, neighborhoods, special purpose associations, clubs, SMEs, etc. in ecological adaptation processes and in sustainable everyday life and habitat design. A good life within environmental boundaries requires additional measures. The working time is reduced to four days a week and 24 hours (six hours on four workdays) per week until 2030 to lower the economic material throughput, guarantee good jobs for all and to enjoy the common fruits of labor. A society not being based on economic growth and the accumulation of capital needs to drastically extend the care economy to guarantee employment. Furthermore, a 12 month long paid suspension for childcare per parent should be introduced.
A solid foundation for a non-growth-based society requires the conversion of shareholder owned companies into democratically run foundations and cooperatives. These are controlled by the employees, suppliers, customers and others being affected by the operations of the business.

The CAP must thus be built on more, not less, democracy. While capitalism has historically contributed to the climate crisis, democracy - if strengthened - can be an antidote to it. In short, we must reclaim our democracies, and make them fit for purpose for the immediate and immense challenge we face. An important challenge lies in overcoming the limits of a democratic framework that is based on elections and parliamentary representation. In such an arrangement, the influence of each individual is insignificant, whereas those who wield economic, social and cultural resources, have control over media and so on, are in a very strong position. Several measures make up the basis for widening societal democratic control. This includes a redefinition of property where private property of social relevance may only be used to the extent that it does not cause any damage to the general public, in particular with regard to environmental protection and climate warming, and private property of social relevance must be made available to the general public if this is necessary from a superordinate perspective (e.g. because of urgent ecological and social concerns). Furthermore, a tax on large assets over CHF 1 million is imposed and the abolition of the lump-sum taxation is put in place. The fundamental principle of democracy is the direct participation of all members of society. To guarantee democratic rights to all citizens of all origins and over the age of 14 is a necessity.

# 10. International Collaboration and Climate Finance

[Read the full chapter]

Switzerland accepts its global climate responsibility; Swiss (climate et al.) policy and action is based on science and Switzerland's (total / historic) climate impact. This implies the inclusion of consumption based GHG emissions, the investments and direct business operations in fossil fuel extraction projects, deforestation operations and other environmentally destructive projects.

Climate justice is the main guide for Switzerland's international climate policy. Climate justice means choosing a political approach to the climate crisis that meets ethical criteria, not only with regard to future generations, but also in the historical-geographical context: Some are responsible or profit, others feel the consequences or have to pay for them. It is therefore not acceptable to consider the dramatic consequences of global warming as a purely technical environmental problem. So climate justice as a concept includes not only the generational (justice) question but also global distribution and equality issues. This means that large emitters such as Switzerland must contribute much more to the global reduction of man-made greenhouse gases than the countries of the Global South who are responsible per capita for far fewer emissions.

In terms of climate financing, global climate justice means that the obligation of the industrialized countries under the Paris Climate Convention to jointly provide USD 100 billion per year for climate protection and adaptation measures in developing countries must be scaled down to Switzerland on the basis of global climate responsibility. This would result in a contribution of CHF 1 bn annually. However, climate finance must not be at the expense of development cooperation. Supporting the poorest and most vulnerable populations in the Global South in the fight against climate change is not the same as fighting poverty or reducing inequality. The reduction of greenhouse gases (mitigation) and protection against the effects of progressive climate change (adaptation) can complement development cooperation, but never replace it.
Currently, Switzerland and other countries in the Global North would like to offset their emissions abroad, mainly in the Global South. This, however, gives countries the false impression that they can continue to delay the elimination of their domestic GHG emissions. On the other hand, the effects of many offsetting projects are questionable or do violate human rights. GHG emissions shall therefore

not be externalized through purchasing of Internationally Transferred Mitigation Outcomes (ITMO) and/or compensation abroad.

Free trade agreements are a main contributor to the climate crisis through deforestation, the destruction of local agricultural practices and the violation of human rights. The application of climate justice needs to include the realm of trade agreements. The respect for human rights and international agreements on environmental protection take precedence over the provision of other international treaties, particularly trade agreements**.** In case of doubt, it suspends the application of provisions in trade agreements. Switzerland should also advocate for the adoption of this concept in international law.

While the CAP states that the Swiss GHG emissions need to be reduced to net-zero by 2030, a similar legally binding target needs to be adopted on the international stage. The goal of the Fossil Fuel Non-Proliferation Treaty is to phase out fossil fuels globally through a legally binding agreement. “Non-proliferation” refers to the prevention of exploitation of new fossil fuel resources. The FF-NPT is based on the existing example of the Non-Proliferation Treaty of nuclear weapons which was negotiated in the middle of the Cold War. The big difference to the Paris Agreement is it being legally binding with member states having the tool to impose economic sanctions on a party violating the treaty.

# 11. Education

[Read the full chapter]

The vision for climate education in Switzerland is to have a broad, fact-based debate on different pathways and specific solutions to the climate crisis. The public discussions should focus on how we want to create and live in a carbon-neutral world. Schools, media and government should make sure that reliable information is spread in an appropriate frequency and provide platforms for the debate. Thus, citizens will have an overview about the problems we have to tackle and what solutions exist, which is the basis for a constructive democratic process.

In order to reach this vision, adequate and relevant knowledge and competences are crucial. People must realize how climate change impacts their own life as well as the lives of their fellow human beings and their posterity. They must have the appropriate skills to actively and appropriately contribute to the societal task of reducing emissions. Lastly, they must also have developed the ability to actually apply their knowledge and skills. This is currently not the case. Despite numerous good initiatives and many committed actors, most people in Switzerland lack the knowledge, the competences and the attitude to make it possible to avert the impending severe climate crisis. Changes in our education institutions, means of educating the broad public and ways of bringing education into the industry will be needed.

## Role of Schools

A praxis-oriented climate education as a fixed part of all curricula and levels is needed, focusing on climate-relevant competences and climate education as a cross-sectional issue. To be able to teach about the climate crisis in all subjects, all teachers in practice have to take part at atraining program.

## Role of the Government

With an information campaign, the government and the FOEN are informing the population about the climate crisis and the need for action and explain how to solve the problem. The campaign is intended to make people understand that we need change if we want to maintain our quality of life in the future. It is intended to show the population in a positive way what the necessary changes mean for them, what enrichments they offer to the individual citizen and how much suffering can be prevented. In addition to general facts, the ability to act should also be conveyed. In its implementation, the confederation is guided by the findings of educational research.
In order to encourage action and participation of the citizens, the government should initiate local climate education projects open to the public. The aim is to reach people outside of the education system. There are already existing platforms which can be used to initiate education projects like local commissions or NGOs. Also, “Climate Assemblies” could be used as a platform to inform people about these kinds of projects. Numerous other organizations are already specialized in climate education. Their services can be used for these projects. The state should support these structures.

People should not only be exclusively educated in schools and through public services. Education needs to play an important role in the industry and the business world as well, as these environments offer the possibility to efficiently reach a big share of the population. To reach employees on all levels an environmental training should be held. This training will be practically based and connected to the employee's field of work. Its goal is to raise the employee's awareness of the influence of their firm on the climate and motivate them to take action.

## Role of the Media

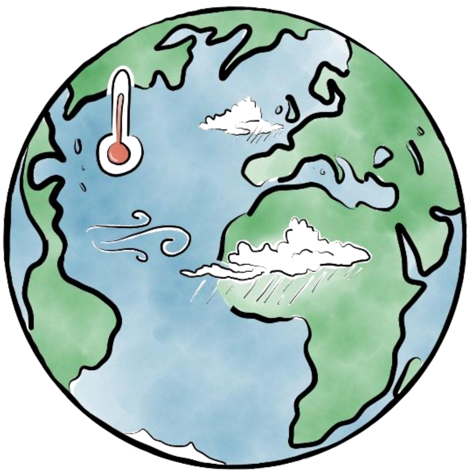
As the informal fourth power, the media can help to avert a climate catastrophe by making their contributions scientifically sound and appropriate to the problem. The treatment of the topic should not be reactively oriented towards sensational individual events, but should be constructively involved in the political process through a debate on ways out of the crisis.

# 12. Adaptation

[Read the full chapter]

We need to adapt to the changing climate. We have to do take adaptation measures and mitigation measures to make sure that we stay below 1.5°C. This will have significant consequences for our complete society. Adaptation will define the level of impact and risks we will sense in Switzerland and elsewhere. Adaptation is a process of transformation, reflecting that the current status quo will not secure a sustainable future, especially as we lack a sufficient progress to mitigate the causes of anthropogenic climate change. Transformational change means that we have to understand how our system works, to understand the history of that system, in particular around sources of control, legitimacy and knowledge, and challenge the assumptions that underpin existing structures and ways of doing things. Reproducing "solutions" without assessing what holds the current system in place may result in simply reinforcing existing failures and inequalities.

Adaptation to climate change is a complex and multi-dimensional process which involves many actors and is happening on a very local level. In times of crisis, the most marginalized people in society tend to suffer the most. It is somewhat different from mitigation in this respect. There are larger risks posed by climate change where even experts are unsure what the exact outcome will be. Damage to roads and railways caused by global heating, and the consequences for hydro- and nuclear power plants, could cost up to CHF 1 billion a year. Mountain regions will probably face problems with water management in agriculture and winter tourism. Water reservoirs for artificial snowmaking, agriculture and hydroelectric power plants could not be filled sufficiently anymore by melting snow. Swiss climate adaptation policy must account for individuals and the sectors most affected by climate change. In addition to the project of the Federal Office for the Environment, that we present in our chapter, we focus our policies on certain vulnerable groups and regions in Switzerland that will suffer earlier from climate change and have limited adaptive capacities. It is our aim that people who are negatively impacted by the changes do not have to bear adaptation costs themselves and get adaptive tools to cope with future situations.



1. **Health: focus on prevention**. Build safe infrastructure for extreme weather events e.g. by building enough green cooling places in cities to prevent heat-stress and consider climatic changes in all future urban planning. Monitor vector-borne diseases and thus enable us to discover epidemics early enough. Build cleaner energy systems and promote safe public transportation and active movement – such as cycling or walking as alternatives to using private motorized vehicles – that reduce carbon emissions, cut the burden of household air pollution and create an incentive to physically exercise.
2. **Health: build resilience**. Build resilience through enhancement of social capital. This involves the organization of a network of resources and strengthening of social linkages that can help to reduce vulnerability and increase community resilience for facing climate related physical and mental health issues
3. **Health: invest in the health system**. Care jobs are green jobs. A green job contributes to preserving or enhancing the well-being, culture, and governance of both current and future generations. Caretaking as it is practiced in hospitals or retirement houses for example requires fewer resources and $CO_2eq$ emissions tend to be lower compared to sectors involved in the production or distribution of goods.
4. **Mountain regions: find alternatives to winter tourism**. No further subsidies for short-term business models that fail to take into account environmental sustainability. Subsidies should have the goal of helping ski regions diversify their offerings towards whole year solutions to make them more resilient to temperature rises. This can be achieved through measures which really evaluate the social and environmental impact of a project.
5. **Migration: protection**. Legal advice, guidance and the development of norms to support the enhanced protection of the rights of people displaced in the context of climate change related disasters.

# Policy Measures

The Climate Action Plan contains very different policy instruments: subsidies, directives, prohibitions, investments, trade systems, levies, quotas, information and education. Compared to other measures, bans and regulations are often received much more critically and politicians are usually afraid to demand them. Therefore, we would like to briefly discuss those here in more detail and explain why we consider them to be justified and necessary and not at all a restriction of liberty.

True liberty does not mean that one can simply do whatever they want, but that one is free in their actions as long as they do not restrict the liberty of someone else. Or figuratively represented: One's freedom to swing one's fist stops where another's nose starts. Our personal right to freedom does not guarantee freedom at the expense of others.
Due to the climate crisis, hundreds of millions will lose their homes and be forced to flee, water shortages and resource wars will threaten, and by the end of the century, millions of people will lose their lives every year due to higher temperatures. So, the claim to freedom for a big, heavy car simply must wait in line. After all, not prohibiting something that destroys liberties to this extent is not liberal. It is also prohibited to drive at 150 km/h over a village road, because this would pose an unnecessary risk to human life. It is natural that rights come along with obligations and to ensure the right to life we are obliged not to endanger it.
Our everyday life is characterized by countless such regulations, which make a functioning coexistence possible in the first place. Without them our society would collapse. The climate catastrophe threatens to lead exactly to such a collapse, which is why fossil fuels and fossil infrastructure must be banned.

If politicians had listened to science 30 years ago, a catastrophic warming of more than 1.5 °C could perhaps have been avoided with less drastic measures. But today it is simply too late to ask for a gentle and gradual decarbonization.
Bans are also more honest than other measures by writing down the necessary end of the fossil age in legal paragraphs. They speak a clear language: zero emissions, not just less emissions.

# Table of Policies

| Chapter 1: Cross Sectoral Policies | |
|---|---|
| Policy 1.1: Moratorium on new infrastructure until 2030 | No new conventional buildings and no new transport infrastructure would be built from 2021 to 2030. Planning and construction permits would be limited to retrofitting and renovating existing infrastructure and buildings. Exceptions could be made for: Infrastructure that is net positive (reduces more GHG than it emits during production), produces renewable energy (e.g. wind turbines), is helping decarbonize the mobility sector (e.g. bike lanes), produces vital new technologies for the transformation (e.g. batteries), represents urgently needed public infrastructure (e.g. schools). |
| Policy 1.2: Greenhouse Gas Pricing | Putting a price on CO2 and other greenhouse gases (GHG) makes harmful activities more expensive and implements the "polluter pays"-principle and ensures true costs. The policy applies to all main greenhouse gases and all actors (including all companies). It should range from CHF 150-200 in 2021 and gradually increase annually by CHF 45 to reach CHF 525 in 2030. |
| Policy 1.3: Border carbon adjustment for a level playing field | To prevent leakage of emissions through outsourcing of carbon-intensive production, a BCA applies the same GHG-levy for imports as for domestic products. The BCA will lead to less consumption of GHG intensive products and reduce distortions. |
| Policy 1.4: "Matterhorn" The net-zero purchasing platform for public purchasing | Public purchasing (6% of Swiss GDP) must be limited to net-zero goods. A purchasing platform must be developed to give direct and competitive access to producers and sellers of net-zero products. The steep slope of the Matterhorn symbolizes the rapid exit envisioned by the CAP and Paris agreement. |
| Policy 1.5: Warranty periods against planned obsolescence | The legal warranty periods should be specifically oriented per product to the technically possible lifespan. For individual components subject to high wear and tear, the warranty periods are to be defined separately and spare parts are to be ensured in the long term beyond the product warranty period. |
| Policy 1.6: Climate impact assessments | Switzerland is establishing a climate and environmental impact assessment for all products and services. Part of these climate impact assessments should be all Scope 3 impacts. The information about the products and calculation of the scores should be in an open-database accessible by everybody to allow everyone transparent access. |
| Policy 1.7: Climate impact label | Based on the climate impact assessment, a climate impact label should become mandatory for all non-food-products (see chapter on agriculture) in Switzerland. This give consumers transparency and helps them to make well informed shopping choices as well as incentivize producers to lower their climate impact. |
| Policy 1.8: Replace commercial Advertising with Art and Education | To reduce consumption of climate damaging products and reduce unnecessary consumption in general, commercial advertising is banned from all public physical spaces. Instead the freed-up space should be used for art and education. |
| Policy 1.9: Climate Bank and Climate Agencies | For the transition of our infrastructure (housing, mobility, energy etc.) funding in large scales is needed. A climate bank would lend credits (dept capital) to so called climate agencies to enable these large-scale infrastructural projects. Climate agencies are e.g. architects, solar panel companies, etc. that are able to realize these infrastructural projects. A lot of the time the expertise and technology already exists but due to a lack of funding and demand, projects at the needed scale cannot be realized. This demand (e.g. for the replacement of oil heating systems) will go up rapidly and so will the needed funding. The money provided would be cheap debt capital that is offered to companies with affordable interest rates, since a public climate bank would not be profit-oriented. |
| **Chapter 2: Mobility** | |
| Ground Transport | |
| Policy 2.1: Re-Prioritization of the traffic system | The constitution (Art. 88) should ensure that there is a re-prioritization in planning for the traffic carriers as following: 1. pedestrians, 2. bike, 3. public transport, 4. rail, 5. road, 6. air. It is crucial to have a network of safe, fast and direct connections on all levels for both pedestrians and cyclists. |

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| Policy 2.2: Reallocation of existing infrastructure | Reallocating 50 percent of the existing infrastructure for private cars in public spaces to pedestrians, cyclists, public transport and car sharing until 2030, should lead to a traffic revolution and a higher quality of life. |
| Policy 2.3: Introduction of a new smart multimodality for people and cargo | The introduction of a hub-system all over Switzerland and a close-mesh of car- and bike-sharing offers can lower the barriers to switch from the private car to a way of combining different means of transport in the best way possible. |
| Policy 2.4: Carfree cities | From 2025 all major cities in Switzerland are car-free with only few exceptions. The already existing offer of public transport in the city and the proximity of everything allows it to cover all mobility needs by foot, bike and public transportation. The distribution of goods will largely be handled by cargo bikes. |
| Policy 2.5: Suspension of federal road construction | A suspension of federal road construction leads directly to a decrease in GHG emissions through less construction, avoids growth of supply driven traffic, leads to a switch to more climate-friendly forms of traffic in the long run and stops further soil sealing and the loss of green space. |
| Policy 2.6: Prohibition on the sale of fossil vehicle fuel and fossil electricity | The sale of fossil vehicle fuels and fossil electricity will be prohibited by 2030. This assures that only renewable energy will be used in mobility and provides an additional incentive for people to avoid purchasing new internal combustion engines (ICE) vehicles prior to 2025. |
| Policy 2.7: Prohibition on the sale of new internal combustion engine vehicles | It will be prohibited to sell new light vehicles (< 3.5t) with ICE by 2025. Heavy vehicles with ICE will be banned by 2030, supported by an interim quota system starting in 2025. |
| Policy 2.8: Prohibition of heavy and overpowered passenger cars | Reduce the number of large SUVs and overpowered passenger cars by limiting curb weight and maximum power to values of 1.5 t and 100 kW. |
| Policy 2.9: Environmental steering levy and road-use tax | A road-use tax will be levied individually, based on vehicle weight and kilometers driven to compensate for the shortfall in revenues from taxes on gasoline and diesel fuel with the switch to electric mobility. |
| Policy 2.10: Decrease the number of home delivery services and shifting to bikes | In order to limit the number of delivery vehicles and encourage group distributions, we suggest applying LSVA and PSVA not only to heavy vehicles but to all motorized delivery vehicles and introducing a fixed delivery tax of 15 CHF for each consignment (delivery by bike excluded). |
| Policy 2.11: Limitation of commuter deduction | A reduction of the commuter deduction coupled with a faveolization of foot, bike and public transport. |
| Policy 2.12: Reduction of maximum speed | The faster one drives, the more energy is consumed per kilometer. A reduction of maximum speed is as immediate and as cheap as no other measure. |
| Policy 2.13: Introduction of a monthly carfree-day | One car-free day per month, breaks up mobility-routines and allows people to explore other forms of mobility. The direct influence of this on overall CO2-emissions is low. Instead it aims at changing people's mindsets. |
| Waterborne Transport | |
| Policy 2.14: Stop the expansion of the Rheinhäfen in Basel | The expansion of the trimodal port basin 3 in Basel-City should not be pursued further. A climate-neutral society is not compatible with an increase in transshipment of fossil fuels, ores, stones, earths and consumer goods, which make up for 86% of the goods handled there. |
| Policy 2.15: Introduction of Standards for Shipping Imports | Introduction of clear environmental and social standards for goods imported by ship. |
| Policy 2.16: Regulating Motorized Boats and Ships for Private, Public and Commercial Use | Analogous to cars, the same steering levy will be charged, the sale of new internal combustion engines will be prohibited from 2025 and fossil fuel banned by 2030. |
| Policy 2.17: Cap on Tons of Imported in Switzerland | The quantity of imported products, most of them being transported overseas, increased dramatically. The goal of this policy is to reduce the quantity of imported goods and therefore emissions and overconsumption. |

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| Policy 2.18: Imposing Standards for Ships belonging to Swiss Companies | Unethical and environmental damaging practices in shipping will be banned as far as possible from shipping companies based in Switzerland. |
| Aviation | |
| Policy 2.19: No Subsidies and Tax Breaks for Aviation | Today, there is a general VAT exemption for international flights and for most aviation-related services, aviation fuels are exempt from the petroleum tax and the CO2-levy and many airfields are financed with state funds. All such tax exemptions and subsidies must be cut immediately. |
| Policy 2.20: Alternative Fuel - Synthetic Fuel from Renewable Energy | Beginning in 2025, 10% of aviation fuel put into planes in Switzerland needs to be synthetic and produced by renewable energy. This quota will scale 25% a year to 100% by 2030. |
| Policy 2.21: Aviation Taxation / Frequent Flyers Levy | This policy taxes tons of CO2eq progressively, over a 4-year period. The purpose is to discourage frequent-flyers and generate revenues for research on synthetic fuel production or financing of other climate friendly ways of transportation. |
| Policy 2.22: Emissions Cap | This policy sets an absolute cap on emissions for the aviation sector and is thus the most direct measure to ensure emissions reduction. |
| Policy 2.23: Ban short-haul flights | In 2018, 77% of air passengers had destinations in Europe. We propose an immediate ban of domestic flights and all flights reachable within 8h with alternatives such as public transport. This radius would increase to 24h by 2030. |
| Policy 2.24: Ban private jets and other forms of luxury aviation | An average private jet journey emits times as much GHG as the same journey made by an economy class flight, and roughly 150 times more than an equivalent high-speed train journey. Therefore, we demand an immediate ban on private jets as well as unnecessary luxury aviation such as taxi-flights or heli-skiing. |
| Policy 2.25: Compensating other climate change effects besides CO2 | High-altitude combustion does not just emit CO2 but also short-lived GHG, such as water vapor and particulates from jet exhausts. To ensure a net-zero goal, also the non-CO2 emissions must be compensated with negative emissions starting from 2030 in line with the polluter-pays principle. |
| Policy 2.26: General Efficiency Measures | There are many small improvements to reduce fuel usage such as electric taxiing, blended winglets and open rotor engines, better launch and arrival scheduling, reducing cabin weight, or optimal flight level and speed. |
| Policy 2.27: Support for people affected by the decline in aviation | Depending on the amount of synthetic kerosene available by 2030, the sector may experience a reduction of 90%. It is therefore crucial to make retraining available and provide financial aid to compensate for lost salaries. We also expect some effect on the tourism industry, both domestic and globally which requires accompanying measures. |
| Policy 2.28: Support for Alternatives to Aviation | A convenient public transportation and train system should be put in place to effectively connect major destinations by developing new night train rides, new railways, improving booking websites and improving bus networks. |
| **Chapter 3: Buildings and Spatial Development** | |
| Buildings | |
| Policy 3.1: Ban and replacement obligation for fossil and electric heating systems | It is crucial to cut emissions by heating systems fast. A regulatory, legal requirement is needed. New fossil powered and direct electric heating systems are banned. A replacement obligation is introduced to make sure all existing ones are replaced in time. |
| Policy 3.2: Climate Fund | In order to significantly increase the total available funding volume for energy-efficient building retrofitting compared to today, a climate fund will be established. This is similar to the existing building program in Switzerland but will be supplemented by a few points (such as higher subsidy rates or a hardship clause). |
| Policy 3.3: Promotion of bio-based building materials | To promote production, supply chain and usage of bio-based construction materials, any new construction project in Switzerland must contain at least 50% wood or other organic materials like hemp or straw by 2022. This will lead to a downscaling of cement, steel, aggregate, limestone, and iron ore mining and production and also has a significant potential to store negative emissions. |

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| Policy 3.4: Net-Zero compatibility of existing laws and building regulations | Building laws must be adapted at national, cantonal and municipal level to ensure building and retrofitting with climate-friendly and sustainable technologies and materials. In order to work out which regulations need to be adapted expert commissions should draw up proposals. |
| Policy 3.5: One-stop-shop advice centers | In order to facilitate the conversion to climate-compatible buildings, independent one-stop-shop advice centers must be set up for those wishing to retrofit, with information on technologies, measures, procedures, costs, financing and subsidies. Such advice centers must be set up in all cantons and larger cities, and where they already exist, they must be more strongly oriented towards climate compatibility. |
| Policy 3.6: Renovation incentives in rented buildings | In order to promote energy-efficient renovations that are not required by law and at the same time protect tenants against excessive energy costs, corrections must be made to the extent to which energy costs are passed on to tenants. These may include, for instance, higher subsidies, the right to rent reductions in the event of failure to retrofit, or more transparency regarding the energy related quality of the apartment. |
| Policy 3.7: Digital material archive and component market to support circular material cycles | In order to promote carbon-neutral and carbon-storing construction, instruments are needed that enable circular material cycles, i.e. the complete reuse of construction components and materials. For this purpose, construction components and materials exchange as well as a national construction components archive (linking the exchanges and providing an overview) will be established. |
| Spatial Development | |
| Policy 3.8: Soil index points for a transparent trade-off between soil protection and infrastructure development | The instrument of soil index points is implemented which classifies the soil by its quality based on certain criteria. This will ensure that new infrastructures are built primarily on low-quality or already degraded soils and high-quality soils stay available for the local production of low-carbon and renewable goods. |
| Policy 3.9: Implementation of Climate Impact Assessments for Planning, Projects & Stock Development | All current and future spatial planning projects must be proven compatible with the goal of net zero by 2030. This is achieved by using climate impact assessments. The same applies to significant structural developments within the framework of existing planning law. In this way, the climate impact of construction decisions is brought to the attention of decision makers and the public. |
| Policy 3.10: Creating frameworks for development processes towards climate neutral cities and communities | Municipalities provide the necessary resources for social initiation, local negotiations and design processes (rooms, material, possible information channels, possible remuneration, etc.). The aim is to implement climate-neutral cities, municipalities, communities, neighborhoods and public spaces. |
| Policy 3.11: Creating frameworks for walkable and livable “cities of short distances” | Municipalities and private individuals contribute to the "city of short distances" by creating suitable conditions on three levels: spatial planning (availability of land), infrastructure (attractive networks of footpaths) and supply (promotion of a variety of local services). |
| Policy 3.12: Designing development processes to develop the potentials of periurban and rural spaces | The transformation to a climate-neutral society must also include peri-urban and rural communities. Peri-urban and rural communities start community development processes, with the special focus on of climate neutrality and their specific spatial conditions. |
| Policy 3.13: Compensating the unequal workplace-share to create regions of short distances | The ratio of jobs to inhabitants or of employees to the working population is currently very unbalanced in large cities. The abundance of jobs in the city centers leads to a lot of commuter traffic. In order to rebalance this ratio, the large cities must impose a stop on the establishment of new jobs in city centers. |
| Policy 3.14: Establishing housing-policies to enable a “just transition” | Packages of measures are needed to prevent "low-carbon" gentrification. This includes the promotion of cost rent, a tenant protection clause, cost transparency for rents or regulations to curb unjustified rent increases. |
| **Chapter 4: Industry and Service Sector** | |

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| Policy 4.1: Ban on technical gases with high radiative forcing | An immediate ban on production, import and use of new products and equipment using synthetic substances with a Global Warming Potential (GWP) > 50 (100-year time horizon). A levy of 500 CHF/t CO2eq is charged for non-substitutable applications (e.g. medical applications). To avoid emissions of already installed F-gases a designated entity buys them a price of e.g. 200 CHF/t CO2eq and burns them for free. |
| Policy 4.2: From Emission Trading Scheme to CCS Financing Instrument | The emission-cap of today's Emission Trading Scheme (ETS) needs to be adjusted to the net zero 2030. After the cap reaches zero in 2030 the ETS would evolve into a market for negative emissions for any residual emissions. |
| Policy 4.3: Regulations for the Swiss Commodity Trade | From 2025 onwards, companies based in Switzerland will be prohibited from extracting fossil fuels, promoting them or providing financial, administrative or technical support for their production. |
| Policy 4.4: Net-zero action plans for all producing entities | All companies that produce additional direct emissions that are not already covered by the other sector policies have to develop and regularly update net-zero action plans to fully decarbonize by 2030. There exist 3 categories for measures: a) economically viable, b) technically feasibly but uneconomic and c) lack of technical feasibility. |
| Policy 4.5: Implementation of all net-zero ready and viable measures incentivized with early adopter bonus | By 2030 all type a) measures need to be implemented. Otherwise the company's operation license is revoked. To speed up the implementation companies get an early mover bonus. |
| Policy 4.6: Support to implement net-zero ready but uneconomic measures | For the implementation of type b) measures, a specialized entity provides both financial and technical support for process and product innovation in order to bring down the costs. |
| Policy 4.7: Net-zero Technology program | In order to implement net-zero plans, the creation of new technologies is required. Companies that depend on the development of type c) measures will be screened for their long-term prospects and then supported to become early implementers of these new technologies. |
| **Chapter 5: Energy Supply & Energy Security** | |
| Policy 5.1: Cantonal electricity certificate trading system | The trading scheme requires cantons to supply an annual quota of renewable electricity. Certificates can be traded between cantons that surpass their designated target and cantons that fail to do so. The scheme is a simple tool to incentivize cantons to scale up their renewable energy generation while offering them the flexibility to decide how to do so. |
| Policy 5.2: Solar Obligation for suitable Roofs | Building owners are obligated to build a solar PV installation if their roofs are deemed suitable. Electricity generation is remunerated in a cost-covering way so that homeowners do not incur additional cost. |
| Policy 5.3: Auctions for PPAs for large-scale RE installations | Competitive auctions for power purchase agreements for large-scale renewable energy installations are held. Offering project developers fixed and stable minimum remuneration for the generated electricity will substantially reduce investment risks and thus attract additional investments in the domestic renewable energy market. |
| Policy 5.4: Simplified permitting process | Permitting processes for renewable energy installations need to be shortened and simplified to reduce waiting times and risks. |
| Policy 5.5: Support program to train RE personnel | Additional personnel for the planning (2500 jobs) and mounting (17000 jobs) of renewable energy installations will be needed to scale up renewable energy capacity additions at the required rate. At the same time this measure compensates for jobs lost in GHG-intensive industries during the transition. Additionally, military personnel could be deployed for the lower skilled job of mounting for short-term scale-up. |
| Policy 5.6: Abatement of grid charges for all storage technologies | The grid charges which still exist for most storage technologies are abandoned. The responsibility for grid stability and thus to invest in enough storage capacity is entirely placed on the grid operators who can pass on the incurred cost to the end consumers. |
| Policy 5.7: Support open-space solar PV | The cantons examine where open-space solar PV installations may make sense and adapt the Spatial Planning Act accordingly. |

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| Policy 5.8: New structure of electricity tariffs | The current electricity tariff scheme with high and low rates will be abandoned for a more flexible market-based tariff structure reflecting the future production regime which will incorporate more intermittent renewable energy generation. We envision a tariff scheme with hourly electricity tariffs and capacity-based or network level-based grid charges to incentivize the consumption of locally generated electricity at peak production hours. |
| **Chapter 6: Agriculture and Food System** | |
| Policy 6.1: Free trade Agreements | Swiss government must revise both planned and existing trade agreements that cover agricultural products so that they adhere to strict and enforceable environmental and social standards. New trade agreements for agricultural products should be reduced to a minimum and may only be concluded if they contain an environmental and human rights compatibility statement. |
| Policy 6.2: Ban for growing, using and trading agrofuels by 2023 | The Swiss government must ban the production, usage and speculation of agrofuels altogether from 2023 onwards. |
| Policy 6.3: International agricultural corporations in Switzerland | These Swiss-based players must change fundamentally to render global agricultural production more sustainable. To this end, the Swiss government must democratically establish enforceable and binding frameworks and rules on climate mitigation by the end of 2021 for these companies. These plans must necessarily encompass the following aspects: Calculation of their GHG Emissions, detailed and consecutive GHG reduction plans and transparency. |
| Policy 6.4: International trade with food in Switzerland | The trade with agricultural products in Switzerland must adhere to strict environmental standards which align with the ambitions of the Paris Agreement. Swiss trading companies must legally commit to only buy and sell agricultural products whose production and distribution inflicts minimal possible damage upon the environment. |
| Policy 6.5: Ban for Speculation with agricultural commodities and food | By the end of 2021 the Swiss government must thus ban all institutional investors and investment funds from the agricultural commodity market. Banks, pension funds and hedge funds may no longer retail financial products based on food commodities accordingly. |
| Policy 6.6: Cross-Sectoral Nutrition Strategy | The federal departments BAG, BLW, BLV and BAFU must work together on a cross-sectoral nutrition strategy. This strategy should guarantee both a healthy but also environmental- and climate friendly diet. Issues like reducing the meat and milk consumption are working for both, the environmental and the health aspect and need to be planned together with the auteurs active in agriculture. |
| Policy 6.7: Sustainable diet in public canteens | Public canteens should have 60% vegetarian or vegan meals by 2025 and 100% by 2030. The food must be seasonal and as local as possible. |
| Policy 6.8: Training courses for professional chiefs | Training courses about sustainable nutrition lasting several days should be obligatory for all professional chiefs and gastronomy-managers. |
| Policy 6.9: Support sustainable alternatives in proceeding sector and retailer | Milk and meat proceeding industries should be supported in proceeding with more and more other foods with similar or different techniques and adapt the development of their products to sustainable food.<br>An independent political consulting institution for retailers should provide comprehensive information about the environmental impact of food and climate friendly alternatives. Grocers should be encouraged to change the food assortment towards a more sustainable diet. |
| Policy 6.10: No subsidies for animal sourced food publicity | The public financing of sales promotion for ASF needs to stop immediately. Instead, this budget should be invested in the elaboration and improvement process of the national nutrition strategy. |
| Policy 6.11: Food, labelling and pricing with climate impact assessment | We need an accurate and transparent assessment of the climate impact of food. Such a labelling should in a first step be implemented for all food products and could further serve as a basis for a pricing policy. |
| Policy 6.12: Taxes on animal sourced food | We suggest higher tax rates on animal sourced food to reflect the true cost on the environment and society. ASF should be excluded from the reduced value-added tax. Possible measures are: higher tax, which will rise each year if a specific GHG aim is not reached. Taxing food concerning its average emission and the introduction of meat certificates. |

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| Policy 6.13: Educate and raise awareness on food waste | The production of food, its impacts on the environment as well as the meaning of seasonality and locality needs to be part of the educational schedule in the Swiss education system at all levels. |
| Policy 6.14: New labeling for expiration dates | The food labels “sell until” and “best before” need to be communicated clearer to the consumer or be omitted completely |
| Policy 6.15: Adjust industry norms | A reduction of food waste from the agricultural production can be achieved by adjusting the industry norms so that less of the products are rejected due to size, form, color or other appearance quality standards not influencing food quality. |
| Policy 6.16: Promotion of initiatives for food waste reduction | Existing and the development of new Initiatives for food waste reduction should be promoted and up scaled at all stages of the food chain. |
| Policy 6.17: Updating the vocational education for farmer | The education should contain an understanding of the climate crisis, its consequences and impact on agriculture and the challenge of a sustainable and productive food system. Theoretical and practical excursion to learn about aspects of the climate crisis and sustainable solutions together with other actors of the food system should be integral parts of the vocational education. |
| Policy 6.18: Improving Farmers Rights and working conditions | Good salaries and working conditions need to be ensured. The peasant land law needs to be protected. The Swiss government should thus tackle the issue of high indebtedness which is rampant among Swiss peasants today. Farmers wife’s need to be insured, so that they have a guarantee for a pension and settlement in the event of divorce. To create a decent working environment for agricultural workers (also migrant workers), jobs in agriculture must be amenable to the Swiss labour law. Swiss agricultural policy must facilitate access to agricultural land for young farmers. |
| Policy 6.19: More people in the agriculture sector | Project to anticipate more people to work in the agricultural sector should be promoted. Access to agricultural land for young educated farmer should be facilitated. Green job programs and ZIVIs shall be used as well as new forms of participation in agriculture to distribute the workload. |
| Policy 6.20: Import of animal products and productivity | Only allow the import of animal products when produced under the same framework conditions as in Switzerland (feed no food, observance of maximum local stocking densities). Promote the concepts of “Feed no Food” and maximum stocking densities on an international level. Support the development of respective international trade regulations. |
| Policy 6.21: No subsidies for feed production on arable land | No subsidies or any other support for feed production on arable land except for leys in arable crop rotations. |
| Policy 6.22: No imports of animal feedstuff | Increasing tax on imported feedstuff until 2030 and then ban it from 2030 onwards. |
| Policy 6.23: Limit stocking densities for ruminants | Limit stocking densities for ruminants on permanent grassland to one livestock unit per hectare on average. The maximum stocking density may be adjusted regionally to take account of differences in local production potentials. |
| Policy 6.24: Limit populations of non-ruminant animals | Limit populations of non-ruminant animals to values according to the latest research or to numbers that can be supported with feedstuff from by-products of the regional food industry (not edible by humans) whichever number is lower. |
| Policy 6.25: Consider maximum stocking densities for new infrastructure | Consider (regional) maximum stocking densities when approving the construction of new or renovation of old infrastructure (e.g. stables), when granting credits or supporting any other long-term investments. |
| Policy 6.26: Promote research and development | Promote research and development in order to optimize grassland-based animal production and convert by-products from the food industry to animal feed. Promote precision feeding. |
| Policy 6.27: Promote alternatives to animal proteins | Alternatives to animal proteins i.e. plant-based protein sources like leguminous crops should be specifically promoted and supported as well as research on breeding, cultivation of those in appropriate scale in Switzerland. |
| Policy 6.28: Promoting alternative income possibilities | Farmers depending on livestock production today should be supported by promoting alternative income possibilities (e.g. support for transition to crop production, energy production). |

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| Policy 6.29: Promote low-input agriculture | This policy suggests production system contributions within the direct payment framework for previously specified low-input agricultural practices incorporating agroecological principles and lowering the GHG emissions in comparison to currently established systems. |
| Policy 6.30: Tax on nitrogen inputs that exceed plant demand & Cap for Synthetic Fertilizer Application | Nitrogen addition should be monitored very closely and inputs that are beyond the plant supply should be taxed. For this, a tool should be made available to farmers that accounts for e.g. the nutrient demand of plants, the availability of nitrogen in the soil, the type of fertilizer used and the application technique. As a complementary measure an incentive tax on synthetic fertilizers can be raised. Further we suggest a cap for synthetic fertilizer application based on local conditions as part of a compulsory fertilization balance for all farmers. This cap will be lowered in a stepwise manner guaranteeing both the aimed reduction and the possibility for farmers to adapt to the new situation. |
| Policy 6.31: Rewetting of organic soils | Despite their long history of drainage, large amounts of carbon are still stored in organic soils. These stocks (equivalent to about two years of total Swiss GHG emissions) should be preserved by rewetting, thereby reducing GHG emissions. |
| Policy 6.32: Apply standard mineral oil tax to agriculture | Standard mineral oil tax should be applied for agricultural production. With this measure additional policies aiming at an establishment of Truth of Costs and changes in the mobility sector can then automatically also be applied to mobility in the agricultural sector. |
| Policy 6.33: Promotion of individual technical mitigation measures | Farmers should have free access to any kind of information (scientific results, meteorological data, soil information etc.) and be supported in actively optimizing their production system (soils, plants, animals, infrastructure). Likewise, farmers should be able to participate in capacity building programs and benefit from consultation services. Their income should be high enough so that they can afford the time and money to optimize their production. As a last option individual technical measures can directly be subsidized. |
| **Chapter 7: Negative Emissions** | |
| Policy 7.1: Negative emissions financing through greenhouse gas pricing | From 2030 onwards, only greenhouse gas emissions compensated in real terms by NETs are allowed. To ensure that NETs are available at affordable costs in 2030, an annually increasing portion of the GHG-levy must flow into NET projects as start-up financing from now on. In this way, the plants are manufactured industrially and become more cost-effective. The goal is to achieve costs below 200Fr. per ton of CO2. In addition to the CO2 tax, the air ticket tax is also suitable as start-up financing. |
| Policy 7.2: Obligation to compensate emissions of imported goods | Switzerland neutralizes its consumption based GHG emissions. The emissions from the production and utilization of all imported goods/energy carriers into Switzerland must be negatively compensated by 1% in 2022. The fraction of total emissions for which negative emissions have to be bought increases to 2% in 2023, 4% in 2024, 8% in 2025, 16% in 2026, 32% in 2027, 64% in 2028, 85% in 2029 and remains at 100% in/after 2030, thereby mimicking a learning curve. The importers pay providers to remove this percentage of CO2 out of the atmosphere and store it for the long term. |
| Policy 7.3: Subsidy of NETs with refunded general greenhouse gas levy | This policy guarantees companies or privates a fixed subsidy for each ton of CO2 verifiably removed from the atmosphere over a predetermined period of time. The subsidy per ton of removed CO2 is gradually reduced as Switzerland's NET capacity is scaled up. The subsidy per ton of CO2 removed is specific to the NET involved. The level of compensation applied to each NET is determined by the NETs portfolio Switzerland aims for post-decarbonization. |
| **Chapter 8: Financial Sector** | |
| Policy 8.1: Legislative reduction targets / adaptation of the CO2 law | The financial sector becomes carbon neutral the latest by 2030. An immediate ban on new investments, credits and insurance services for projects and companies active in fossil fuel extraction. The financial institutions need to present decarbonization plans until the end of 2020. |
| Policy 8.2: Obliging financial institutions to perform stress tests | Financial institutions should undergo an annual climate compatibility test and disclose this information. |
| Policy 8.3: Green investment facility | A Green Investment Facility would complement the existing funds by investing in climate-friendly energy projects. The Green Investment Facility is intended to provide debt capital to companies and projects, for example in the form of Green Bonds. |
| Policy 8.4: Adopt EU Green Taxonomy | The Taxonomy identifies and classifies economic activities of companies in the most CO2 intensive industries according to climate criteria. Companies can use this taxonomy to issue so-called |

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| | "green bonds", financial institutions can invest in them. Such taxonomies provide the basis with which net zero financial flows can be achieved. |
| Policy 8.5: Carbon Accounting | In order to create transparency for the financial sector and for the general public, existing Swiss accounting standards (e.g. Swiss GAAP FER) should be extended to include the documentation of CO2 emissions, taking into account all scopes (Scopes 1-3). This extension should also become an admission requirement for the Swiss Stock Exchange. |
| Policy 8.6: Defining fiduciary duties more clearly | Fiduciary duties need to be extended to include the impact of the climate crisis. Its explicit rewriting in the legal texts is necessary so that insurance companies can exercise their fiduciary duty and have legal certainty. |
| Policy 8.7: Include sustainability targets for SNB | Sustainability and climate risks should be a top priority for the SNB. The federal constitutional and legal articles concerning the SNB should be supplemented by the concept of sustainability. |
| Policy 8.8: SNB shall exercise vote as shareholder | The SNB should exercise its shareholder voting rights. It is often among the top 40 shareholders of many companies that emit CO2 and thus potentially has a great deal of leverage on the corporate strategy of commodity traders and CO2-intensive companies. |
| Policy 8.9: Climate reporting for financial institutions | Financial institutions should transparently report on their ecological impact to costumers. |
| Policy 8.10: Education and training for employees of pension funds, banks and insurance companies | All consultants and employees are to be made aware of climate risks, not only with regard to the investment side, but also in the credit business. As part of an education and training offensive, companies in the Swiss financial sector should be required to train 10% of their employees in climate risks each year until 2030. |
| Policy 8.11: Tax incentives for green pillar 3a | A Green Pillar 3a of the private retirement provision should be introduced. This scheme could be incentivized through different ways such as a bonus-malus system or to increase the tax-free allowance for the Green Pillar 3a. Funds could also automatically be invested in the Green Pillar IIIa unless the insured explicitly request otherwise. |
| **Chapter 9: Economic & Political Structures** | |
| Policy 9.1: Public Program for Green Jobs | The Public Program for Green Jobs (ProGJ) should mitigate the social consequences of the transition to a GHG neutral economy. It will help workers in finding a new occupation, support them financially if they become unemployed and promote a socio-economic transformation by creating new green jobs in sectors that are crucial to kick start the green transition. |
| Policy 9.2: Nationwide network of climate workshops | Climate workshops provide equipment for loan, offer repair services and organize further training and courses. They are part of public services and should be set up in all districts and villages. |
| Policy 9.3: Working Time Reduction (WTR) | The number of full-time weekly working hours is gradually reduced to 24 hours a week by 2030 and the working week is immediately reduced to four working days. When workers do work for a shorter time period the output of the whole economic system can be substantially reduced and therefore also carbon emissions. WTR is also a crucial measure to redistribute the productivity gains of the economy to the workers. |
| Policy 9.4: Strengthening the care economy | The care economy is a relatively low-carbon economy and should replace some of the other (carbon-intensive) sectors in the economy as an important job and wage-earning market. The care economy (caring for children at home and in day-nurseries/Kindergartens/Schools, caring for elderly at home or in retirement homes, caring for sick people in hospitals) will be expanded. The state will pay parents for in total up to 24 months of childcare. Strengthening the care economy will have socially positive impacts by contributing to gender equality. |
| Policy 9.5: Foundations and cooperatives replace corporations | The legal form of corporations and stock-companies are prone to be dependent on growth and expansion at cost of nature. Therefore, democratically run foundations and cooperatives should become more relevant legal forms for new and existing companies. |
| Policy 9.6: Replacement of GDP by Sustainable Development Index (SDI) | The SDI is based on five indicators (education, life expectancy, income, CO2 emissions, material footprint). Switzerland is setting up an internationally oriented foundation for promoting the SDI and financing it with CHF 5 million annually. |

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| Policy 9.7: Financing the initial phase of a World Climate Forum | A World Climate Forum formed by grassroots movements should find solutions for the climate crisis on a global level. The confederation should finance its initiation three-year phase with CHF 10 million per year. |
| Policy 9.8: New Concept of Ownership | Private property may only be used privately to the extent that it does not cause any damage to the general public, in particular regarding environmental protection and climate warming. Private property of social relevance must be made available to the general public if this is necessary from a superordinate perspective. |
| Policy 9.9: Climate-protection tax on large assets and the establishment of capital controls | A climate asset tax of 20% is raised on all asset shares above one million francs per household. This does not include owner-occupied property and tangible assets that are in daily use. Half of the revenue from this tax is to be used in the countries of the Global South for climate mitigation projects. The other half will be used for climate policy measures in Switzerland. |
| Policy 9.10: Abolition of Lump-sum taxation | The lump-sum taxation is abolished. This scheme benefited a few thousand rich people with mass tax deductions. This policy will not have a direct impact on GHG emissions but has important consequences for regarding the aspect of climate justice. |
| Policy 9.11: Climate delegate of the Federal Council and Monitoring the progress in climate protection policies | The delegate will coordinate the climate policy projects of the confederation, cantons and municipalities, maintain a lively exchange with NGOs and climate movements, create a monitoring process and draw up an annual report. Each year, the delegate convenes a conference to discuss progress in climate policy. |
| Policy 9.12: Democratic Rights for all Residents of Switzerland | Switzerland is introducing all democratic rights for non-Swiss citizens who have been resident in Switzerland for at least five years. The major challenges posed by climate change are increasingly affecting everyone, therefore everyone should be able to participate in the decision-making. |
| Policy 9.13: Democratic rights for everyone aged 14 and over | Switzerland introduces the right to vote and stand for election for all people who have reached the age of 14. Global warming particularly affects the younger generations. It is therefore more than justified to grant this generation full democratic rights. |
| **Chapter 10: International Collaboration and Climate Finance** | |
| Policy 10.1: Switzerland contributes CHF 1 billion in climate finance each year | Switzerland contributes CHF 1 billion in climate finance each year. The available funds are transferred to institutions, funds or programs to finance measures in the target countries. Money is mobilized or generated through taxes, sanctions, levies, voluntary contributions, etc. |
| Policy 10.2: No Externalization of GHG Emissions | Switzerland does not externalize the necessary reduction of GHG emissions through purchasing of ITMOs and/or “compensation” abroad. |
| Policy 10.3: New Interpretation of International Trade Agreements | Switzerland declares that the respect for human rights and international agreements on climate protection clearly take precedence over the provisions of other international treaties, particularly trade agreements. In case of doubt, it suspends the application of provisions in trade agreements. |
| Policy 10.4: Prioritizing human rights, peacekeeping, climate protection and climate justice in international law | Within the UN framework, Switzerland proposes the creation of a clear order of priorities. In this context, agreements on international law, human rights, peacekeeping, climate protection and justice should be given priority over all other international treaties, particularly trade agreements. Thus, provisions in international agreements that contradict these priority agreements are suspended. Violations of the priority law should also be sanctionable. An office is set up to win over allies for this project. |
| Policy 10.5: The Fossil-Fuel Non-Proliferation Treaty (FF-NPT) | The goal of the FF-NPT is to phase out fossil fuels through a global legally binding treaty. Switzerland takes up a leading role in the negotiations and its implementation. |
| **Chapter 11: Education** | |
| Policy 11.1: Climate Change Education as a core element of the education system | Climate Change Education has to get a focal point at all school levels by implementing it in in all curricula. |

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| Policy 11.2: National advanced training program for teachers | Implementing an education program on climate change for teachers. This program is aimed at teachers already teaching. The content of these training courses should be based on the UNESCO goals of climate change education. It guarantees that the teachers understand the topic and are able to pass on their knowledge to their students. |
| Policy 11.3: National climate action week | The "National Climate Action Week" is a project week taking place throughout Switzerland at schools and universities. It is provided by the federal government and cantons. During this experience-oriented week, all participating students deal with topics related to climatic and ecological changes. |
| Policy 11.4: Climate education on a local level | Using social structures (local networks, NGOs, climate assemblies, etc.) to organize climate education projects and events. The aim is to share knowledge and skills on a more personal level to all people. The state provides to start those projects. |
| Policy 11.5: Government information campaign | Governmental organizations like FOEN, MeteoSwiss etc. are informing the population about the climate crisis. A governmental information campaign informs about the need for action and stimulates corresponding behavior, skills and mindsets to reach the aims to reduce Swiss net greenhouse gas emissions to zero by 2030. |
| Policy 11.6: Journalism reflecting the reality of problems | Media should label opinions and scientific facts/estimates accordingly. The treatment of the topic should not be reactively orientated towards sensational single events, but should be constructively involved in the political process through a debate on solutions for the crisis. |
| Policy 11.7: Counsellor for environmental awareness | Every swiss firm has to have a counsellor of environmental awareness. This person is responsible for the organization of educational training on climate change for the employees. |
| Policy 11.8: Environmental training for all employees and apprentices | Employees and apprentices should take part in environmental trainings. This is organized by the counsellor and held by experts. It should be practically-based and connected to the employee's field of work. The training should help workers to reduce their company's emissions. |
| Policy 11.9: Carbon conversations | People within their municipalities meet up and discuss their feelings and practices related to climate change in small groups. It is important to discuss and share one's thoughts and emotions regarding climate change as a contrast to all the fact-based education. |
| **Chapter 12: Adaptation** | |
| Policy 12.1: Focus on prevention, build resilience and invest in the health system | Many policies for mitigation already have positive health effects. In general, more investment is needed in the health sector. Additionally, the enhancement of epidemiological surveillance targeted at specific territories and the active support from the government in order to strengthen the social capital is needed. This involves the organization of a network of resources and the strengthening of social linkages that can help to reduce vulnerability and increase community resilience. |
| Policy 12.2: Sustainable alternatives for tourism | In the future more and more ski regions will be unable to continue offering the current version of winter tourism without artificial snowmaking. As snow machines are not climate friendly and only delay the problems winter tourism regions have to adapt to the changing climate. Subsidies will therefore go to ski resorts in order to develop sustainable and long-term alternatives for tourism without artificial snowmaking. No further subsidies will be given to short-term business models in ski regions that fail to take environmental sustainability into account. |
| Policy 12.3: Legal framework to support climate refugees | Individuals around the world are being displaced by the effects of climate change and thus forced to relocate in order to survive. Refugee law therefore has an important role to play in this area. Legal advice, guidance and the development of norms to support the enhanced protection of the rights of people displaced in the context of climate change related disasters is needed. |

This is the end of the
Executive Summary.
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The extensive version of the
Climate Action Plan follows.

# 1 Cross Sectoral Policies



# Introduction

The climate crisis is in its complexity and scope an unprecedented challenge for mankind. It requires fundamental changes in all areas of the social, political and economic system, and this in the shortest possible time.

While the other chapters of the Climate Action Plan deal with solutions in specific emission sectors, this chapter will deal with all policies that are of great importance for several areas. For, just as the underlying problems are often rooted in different sectors, some solutions are useful for different sectors. The following measures therefore cover a broad spectrum, ranging from taxes to financing instruments and sales platforms. What they all have in common is that they take an across-the-board approach and propose particularly fundamental changes. Thus, the cross sectoral policies play a central role for a transition to an ecological and social future.

# Policy Measures

## Policy 1.1: Moratorium on New Infrastructure until 2030

### Description

To achieve full decarbonization within 10 years in the building and industry sectors, demand levels have to decrease significantly from current levels. This applies in particular to cement and steel production, where there are currently no scalable net-zero emissions solutions available but holds true for other materials as well.

A moratorium on new infrastructure (buildings and roads) has two main goals:

1. significantly reduce demand for high-emission materials and
2. ensure a large enough workforce for retrofits in the building sector. This becomes feasible when at least a significant part of the workforce currently employed in new construction becomes temporarily available for renovations and retrofits.

Under such a moratorium, no new conventional buildings and no new transport infrastructure would be built from 2021 to 2030. Planning and construction permits would be limited to retrofitting and renovating existing infrastructure and buildings. Exceptions could be made for:

- Infrastructure that is net positive (i.e. it reduces and stores more greenhouse gases than it emits during production, use and demolition).
- Infrastructure to produce renewable energy, such as PV power plants and wind turbines.
- Infrastructure to help decarbonize the mobility sector such as bike lanes and public transport infrastructure.
- New production facilities for vital new technologies needed for the transformation, such as batteries, new types of renewable plastics or catalytic elements to be used for the substitution of fossil fuels.
- Other exceptions may include urgently needed public infrastructure (e.g. schools, hospitals)

### Financing

The moratorium itself will reduce public and private spending and would not need any additional finance. The focus on retrofitting and renovation will require training of additional experts and workers (see Buildings, Policy 8).

Today, about CHF.- 28 billion are spent annually on new buildings and only about CHF 12 billion for retrofitting and renovation (Guerra Fabio and Schläpfer, EnDK, EnAW-Fachtagung 5.11.2019) Ideally a significant part of the CHF.- 28 billion would become partially available for renovations and retrofits.

### Impact

This policy would lead to substantially more renovations and retrofitting. This would help reduce emissions in the building sector. It would also reduce the demand for steel and cement and therefore reduce emissions in the industry sector. The mitigation effect would likely be several million tonnes of $CO_2eq$ each year.

## Social Compatibility

**Jobs:** To prevent an unemployment crisis, workers in affected jobs need to be re-trained for retrofitting, renovating and other jobs needed for the transition to net-zero. For this, a government program should be created.

**Roads:** Many new road projects are currently in the planning or early implementation phase but most of them will not be completed by 2030. Therefore, increases in traffic jam hours per year will not change much by 2030 with or without moratorium. Bottlenecks in road traffic are nowadays almost the only measure to slow growth in traffic volume. Therefore, a moratorium may save us stranded investments and preserve some of the landscape and biodiversity left.

**Housing:** Such a moratorium would raise substantial equity issues if it would make finding an apartment more difficult, especially in areas where there is already a shortage of apartments. The moratorium may lead to higher prices for apartments as supply will be decreased. Newcomers (e.g. young people who move out from home) would have a disadvantage compared to people who already have an apartment/house. More competition in the housing market could reinforce or trigger gentrification of entire neighborhoods.
It makes therefore sense to look at the current housing situation in Switzerland and discuss additional measures that could be taken to alleviate negative impacts: In 2018 each person in Switzerland used on average 46 m2 of living space. Families have the lowest average with 32 m2 and older, single-occupancy residents the highest with 70m2.
In 2019, the number of vacant apartments was high with around 75,000, i.e. 1.66% of all apartments (Bundesamt für Statistik (BFS / FSO) 2019). In addition, the number of vacant office spaces is also quite considerable. However, there are large regional differences.
The growth in apartments is about 1% per year. With a moratorium on new construction the number of apartments will roughly stay the same. If the population grows, as predicted by 0.5% each year, the available living space would be reduced by about 5% in 10 years, this translated to an average reduction from 46 m2 to 41 m2. This would require a substantial shift in how people live. Some of the possible shifts may include:

- Office space to be retrofitted to apartments.
- New life/work arrangements to reduce the hours buildings are not occupied.
- Reduction of single person households in favor of cohabitation.

Such a trend could be supported by either helping to find appropriate roommates, and service packages for the adaptation of single-family houses to new uses. Housing cooperatives in Switzerland have much expertise in managing high occupancy rates of their property and subsidized housing applies strict rules. Living with housemates may also lead to co-benefits such as better physical and mental health, see for example Wu et al. 2003, J. Kim and Cho 2019 or “The Health Benefits of Shared Living - Harvard Health” 2018.

A bonus-malus system could be introduced to create an incentive to live in smaller spaces or with roommates. Such a system would also generate revenue which could be used to provide subsidies for people strongly affected by rising rents. Households that use more than 50m2 per person would need to pay a “occupancy malus” of a fixed amount per m2 heated floor. Households that occupy less than 25m2 per person would profit from a bonus of a fixed amount per m2 heated floor. The fixed amounts are set in a way that makes this measure cost-neutral and allows for enough free apartments (e.g., more than 1%).

Other supporting policies and measures may be necessary to mitigate impacts on rents for low income people.

**Impact on immigration and immigration policies:** A housing moratorium would have to be supplemented with other measures to ensure that it does not lead to more restrictive immigration policies. The demand for apartments is growing considerably faster than the population. The population in Switzerland has tripled since 1850. In contrast, the number of households has increased sevenfold. Between 2012 and 2016 the population has grown by 4.7% and the number of households has increased by 5.6%.

### Questions and Uncertainties

The specifics of how such a moratorium would work would need to be carefully evaluated and designed. Some of the relevant questions that would need to be explored:

- Which exceptions to the moratorium should be possible and what would be the decision structures for permitting such exceptions? (Should exception be possible if the owner pays for the created emissions into a climate fund?)
- Does this measure free up a sufficiently large trained workforce to accomplish all the additional needs outlined in the CAP?
- How will such a moratorium affect Switzerland's economic competitiveness, i.e. what will be the economic costs and benefits of such a moratorium? What will be the consequences in terms of employment and income for people in Switzerland?

# Policy 1.2: Greenhouse Gas Pricing

### Description

Putting a price on CO2 and other greenhouse gases (GHG) makes harmful activities more expensive. There are two ways to determine the cost of a ton of:

**Damage cost approach:** The price per ton of CO2eq is set based on taking into account all the costs and damages that climate change causes (e.g. food security, health, economic, and infrastructure impacts). There are many studies that estimate the true costs of GHG emissions. The results range from USD 12, an estimate from the US government (Epa and Change Division 2016), to EUR 640 per ton of CO2eq, an estimate from the German government (Matthey and Bünger 2019). The large range is due to the fact that the estimates depend on many assumptions with ethical implications. For example, how do we account for the damages on future generations? Should we assume the costs are the same (like in the German estimate) or should we value those costs less, because they are in the future? (The US government uses a discount rate of 5%, meaning the same damages that costs USD 100 today, are assumed to cost only USD 22 in 30 years). A Damage Cost Approach also involves decisions on how much to value human life - e.g. health costs are usually valued in units of lost GDP. Thus, implicitly, human lives in the global South are valued less than the life of a person in Switzerland.
Overall, damage costs have serious limitations because of the radical uncertainty of potentially catastrophic effects, such as the melting of the polar ice caps in Greenland or West Antarctica cannot be well incorporated (Weitzman 2009). Therefore more often the avoidance cost approach is used.

**Avoidance cost approach:** The price per ton of CO2eq is set to ensure consumption of fossil fuels and therefore GHG emissions go down. There are many different estimates available for this approach. Here the time frame is also relevant: The EU for example gives estimates for the short-and-medium term costs of EUR 60 - 189/t CO2eq and for long term costs of EUR 156 - 498/tCO2eq ( European Commission, Directorate-General for Mobility and Transport 2019).

**Pricing Systems**
Putting a price on GHGs raises the price of fossil fuels and will therefore lower their demand (how much will depend on the price level and the elasticity, see below). GHG taxes may also make climate friendly technologies more competitive and may therefore drive innovation. These policies also all raise revenue.
There are different approaches for greenhouse gas pricing policies. The main ones are: 1) Tax, 2) steering levy or 3) Cap-and-trade systems (discussed in chapter Industry, policy 4.2). Different pricing policies are designed depending on their main purpose. For example, the current Swiss CO2 steering levy on heating oil and gas is tied to emissions reductions targets. If these targets are not met, the CO2 price is raised. We propose a GHG pricing policy that is similar to the existing CO2 steering levy, with the following differences:

- The policy applies to all main greenhouse gases, including CO2, Methane, N2O etc. (The current Swiss CO2 steering levy only applies to CO2)
- The policy applies to all sectors, including buildings, industry, transportation, and agriculture as well as to fossil fuels used for non-energetic uses (the current Swiss $CO_2$ steering levy of CHF 96 only applies to the building sector. Transport and agriculture are completely exempt. Industry is partly exempt)
- All actors, including all companies should be taxed. (Currently all large companies and many mid-sized companies are exempted)
- The tax should start in 2021 in the range of CHF 150 - 200 per ton of CO2eq and then gradually increase. For example, the tax could start in 2021 at CHF 120 (the current maximal price for the CO2 levy) and then increase annually by CHF 45 per year to reach CHF 525 in 2030 (the EU’s high estimate for long term avoidance costs) The gradual increase ensures price predictability and also enables the Border Carbon Adjustment policy to be implemented more easily (see policy 3).
- There are legal differences between a tax and a steering levy. We leave it open, which option is chosen.
- We leave it open, if the tax or levy should be tied to reduction targets and raised if those are missed or if the price should simply rise by a certain percentage point each year. Both options would be possible. An example for the latter is the Swiss levy on heavy duty transportation (LSVA, Heavy vehicle charge (performance-related and lump-sum)).
- We do not define where in the production chain the tax or levy would be charged. It can be charged close to the source (e.g. fossil fuel imports), at the site of emissions (e.g. cement plants for the process-related GHG emissions) or in the retail chain (e.g. on meat and other animal products). The options with the least administrative burden should be chosen.

It is important to note that the GHG pricing policy will only be effective if it is accompanied by the other overarching policy measures outlined in the CAP (see Impact section below).

## Financing

The GHG pricing policy would generate considerable revenue. A rough estimate shows that at CHF 150 per ton, it would generate around CHF 6 bn in revenues in 2021 and then decrease to almost zero by 2030 under the goal of net-zero by 2030. We estimate total revenue through 2030 to be around 30 billion CHF.

There are strong reasons of climate and social justice (see section on social compatibility below) to give back at least parts of the revenue to the population. However, others argue that the revenue should be used increasingly to finance the needed negative emissions technologies, see for example the section "Policy Measures" in the Chapter on Negative Emissions.

## Impact

**The effect of carbon pricing is limited.**
Although carbon pricing is often portrayed as the single most important policy measure, it is in fact only effective if it is part of a broad set of policies and measures. Although a valuable policy tool, its effectiveness is limited due to a variety of factors, including:

- Purchasing and investment decisions are often not primarily based on cost-considerations. (In economic theory this is called "non-rational behavior");
- Some behaviors do not change very much, even if prices rise. For example, if gasoline prices go up by 10%, people drive on average only 2-3% less. (In economic theory this is called "low elasticity");
- There are many non-cost barriers that lower the effectiveness of carbon prices: if for example no low-carbon alternatives are available (e.g. no public transport). Also, for a variety of reasons carbon pricing alone cannot drive cost-effective investment in renewable energy. (In economic theory this is called "market failures").
- Given the political realities, carbon prices are often too low to be effective. (This is especially true in complex systems such as cap-and-trade schemes where there are many leverage points that can be used to weaken the policy.) Often policies that are less efficient from an economic theory perspective are more effective under real-world circumstances because they are politically and socially more acceptable (e.g. incentives, emissions standards or subsidies);
- For carbon pricing to work, subsidies for fossil fuels have to be removed. They undermine the effectiveness of carbon pricing because the price for fossil fuels remains artificially low. According to the International Monetary Fund (Baoping 2019), fossil fuel subsidies amounted to about 5.2 trillion USD worldwide in 2017, which is over 6% of GDP.

Nevertheless, GHG pricing is an important element of a successful decarbonization plan. If part of a well-designed policies-mix, the GHG pricing policy could help trigger an exponential transition, once GHG-free substitutes become cheaper than fossil fuel-based technologies. The transition will be fastest for products with short lifespans.
A GHG pricing policy as suggested above could trigger additional reductions between 2% and 30% depending on how it is designed and how it interacts with the whole policy mix (For heating buildings and transportation fuels, but also in industry economists estimate the elasticity of fossil fuel demand to be around -0.1 to -0.5.).

## Social Compatibility

Less affluent people spend a higher percentage of their income on energy costs and will therefore be burdened more by such a tax. Recycling back the income can alleviate some of the burden that will arise from rising costs (Sigrist, Iten, and Zimmermann 2019). Therefore, some argue that the majority of the revenues should be earmarked to support these groups, either by recycling the revenues back to them or by subsidizing cost-containment measures. (E.g. house insulation will lower heating costs and $CO_2$ emissions or measures for regions with increased transportation costs, low population density and a lack of public transportation.) Others argue that social justice may be tackled more efficiently with other policy measures than a lump sum recycling of such a levy. Additional policy measures may therefore be needed to ensure low income households are not disproportionately burdened.

In addition, it is very important to note that this policy should not be seen as a stand-alone measure. It can only work in combination with other policies. This should on one hand contain further measures to counter financial pressure but on the other hand also measures to boost the availability of alternatives. Especially in the mobility sector it is crucial to offer people alternative forms of transport.

## Questions and Uncertainties

Such a GHG pricing policy could distinguish between products that are necessary (e.g. bus to work) and those that could be considered a luxury (e.g. air travel for vacation). The answers will to a large extent be subjective and normative, nevertheless, we will at some point need to determine what we as a society deem necessary and what should be considered a luxury.

An additional levy could, for example, be put on high-impact products and activities that have been defined as non-essential, e.g. air travel or high levels of meat consumption.

# Policy 1.3: Border Carbon Adjustment for a Level Playing Field

## Description

In addition to effective GHG pricing, **Switzerland introduces a "Border Carbon Adjustment".** This means that for all customs categories the GHG emissions are calculated and priced according to the swiss GHG pricing. This levy is then charged as a customs duty on the corresponding products, either per physical units (kg) or per CHF import value.

**Background**
If a comprehensive greenhouse gas pricing mechanism is introduced (see policy 2) the production costs of Swiss companies will rise. The additional costs faced by producers are the sum of abatement costs and the costs for the remaining emissions. If these companies compete internationally with producers with less stringent climate policies, the risk of leakage arises. Leakage can occur in two ways: One way would be that companies relocate to countries which have a less stringent climate policy to avoid the higher carbon prices. The second way would be that Swiss companies will lose some of their market shares to unregulated foreign competitors who may import cheaper products or replace some of the Swiss export. Thus, both types of leakage will not reduce global emissions and just shift them from Switzerland across the border. Since they will both result in lower production of the domestic industries, they will have a negative impact on Switzerland since jobs and income are lost.

In the past, two approaches have been applied to address the risk of leakage in Switzerland:

(i) emissions intensive companies are exempted from the CO2 levy if they opt for a target agreement (this is the case in Switzerland). This means they face only abatement costs for economic viable abatement measures but do not have to pay for the remaining emissions. They may sell emissions reduction certificates to KLIK if they overachieve the target, thus also have an incentive to overachieve their target.
(ii) companies with the risk of leakage receive free allowances under the Swiss (and EU) Emissions trading scheme on the basis of best available technologies and full plant closures are penalized by withdrawing the related allocation. This means emissions efficient companies get an incentive to invest in abatement given the opportunity to sell the surplus units.

Both approaches reduce the environmental effectiveness of the instruments as it prevents the full pass through of CO2eq costs to consumers, which will weaken the substitution effect away from CO2eq intensive commodities and reduces the incentive to reduce production. In order to overcome such distortions by abolishing free allocation in the ETS and making all other companies pay the greenhouse gas levy, border carbon adjustments (BCA) would be a promising way. As the World Trade Organization

(WTO) rules are rather strict on non-discrimination of foreign producers we propose a BCA that would seek to achieve the same treatment for domestic and foreign products by applying the same requirements for imports (payment of greenhouse gas levy or ETS price on “carbon footprint”) and exempting Swiss exports (reimbursement of the levy or ETS price).

**Implementation**

Broadly speaking, there are two ways a BCA could be applied: either per product group (e.g. cement) or by individual product. The former has the large advantage that it is not extremely complex to administer so administrative costs could be kept low. Practically, the customs administration would calculate the levy either per physical units (kg, m3, etc.) if the products are homogeneous or per CHF for all other goods and services. The disadvantage is, that this standardization would not allow to account for the actual emissions of a product. For example, all imported cement would be taxed equally, even if one was produced with CCS and the other not. However, it would simplify the implementation and keep administrative costs low. A similar system is also applied for the Value Added Tax at the border.
Ideally, BCA would be introduced jointly with other countries e.g. Switzerland jointly with the EU. Both, in the US and EU some groups and leaders have discussed this instrument for many years. In the US there has not happened much as of now (Nov. 2020), this might however change under a Biden administration since the US has always included BCA in discussions on carbon pricing. In the EU but also in Switzerland (where the Federal Council discussed to abolish industrial tariffs) a window of opportunity has recently opened. As part of the European Green Deal the European commission announced the introduction of a Carbon Border Adjustment Mechanism (CBAM). The commission is focusing on “imports only” solutions e.g. a CO2-price on certain emissions intensive sectors, implemented as an additional customs duty or as allowances surrendering requirements via the European Emission Trading Scheme (EU ETS). This offers a great opportunity for Switzerland to simultaneously introduce its own BCA and coordinate with the EU, given that emission intensive industries are regulated by the Swiss ETS which is linked to the EU ETs.

## Financing

The finance situation will depend on the net-import of CO2eq in the products covered by the BCA as well as the price determined by the GHG-levy and ETS price. Rough estimates by Droz-Georget (2017) assuming a tax level of 120 CHF/t CO2eq and a net-import of goods falling under the BCA of around 70 million tCO2eq calculated a net revenue of 10 billion CHF per year. Assuming that the net-import could be halved by 2030 and the tax level raises to 210 CHF/t a total of 90 billion CHF would be generated by 2030.
This measure would increase the living and production costs in Switzerland which will have negative impacts on competitiveness. Therefore, a part of the net revenue could be used to either lower other cost factors e.g. labor costs or to be recycled back on a per capita basis.

A part of the revenues could also be used for climate finance in poor countries (see International Collaboration & Climate Finance).

## Impact

The BCA will reduce distortions by abolishing free allocation or target agreements, therefore it should increase efficiency and effectiveness of those instruments. The additional impact will be largest abroad because less GHG-intensive products will be consumed and because the revenue will contribute to global mitigation efforts. At global mitigation costs projected by the World Bank for 2030 of 70 USD/t one could reduce more than 1’000 million tons of CO2eq with the BCA revenue if spent on mitigation only.

## Social Compatibility

Due to higher cost-pass-through the costs of energy-intensive goods and commodities would rise significantly. This may affect poor households disproportionately as they spend higher shares of their salaries on energy-intensive goods. Therefore, part of the revenue may be used to improve the income situation of poor households.

## Questions and Uncertainties

There is a risk that trading partners would call for WTO or GATT conflict resolution and delay the introduction.
In case of a stepwise introduction, this might result in a distortion in the market for manufactured products. E.g. if imports of aluminium profiles are charged a BTA but window imports not, then the Swiss window producers would lose market shares.

# Policy 1.4: "Matterhorn" The Net-Zero Purchasing Platform for Public Purchasing

## Description

Incentives to supply net-zero products are needed to speed up the transition. Public households (communities, state, federal level) including publicly owned entities and companies are an important economic sector (spending of 6% of Swiss GDP (=40 billion CHF/a) and responsible for a similar share of the Swiss consumption footprint) and owned by all of us.
The relevant laws (BöB and others) must be changed to require that public purchasing be limited to net-zero goods.
Net-zero goods either cause zero GHG emissions in the whole production and use phase or make sure that permanent negative emissions compensate for remaining technically non-avoidable emissions. Such negative emissions need to follow strict criteria and shall not be counted towards the host countries NDC (i.e. needs corresponding adjustment).
To make this possible a purchasing platform must be developed to give direct and competitive access to producers and sellers of net-zero products. The platform could be called "Matterhorn" and compete globally. The steep slope of the Matterhorn symbolizes the rapid exit envisioned by the CAP and Paris agreement. The platform would be open to private buyers as well.

For products unavailable in a net-zero quality on the global market the platform would both organize competitions (prize money for those meeting the specifications) or guaranteed purchasing submission (we buy a million net-zero pieces below a certain price). The net-zero requirement would include the full supply chain. If this requirement would prove to be unrealistic one could relax the requirement by asking for purchasing from companies that have agreed Science Based Targets for 1.5° agreed by https://sciencebasedtargets.org/ and implement them by 2030.
The existing platform KBOB https://www.kbob.admin.ch/ in the building sector and the relevant Swiss Association https://www.svoeb.ch/ for all sectors could become the hosts or driver of the platform. While it should be established immediately, the platform would steadily grow by both number of net-zero goods and services and the volume of sold/enabled purchases.

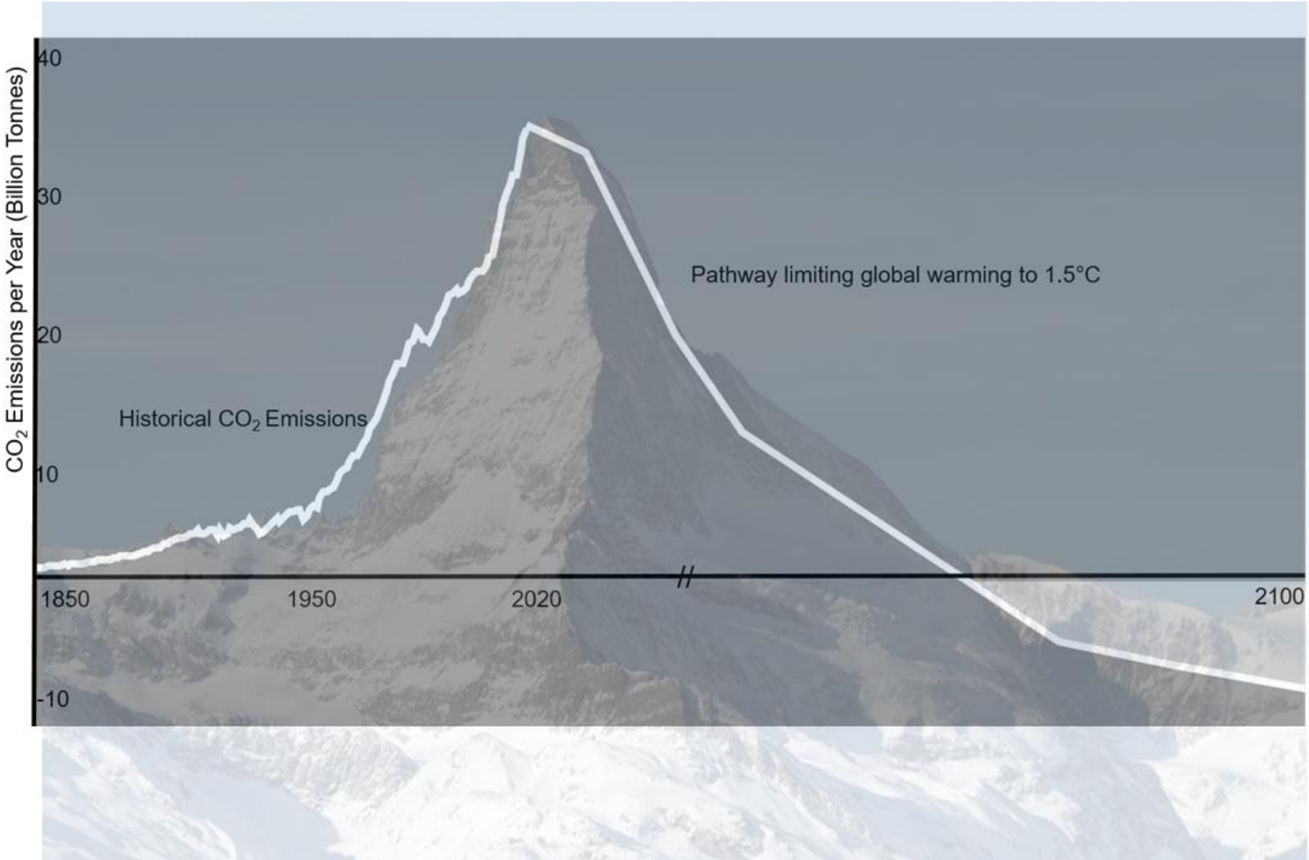



*Figure 1-1 The Matterhorn and a pathway of emissions*

## Financing

Since the measure would be indirectly mandated by law, the surplus costs would be carried by those purchasing or selling through the platform. A one-off loan to kick-start the platform could be granted by the public administration and later be repaid through revenues from a service charge.

## Impact

If public purchasing becomes net-zero this will reduce the consumption emissions of Switzerland by about 6%. If the platform is used by the private economy as well the impact could become much higher.

## Social Compatibility

Producers that do not adapt to net-zero-production and highly depend on the public sector may lose their business. However, this is an intended consequence of a rapid transformation and does not imply that employees of such companies do not find new employment.

## Questions and Uncertainties

Such a platform may violate certain rules of WTO and WeKo because it is the intention to exclude some suppliers. The design of the platform should make sure that the best ideas and products can compete globally.

# Policy 1.5: Warranty Periods against Planned Obsolescence

## Description

The statutory warranty periods should be specifically geared per product to the technically possible service life. For individual components with high wear and tear, the warranty periods are to be defined separately accordingly and spare parts are to be ensured in the long term beyond the product warranty period.

This should prevent manufacturers from falling victim to short-term profit logic and trying to increase their sales by means of "planned obsolence".

In order to enable long lifetimes, qualitatively better products have to be developed and produced. This raises the requirements to product development and manufacturing and promotes long-term partnerships and the development of a production culture (building culture). Producers will prefer more durable, simple and robust designs because they are easier and cheaper to repair in case of damage.

The introduction can take place immediately. The warranty periods must be periodically checked and adjusted.

## Financing

Increasing investment costs and decreasing maintenance and amortization costs can be expected. If necessary, alternative ownership/usage concepts must be established (sharing economy/contracting/maintenance contracts).

## Impact

Longer life cycles mean that products need to be replaced less often. This reduces resource and energy consumption and is more cost-effective in the long term.

## Social Compatibility

Market saturation is reached faster, which leads to decreasing sales for producers. This loss of profit can be passed on to prices.

## Questions and Uncertainties

For prototypes or new developments no comparison and experience data is available. This includes buildings, components and constructions. It is important not to make developments and prototypes impossible. This regulation is only suitable for serially manufactured products.

# Policy 1.6: Climate Impact Assessments for Products & Services

## Description

Switzerland establishes a climate, environmental and social impact assessment (in the following referred to as climate impact assessment) for all non-food products and services. This impact assessment represents the basis for further policy actions such as the introduction of a carbon label as well as the taxing or banning of environmentally and socially harmful products and services.
Part of these climate impact assessments should be all Scope 3 impacts including (but not conclusive) packaging, chains of transportation and transportation infrastructure, emissions through deforestation and agriculture, enteric emissions from livestock, energy and heat production.

The climate impact assessment should be introduced for all non-food products and services traded. For all kinds of food an additional impact assessment and label should be done, as proposed in the chapter on agriculture. For the climate impact assessment companies and institutions are called upon to initiate appropriate audits of their own accord as soon as possible and to disclose the corresponding results. The appropriateness of such tests should be assessed by an independent public body. If necessary, this body must be able to carry out audits itself if those of the companies fail to do so or are found to be inadequate. The benchmark for the assessment must be the best known climate, environmental and social policy practice per product/service with regard to production, packaging, transport routes, distribution, life cycle, repairability and recycling at the end of use. Effective sanctions must be created so that climate impact assessments are enforced and their results lead to real improvements. If necessary, the production, distribution and trade of climate-damaging products/services must be prohibited.

The information about the products and calculation of the scores should be in an open-database accessible by everybody to allow everyone transparent access.

## Financing

The financing and implementation of the climate impact assessments is the responsibility of the companies that trade the relevant products. The financing of the supervision of these tests and possible interventions (up to and including the performance of own audits) is the responsibility of the Swiss government. A part of the money needed can and must also be raised by the companies concerned, especially if the audits carried out by the companies themselves are inadequate and have to be taken over by the public authorities.

## Impact

Climate, environmental and social impact assessments make it possible to uncover practices that are harmful to the environment and climate for the entire range of goods and services and to implement the best practice in terms of climate and social policy. This also applies to practices that contradict social standards, e.g. with regard to a humane labour law.

Another important dimension of climate compatibility is the transport routes that a product and its components take. Transport costs that are far too cheap, enormous wage differences worldwide and the lack of ethical behaviour on the part of many companies often lead to grotesquely high transportation. For example, Norwegian smoked salmon is transported to China to be carved there before being shipped back to Europe and ending up on the shelves of supermarkets (Donaukurier, 11.5.17). Thanks to the climate impact assessment, such practices can be uncovered and immediately stopped.

## Social Compatibility

In addition to climate-relevant criteria, the assessment should also reflect other environmental concerns (e.g. biodiversity, marine protection) and social concerns. Trade unions and professional associations are to be involved in conducting the audits and assessing the concrete consequences of sanctions. If necessary, measures in the sense of a just transition must be defined and implemented. This must be the case when the results of the climate impact assessments have consequences in the manufacturing of goods, for instance lowering the output because of elimination of obsolescence.

## Questions and Uncertainties

The method of climate impact testing starts with the trade in the finished products. The chapter on industry proposes measures that intervene in the production process. Any coordination of these measures must
be examined more closely. In particular, the approaches in the chapter on industry must be used as a basis for examining how climate impact assessments can be carried out on export products and what effects this may have.

Since all products traded in Switzerland are treated equally, there should be no conflicts with provisions in international treaties on trade - although we recommend in any case suspending those provisions that
stand in the way of a successful climate policy. It could happen that certain foreign manufacturers will refuse to continue supplying the Swiss market. In any case, it is clear that climate impact assessments should quickly gain a foothold in other countries as well, i.e. become an instrument of international climate and social policy.

The argument that such an impact assessment would entail a great deal of bureaucracy is undoubtedly true. But only with the help of such bureaucracy can it be ensured that the best possible progress in climate policy can be made in each individual case. In view of the threat this bureaucracy is more than justified. Moreover, it builds up knowledge and know-how that is of the highest value for the areas and sectors concerned and for society as a whole.

# Policy 1.7: Climate Impact Label for Products and Services

## Description

A climate impact label for non-food products is already possible today for some products and will, with the introduction of the climate impact assessments, become possible for all. To enforce a climate impact label for all non-food products sold in Switzerland a policy is needed. The targeted climate impact label is of similar character as the well-known nutrition indications on all food products. The goal of this policy would be to improve the transparency of the emission of each product, to sensitize and help consumers to make educated choices and reduce their ecological footprint. It will further have an impact on the companies by encouraging them to improve their processes to lower the climate impact of their products.

For food products a separate label should be created as proposed in the chapter on agriculture.

The climate impact label will be calculated based on the climate impact assessment (Policy 1.6). This label will have a detailed part mentioning the CO2eq emitted by the production and transportation of the final product as well as preceding production levels. Depending on the product type also further important information could be included, for instance the use of water resources, the impact on deforestation or animal welfare aspects.
A clear labelling strategy should be established (e.g. good, average, bad, very bad with respective color code) to facilitate the understanding for consumers and to underline when a product is climate damaging.

For a product to be sold in Switzerland, a climate impact label will need to be present on the packaging. However this obviously does not replace active measures to improve the climate compatibility of products.

## Financing

Financing is needed only for the climate impact assessment which's financing is described in the respective policy (Policy 1.6).

## Impact

Companies will be interested in buying or producing goods that produce small amounts of CO2eq to make their product more attractive. This is especially because the consumers' awareness will rise significantly. Competition between products depending on their CO2eq consumption will be enabled because the consumers have reliable information for the comparison of these goods. The result of such a policy will be reduced competitiveness of climate-damaging products and companies encouraged to reduce the climate impact of their products.

## Social Compatibility

Prices will not be affected at first. Based on the climate impact labelling, a ban on climate damaging products could be done. Moreover, pricing based on the climate impact could also be done but social compatibility should be taken into consideration. The solution will be to tax "climate damaging products" and substitute other products to keep essential products affordable.

## Questions and Uncertainties

- It might be more difficult to calculate the climate impact of non-food products because they do not have a clear list of ingredients, but it can be done by improving the life-cycle estimation.
- How can a carbon tax be implemented in a later stage? The carbon price should be higher than 200 CHF.-/ tones in order to make any significant difference in the price.
- The ideal system would actually be to have a carbon budget, but this is difficult to implement.

# Policy 1.8: Replace Commercial Advertising with Art and Education

## Description Ban of Commercial Advertising from all Public Physical Spaces

In view of the threat posed by climate change, advertising and sponsoring in particular climate-damaging products (e.g. flights, dairy products, cars etc.) and services but also in general are no longer acceptable.

For example, Switzerland has been subsidizing the advertisement of milk products for decades despite its significant climate impact. Just as problematic is the omnipresent encouragement to consume more and more. The consumerist society promoted by today's advertising campaigns is neither compatible with our vision of a future based on more than material values nor with the target of reaching net zero by 2030.

**Therefore, commercial advertising will be banned from all public physical spaces (streets, train stations, public transports etc.). The advertising spaces freed up by this, should be used exclusively for educational purposes and art.**

In addition, an expert commission should be created to develop a model of an advertisement-free internet and a clear plan to transition to it.

## Impact

The permanent consumerist takeover of public spaces is reduced. This should alleviate the pull to seek compensatory short-term satisfaction through consumption, which has climate-damaging effects. Since advertising bans often come along with a general social transformation there is some uncertainty about their specific impact. Research implies that only comprehensive bans, as proposed here, have a relevant effect (Blecher 2008). The ban will not solve technological problems, but it can help to prevent unnecessary emissions in a mid-term perspective. In the medium and long term, the most important effect will be a reduction in consumerism and a shift of desire to other fields (time prosperity, new care in dealing with goods and materials).

## Financing

This measure leads to a reduction of the advertising income of the public sector, private companies and state enterprises.

However, this enables considerable savings in marketing and advertising.

If financing is needed to achieve a just transition it can come from revenue of taxes suggested in other chapters.

## Social Compatibility

For some of the employees in marketing and advertising, programmes for a just transition are needed, which are to be developed together with those concerned. This can be done by the ProGJ (see policy 9.1 in the chapter Economic and Political Structures).

## Questions and Uncertainties

- The broader economic consequences of the reduction in consumption are not clear. The social problems in forms of job loss created by this measure could be massive. This would then have to be countered by other fundamental structural change.
- Many important services of today's society, particularly social media and media, are financed only through advertisement. For these businesses an alternative business-model needs to be developed.

# Policy 1.9: Climate Bank & Climate Agencies

## Description

**Note:** The basis of a climate Bank/Climate Agency policy are clear targets and rules set in all the relevant sectors to achieve GHG neutrality. The agency can then offer support by providing funding for projects needed to adhere to these rules and targets.

**Concrete Policy:** A climate bank is created. The bank is public, i.e. it must be self-supporting in the long term, but not profitable. This allows the financing costs, i.e. the interest on the loans, to be kept lower than in the case of private banks.
The climate bank grants credits to Climate Agencies. They are also non-profit and public. Climate Agencies are the general contractor for investments necessary to fulfill rules and targets described above and/or generally improve the GHG footprint, e.g. new heating systems, solar systems and so on. Customers of Climate Agencies are private households, companies, institutions and, if required, also public bodies. While the Climate Bank regulates the financing through banking, the Climate Agency is responsible for the practical implementation of the investments. Climate Agencies are competence centres, who have technological, business, process and legal knowledge and know the networks of providers, craftsmen and so on.
The public sector thus assumes the investments costs, which have so far been a major obstacle to the substitution of sustainable technologies. Property owners are not forced to take advantage of the agency's offer, but can also meet the requirements with their own investments.

A depreciation plan determines the annual depreciation of the investments. For example, a users' new "energy bill" consists of annual amortization payments in the amount of the depreciation and interest payments as well as the greatly reduced energy costs (e.g. to operate a heat pump). Due to the longevity of the measures implemented, these costs should be lower (and less fluctuating) than the costs of fossil fuels.
The user of the new systems is not a debtor. He only pays for the use. The only condition is that, in the event of the sale of the properties concerned, the Climate Agency is entitled to a part of the proceeds in the amount of the remaining residual value of the investment. This amount corresponds to the increase in value due to the investment. The users purchase the services of the facilities created by the investment as energy contract partners. The contract to be concluded for this purpose is valid for the lifetime of the plant. It is possible for the property owner to buy the system from the Climate Agency at a later date at the then existing residual value. Likewise, the use can also be continued with a new owner after the sale of a property, provided that the latter does not buy the system at the same time.

## Financing

Money is not a scarce resource. Money is created when loans are granted (e.g. by opening a new credit line). Credits are only granted to Climate Agencies. Climate Agencies' debts are covered by real assets, i.e. the real value of investments to households and companies. Depreciation generates the cash flows with which the loan can be repaid. With the repayment, the balance sheet total of both the agency and the bank is reduced again. So the crucial question for climate financing is not whether there is enough money, but how the model and payment plan of an investment works. In short: for the operation of the system, there is no financing necessary, because the policy is credit-based.

The only need for the Climate Bank is to fulfill legal framework conditions such as equity ratios and minimum reserves. While minimum reserves can be obtained via access to central bank reserves and the interbank market, equity capital would have to be generated, for example, via a deposit from the public sector.

## Impact

The reduction of greenhouse gas emissions to net zero by 2030 requires a comprehensive ecological restructuring of energy production and consumption. Numerous technological solutions are available. Solar energy, alternative heating systems and thermal insulation are either already competitive today or will be in the foreseeable future. Their application often fails because of the high investment costs. The high initial fixed costs are offset by savings that can only be realized over longer time horizons. Demanding large investments from private households raises questions about the social compatibility of climate protection.
With a credit based solution, the achievement of climate targets could be significantly accelerated. There are no reasons for long transition periods and delays.

In the case of technologies where competitiveness is still lacking, even including the reduced risk due to the absence of cost fluctuations, financing through the Climate Bank can also be combined with subsidy contributions provided for in various areas of climate and energy policy.

Subsidies could also come into play when existing installations must be replaced for ecological reasons a long time before they are depreciated, and cost-savings by new technologies cannot compensate for an early depreciation.
The model not only massively accelerates ecological conversion, it also generates employment. In fact, the bottleneck is the working force. So, there is a strong link to policy 1.1. (Moratorium on new infrastructure until 2030).

## Social Compatibility

With the system of a Climate Bank & Climate Agencies everybody has access to needed credits when being obliged to invest in climate-friendly technologies – also households with low income, but having their own house. Furthermore Climate Agencies unify the necessary competences to minimize the risk of poorly planned or implemented infrastructures.
Because Climate Banks and Climate Agencies must be non profit Organisations, costs can be lower than in a commercial setting, and there is no interest in selling oversized solutions.

## Questions and Uncertainties

The risks for the Climate Bank are very low. Even if the owner of the properties should become insolvent, the agency is entitled to an amount corresponding to the current value of the investment when the real assets are sold. A greater risk occurs when property prices generally fall sharply, so that the sale yields insufficient income. This is a normal investment risk, which is very low thanks to the standard and relatively homogeneous investments required for ecological reconstruction.

If necessary, some legal frameworks may also need to be adapted. The following points should be noted:

- Solar installations and heating systems can be distinguished from a property. This is not possible with thermal insulation. As soon as an installation is inseparably linked to a building, it becomes part of the property, which means that the property owner also becomes the owner of the investment. So that such energy-saving renovations can also be financed via the Climate Bank, the appropriate legal adjustments must be made. This question is particularly important when selling a building.
- In the event of a real estate crisis, in the case of a bankrupt mortgage debtor, on the one hand the investment of the climate agency is included in the bankruptcy assets in addition to the building. On the other hand, the owner will also be pursued by the Climate Agency for his debt if he cannot pay the monthly instalments (depreciation + interest). This means that the Climate Agency can also assert claims.

# 2 Mobility

# Vision

The idea of avoid, shift and improve should be in the center of a new understanding of traffic. The most sustainable traffic is one that does not even exist. Less traffic is not a loss in quality of life; indeed it has to be seen as a gain for the society, environment, climate and oneself. Less traffic does not imply less mobility. The idea of striving for more and faster, is replaced by putting humans and quality of life for all beings in the center. Switching to active forms of mobility has many positive effects besides a reduction in GHG emissions - people are healthier, happier and it uses less space. Certainly, there is little individual traffic that will also in the future have to rely on motorized forms of transport. For that remaining individual and public motorized traffic, we envision a radical decarbonization and a more efficient use.

## People

By 2030 a drastic modal shift has taken place. Individual mobility highly decreased and the remaining means of transport are fossil-free and decarbonized. A convenient, safe and fast network of pedestrian routes, bike lanes and public transportation is developed on national and international scale. People choose to walk or go by bike as often as possible. This will lead not only to a decrease in GHG-emissions, but also to happier and healthier citizens. We imagine a sharp reduction in road traffic through different means, like adaptations of the public space or more efficient use of cars. The business sector is localized to reduce transport distance wherever possible and else acknowledges the vast potential and advantages of digitalization and move from physical meetings to telephone and video conferences. In many ways we already started to see the benefits of a decelerated life.

Specific needs are taken into account to ensure the diversity and characteristics of all regions: There is no single solution, but an intelligent mix of the required means of transport. Technical solutions facilitate car sharing, and multi-modal use of means of transport. Transportation becomes a collectivized public service and the era of private oversized cars is over. The remaining motorized means of transportation are light and powered by renewable and sustainable energy sources. Car traffic was slowed down on every level, which encourages people to travel less far. When still travelling long distances, one travels by train, since that is faster or more convenient than motorized individual mobility. Furthermore, people gain productive time, by being able to work or relax whilst being on the move and not having to steer a car.
The full price for transportation will be paid by the people who are moving, including emerging costs from possible environmental damage. This will lead to a decrease in traffic in general. There should be no incentives that possibly cause more traffic. If public transport was free, people might be encouraged to use it more or use public transport in the cities instead of biking or walking. Therefore, initiatives such as lowering the price of public transportation or subsidized general abonnement are not included in the policies. Nevertheless, social justice is an important issue and people who struggle financially must be supported sufficiently in general in order to have a budget that allows them to buy regular tickets for their journeys.

In air traffic, we imagine a massive reduction. Intra-European flights will be forbidden, and airlines do not benefit from any kind of financial advantages (like tax cuts, etc.). Flights are replaced by trains or technical solutions, such as video conferences and calls, whenever possible. The flights that are inevitable run on synthetic fuel, produced from renewable energy. When traveling to remote destinations, people take trips of multiple weeks and make the most of the experience instead of taking weekend trips.

## Cities

In Cities there will be almost no individually owned cars and City-Centers are mainly entirely car-free. With a close-mesh net of public transport, including automated vehicles, bike and foot lanes, there is in general no need for cars within cities for the transportation of passengers. These changes bring more advantages than disadvantages. Imagine a city, where the only sound is children laughing while playing in the streets and birds singing from trees, which could grow on all the space saved by reducing individual motorized traffic. There will be air as clean as in the mountains, as combustion engines are banned from ground transport. A prioritizing organization of public transport and its infrastructure and semi-centralized localization of mobility-hubs at the outer boundaries of cities make intermodal mobility possible.

## Agglomeration

People conveniently use an efficient system of public transportation. Within walking or biking distance or by public transit they reach a train station connecting them with their place of work or leisure. Furthermore, commuting by bike is safer and often faster than by car, due to a better cycling path network. Multimodal systems with hubs lead to an optimization of connections and more efficient transportation. The roads used for cars are reduced to give more space to pedestrian, bike lines and public transport.

## Rural Areas

In rural areas, technical solutions smartly using digitalization can be the key to sustainable mobility. Shared cars, small (maybe autonomous) busses are conveniently available on demand. With these means of transport, people living in rural areas can reach a train station connecting them with their place of work or leisure. Since mountain regions face specific challenges, and they should not be cut off, using a car might be unavoidable in some cases. Those cars will be electrical, whenever possible shared, and ride sharing should be introduced.

## Travelling abroad

The number of trips is reduced, people choose closer destinations and take more time for travel. The time efficiency is not the main driver but rather the minimization of the carbon impact of the travel. Flights will no longer be preferably used, as the differences between the prices for travelling with different means of transport will reflect the differences in environmental impact, and alternatives are sufficiently convenient. Hence, people will prefer the train or a public bus.

**Leisure:** The journey is part of the travel experience. Modest, socially and environmentally responsible tourism will prevent mass tourism from spoiling global hot spots. Longer travels allow a deeper, more meaningful and more personal engagement with other cultures and places. Short vacations are spent close to home.

**Business:** The hectic air-commuter life is replaced by digital solutions. Instead of spending evenings at security checks, one will be at home with family or friends.

**Europe:** Europe is connected by a vast network of railways; thus, all travel is carried out with trains. Night train connections lead to more comfort, and convenience in travel. There are no flight connections between European cities, they are unnecessary.

**Intercontinental:** Overseas travel is seen as a once in a lifetime experience with sufficient time to stay in the destination. Therefore, they are mostly taken by ship, since the trip there is seen as part of the experience. Cross-ocean ship lines are re-opened with energy efficient decarbonized boats that are considered as means of transportation and not means of leisure. Leisure cruise ships are forbidden due to their disastrous carbon emissions and impact on the sea biodiversity.

# Cargo

The challenges for cargo transportation are overcome by a change in consumption and a modal shift.

**Consumption:** The total tons of goods transported in Switzerland has been reduced, since people tend to see value in quality rather than quantity and a shift in the consumer behavior is taking place to a more sustainable use of goods. Goods will be produced long-lasting, durable and whenever possible with local means. Therefore, people are more connected to the production of their goods. We are satisfied without instant delivery and very limited products coming from the other side of the planet or depending on raw materials from other continents. Consumption of locally produced goods is encouraged by policies that increase the price of goods coming from further abroad and labels with their carbon impact on every product are implemented to raise awareness to the consumers. Over-consumption is stopped, and people become aware of what they consume. A circular economy is established through upcycling of goods, secondhand shopping, repair cafés, and by product design that keeps the whole cycle in mind.

**Modal Shift:** By 2030, a drastic modal shift has taken place in the Swiss cargo sector. Rails become the main mean of transportation in the conveyances of goods for medium and long distances. Central sorting stations in cities connect rails, underground cargo routes and bikes are key points in the developed conveyances sector to make the system efficient. Railways are built to directly connect the factories and storing facilities with the railways. Cargo-bikes play an important role in transportation within the cities. Bicycles are the most efficient and sustainable means of transport and in the future their full potential will be used for the transportation of goods. With smart technologies and digitalization, systems have evolved to create an interplay between bikes and trains. Furthermore, heavy goods will be transported by electric or hydrogen and fuel cell powered trucks. Efficient systems and specific policy measurements result in economically attractive conditions for decarbonized freight transportations. Because of policy measures and rise of the fuel price, carbonized freight transportations are becoming economically disadvantageous.

# Current Situation

## Ground Transport

Mobility continually changes due to lifestyles, new business models, and technological progress. Agglomerations, rural, and urban areas demand different solutions, to ensure their access to the traffic system (FOEN 2018). A well-functioning traffic system is the basis of our society. Over time the means of transport have gotten faster. The passenger car has transformed modern life. It led seemingly to a gain of reachability. No matter where one lives, places get accessible more easily. The increase in speed, basically through the introduction of passenger cars and the acceleration of street-infrastructure - mainly from the 60ties up to today - as well as the improvement of railways' supply, allows people to get further in the same time. For many people in Switzerland today, living, working, leisure, shopping, family, and friends often are wide apart. As the means of transportation got faster the travel distances simply got longer but the time spent on mobility stayed constant (Knoflacher 2013). Spatial planning has supported this trend. Small-scale, local structures are lost. The build-up of transport infrastructure is an essential driver of urban sprawl, between 1970 and 2017 the Swiss road network of national roads almost increased by a factor of 3 (FSO 2018).

The implications are varied. The quality of stay in cities has lowered, as well as a sense of belonging. The increase in speed has led to a decrease in quality of life. Beautiful town centers have become dormitory towns.
While mobility has stayed the same, traffic has increased. Next to high emission rates, road traffic has a negative impact on air quality, and high noise levels. Cities are clogged with traffic and air pollution. We are facing a complex challenge that needs taking into consideration different aspects, finding reasonable solutions that are tailored to different regions, and setting priorities consistently.

### Mobility in Switzerland

Traffic is the area that accounts for the most significant share of total GHG emissions in Switzerland. Of all inland emissions (international air transport excluded), traffic emits 32% of Switzerland's GHG emissions (Frischknecht et al. 2019). That fact makes ground transportation an area of major concern. In contrast to the sectors industry and building, the traffic sector has not shown decreasing numbers of GHG emissions. Even though energy efficiency has risen, the increase in traffic volumes has overcompensated this gain—the average kilometers driven by car increase every year (Akademien der Wissenschaften Schweiz 2016). Moreover, the fleet of vehicles is increasing (FOEN 2018). Of the 32% GHG emissions caused by traffic, 98% is due to road traffic ( BAFU 2019). That makes road traffic the single largest source of GHG emissions in Switzerland.

The average Swiss person covers a distance of 24'489 km (13'754 domestic, 11'095 abroad) per year (ARE, 2015). On average, per day, a person is commuting 90.4 Minutes and 36.8 km, with cars being the main means of transport (65%) (FSO 2017b). The purposes for which these distances were traveled vary. While most cars were built to transport five people plus luggage, on average 1.6 people sit in a car, during rush hour it is only 1.1 people (FSO 2017b). The most significant shares consist of leisure travel with 44% and work commute 24% (FSO 2017b).

The choice of means of transport and daily km depend on the level of urbanization. In general, people living in the city have a shorter daily distance covered than people living in agglomerations. The most extensive daily distances are covered by people living in rural areas. Figure 1 illustrates that the more urbanized the place of living is, the less km are covered by motorized individual transport, and the more on foot, or by bike. Moreover, the choice of means of transport also varies between gender, age group, language region, and income (BFS, 2017).

However, figure 1 states that cars are the means of transport used for the most significant share of the daily distance (BFS, 2017).

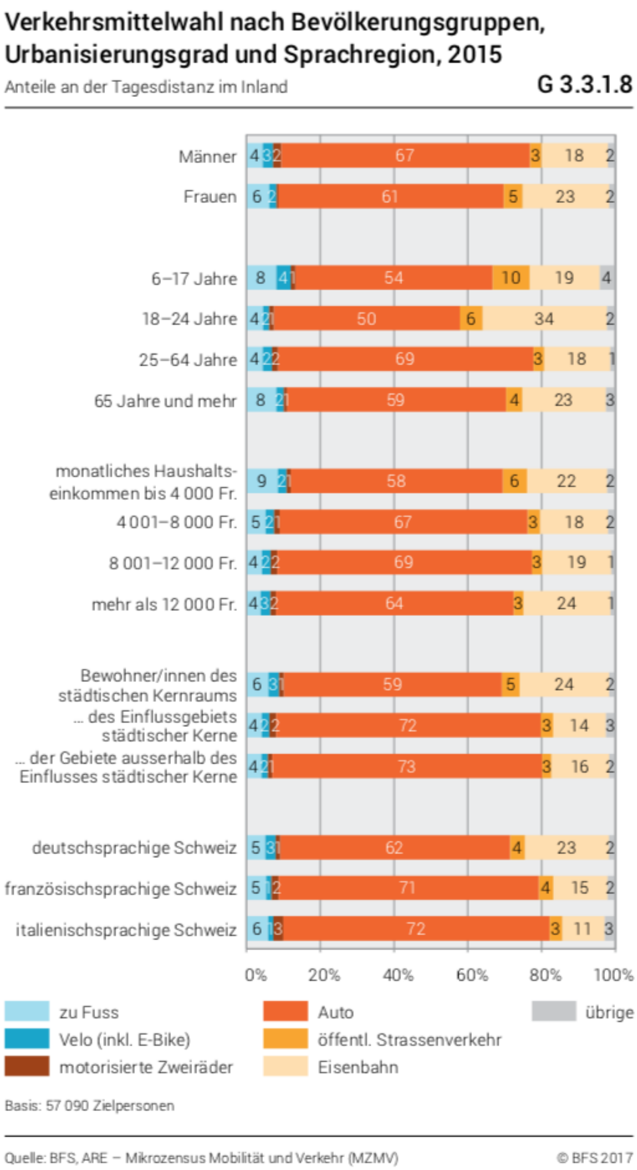



*Figure 2-1: The difference in modal choice between age, gender, level of urbanization, monthly income per household and language region. Means of transport are: by foot, bicycle, bike, car, public transport (excluding trains), trains and others (BFS 2017).*

## A Comparison of Means of Transport

Life cycle assessments studies show comparable high greenhouse gas emissions for all fossil energy operated powertrain technologies and comparable low greenhouse gas emissions for renewable energy operated powertrains.

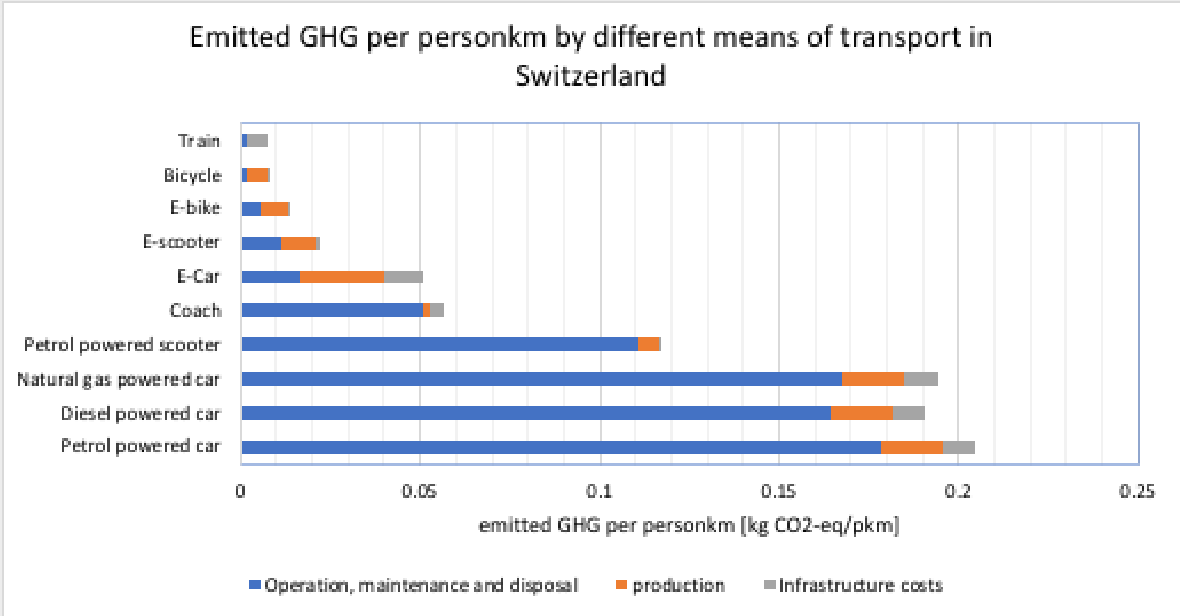



*Figure 2-2: The emitted GHG emission per person-km [kgCO2-eq/pkm] in Switzerland compared between the different means of transport. Included are the GHG emissions produced through the provided infrastructure, the production, and the operation (including maintenance and disposal). Based on ESU-Database 2020. Electric vehicles were modeled with green power as energy sources (ESU 2020).*

## Cost of Transportation

The Federal Office for Spatial Development presents precise numbers concerning costs and benefits of traffic (FSO 2017b): In 2016, the external costs of mobility (air pollution, noise, GHG-emissions, accidents) in Switzerland accounted for 13.3 billion (FSO 2017b). The transportation of people causes 81 % of external costs of traffic in Switzerland. Moreover, the ARE assigned ⅔ of the external climate-costs by traffic to road transport (FSO 2017b).

However, it is unconscionable to fix a monetary cost for the effects of traffic. While accidents and noise can be estimated, it is impossible to price the impacts of an emitted ton of GHG reasonably. Firstly, how could we rate damages to human well-being and loss of life beyond reduced economic output? (Stern 2016) Secondly, as the effects of climate change accelerate with every further emission, the marginal cost of a ton GHG must increase as well. Furthermore, since climate change does not linearly depend on the amount of CO2eq in the atmosphere, the cost of each ton CO2eq emitted is not constant but increasing. Nevertheless, if there is a reasonable price for a ton of GHG emissions, it would be the price for effectively removing and storing it for 10’000 years, including the risk of overshoot.

It is difficult to estimate the cost of emissions. But the relation between household income and the expenses for public and private mobility are well known (Figure 3). Although road transport is responsible for the majority of the external costs, it has become significantly cheaper in recent years. However, prices for public transportation have increased steadily. This means incentives are currently set towards private mobility and against less emissions intense alternatives like public transport.

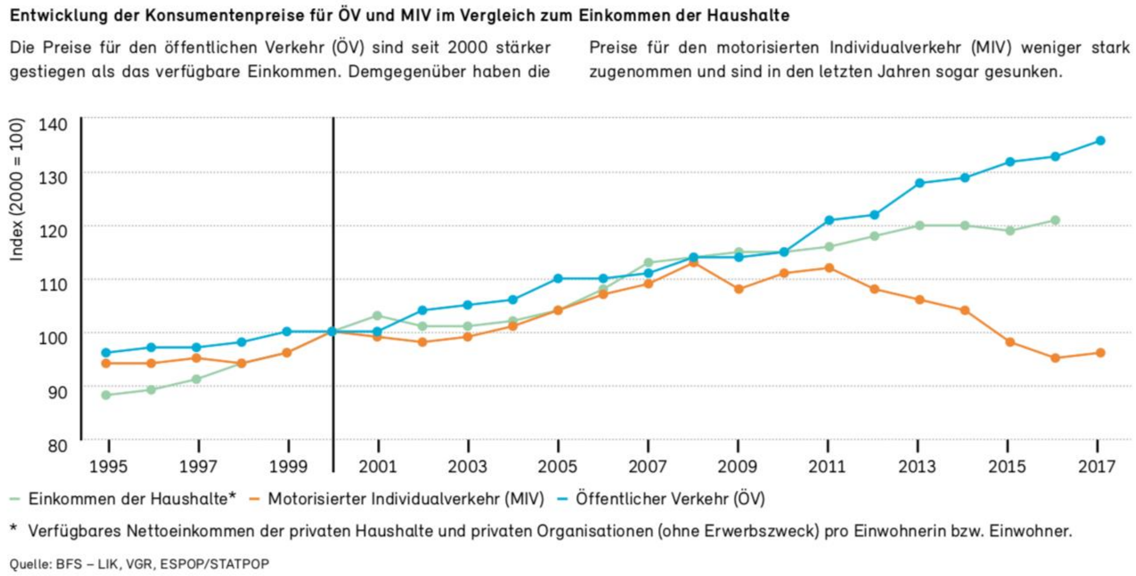



*Figure 2-3: Development of prices for public transport and private mobility, set in relation to the income of households. Since 2010, the trends of the different parameters are diverging (BFS 2018).*

## Parliamentary Procedural Requests

There had been several attempts to tackle the tremendous GHG emissions from the transport sector. However, the federal council proposed the rejection of a recent request that would align swiss road traffic laws with the Paris agreement (DETEC 2019). The board argued that it would propose long-term goals to the parliament for the strategy after 2030. So far, the federal council neglected calls to Act-Now and take responsibility in the current crisis, as he had set all goals for 2050. Moreover, a primary goal of cost-benefits analysis conducted by the Swiss government in road infrastructure projects is a reduction of the commuting time(DETEC 2019). In the past, a reduction of the commuting time resulted in longer distances travelled by individuals and the actual time spent for mobility stayed constant (Knoflacher 2013). Hence, an increase in traffic volume is promoted. At the present state, the government rejected all attempts to substantially reduce traffic and tackle emission issues in the transport sector. Although, the mobility sector is the key driver in missing the Swiss climate goals of 2020 (SRF).

## Freight Transport

Figure 4 illustrates that nowadays, 19% more goods are transported on roads and rail in Switzerland compared to the year 2000. The increase in commodities is predominantly carried by transportation on roads (FSO 2019b). Since, the majority of the growth in the transport sector has taken place in the private motorization division, the GHG emissions increased substantially.

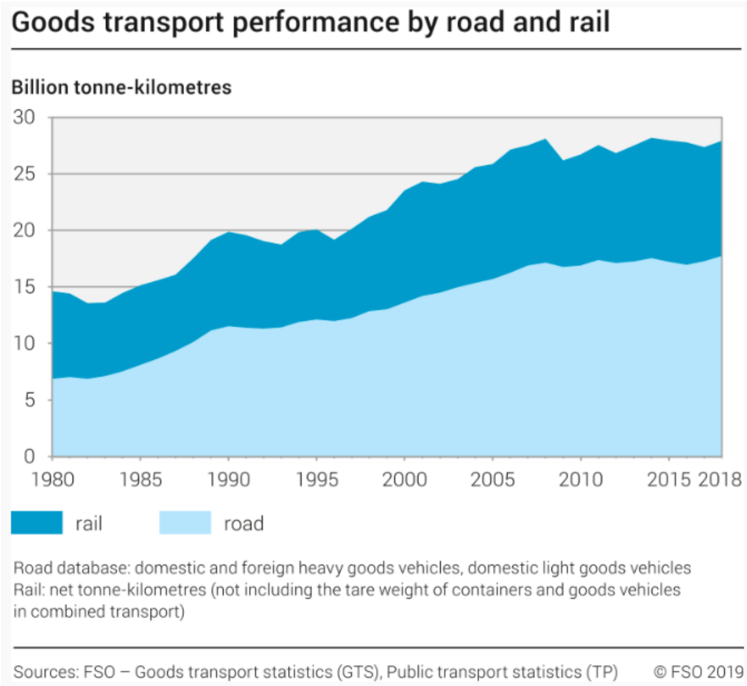



*Figure 2-4: The amount of goods transported on roads and rails plotted over time. On roads, domestic and foreign heavy vehicle goods and domestic light vehicle goods are represented. The graph does not include the tare weight of containers into the amount of goods transported on rails* (FSO 2019c).

For freight transport, the majority (61%) is transported on roads and 39% on railways in 2016 (FSO 2019c). Between 2000 and 2016, the share of goods transported on the road increased three times more compared to the share transported on the railway (FOEN 2018). Consequently, the number of trucks and delivery vehicles in Switzerland is increasing drastically (60% increase for delivery vehicles and a 41% increase for articulated trucks since 2000). The rise in delivery vehicles (363,000 in 2017) can be strongly correlated to the enormous growth in the domestic transport sector (nearly 5 percent increase in 2018) (FSO 2019c). Moreover, trends of the ARE reference scenarios (2015) consider growth of 37% in the tons of goods transported by 2040. Compared with the population growth of 22% until 2045 (BFS 2015)this would lead to a substantial increase in the transport volume per person. Furthermore, the ARE scenario suggests that the split between road and rail transport will be nearly identical to the present, with road transports dominating the sector by covering 84.2% of all conveyances. Thus, if nothing changes the transport sector will list a considerable rise of GHG emission.

# Waterborne Transport

Traffic is not only caused by bringing people from A to B. The transportation of goods takes up a big share in the traffic sector. Therefore, the way we consume and the journey our goods take plays a crucial role in the discussion about the mobility sector. By only focussing on inland traffic, we do not get the whole picture. Both travelling abroad and importing goods have to be included. Thus, water transport has to be looked at next to air and land transport, even if on the first glance it seems to be neglectable in a landlocked country like Switzerland. In our highly connected global society, it truely can not be left aside. 90 percent of all goods consumed are being transported by ship (Delestrac 2016). But transparency for consumers is missing. Finding out how far a product has traveled and what it means environmentally and socially is not easy. Big ports are outside city centers and therefore invisible to the public. Today's cargo ships are bigger than the Titanic, and keep being bigger and bigger. The economic incentives for producers support long transportation ways, regardless of the environmental or social costs. Economically seen it is favourable to transport goods around the world, as long as somewhere labour costs are so cheap that they outweigh what is needed to be spent on transporting the goods to the country where they are consumed. The low transportation costs are only possible if people are exploited (poor working conditions) and the environmental consequences are neglected (and costs are not paid by consumers). The consequences of current shipping practices on nature and humans are various: Inhumane working conditions lead to accidents with freight ships that lead to leakage of fuel and as a consequence destroy maritime habitat and cause pollution - as laws and regulations of the country under which flag a ship is run are applicable, “western” environmental and social standards do not apply. Pumping ocean water in and out to stabilize the ship and the massive noise level ships cause, have a drastic impact on the ecosystem ocean and the fish. Dirty fuel (residual fuel, which is not allowed for cars) causes air pollution that leads to health issues for people living near ports. For the customer ordering/buying a product it seems to be clean and simple: It takes a mouse click and a few days waiting or going to a store and buying it cheap. In Switzerland 10% of imported goods arrive by ship (FOC 2016). The most important (and practically the only) entry points are the "Schweizerischen Rheinhäfen" in Muttenz-Au (BL), Birsfelden (BL) and Kleinhüningen (BS).

Just as convenient as it is to buy goods that have been produced far away, is to go on a cruise. Hopping on a ship and enjoying two weeks of all inclusive travel on a floating hotel entertainment island. Ship motors cause not only greenhouse gas emissions but other environmental impacts. A Swiss study shows that the most important criteria in environmental friendly travelling are how the destination is reached, the relation between travel distance and time spent in the destination as well as renouncing environment damaging activities such as cruises (Büsser, Stucki, and Jungbluth 2010).

Summing up, the transport sector accounts for 27 percent, international shipping accounts for 2 percent of all global GHG-emissions (FOEN 2018). The International Maritime Organization has recently updated its own estimate and has found that international maritime activity emitted a total of 1,120 Mt of CO2 – more than twice the IEA estimate for 2005 (IMO) and more than emission produces by global aviation industry (Marine transport and CO2 emissions)

Beside GHG-emission, shipping also contributes to climate change by emitting "black carbon" produced by combustion of heavy fuel oil. Black carbon accounts for 21% of CO2eq emission from ships, making it the second most important driver of shipping's climate impacts after carbon dioxide. No regulations are controlling these black carbon emissions (Transport and environment, 2020).

Moreover, another aspect of which shipping impacts climate change is the by transporting living organisms (though ballast water taking up to stabilize the boat) from different ecosystem creating invasive species that are responsible for destroying marine ecosystems and threaten the life of endangered species. Shipping accounts for 60-90 % of the introduction of exotic species into new territories (Sardain, Sardain, and Leung 2019) and approximately 42 of threatened or endangered species are at high risk due to invasive species (The National Wildlife Federation 2020). Another aspect that is threatening for marine wildlife is the low frequencies emitted by the freighters, they are causing severe earring defects, communication problems and difficulties to orient themselves (Southall et al. 2017).

Even if the share of shipping is globally seen not the biggest, and in Switzerland's CO2-emission analysis transport by ship is even only mentioned in the category "others" (IEA, n.d.), it is a sector that has a lot of potential for improvement and needs to be taken in consideration not only for this fact but as it has various other negative environmental and social impacts and can be assumed to increase in the future.

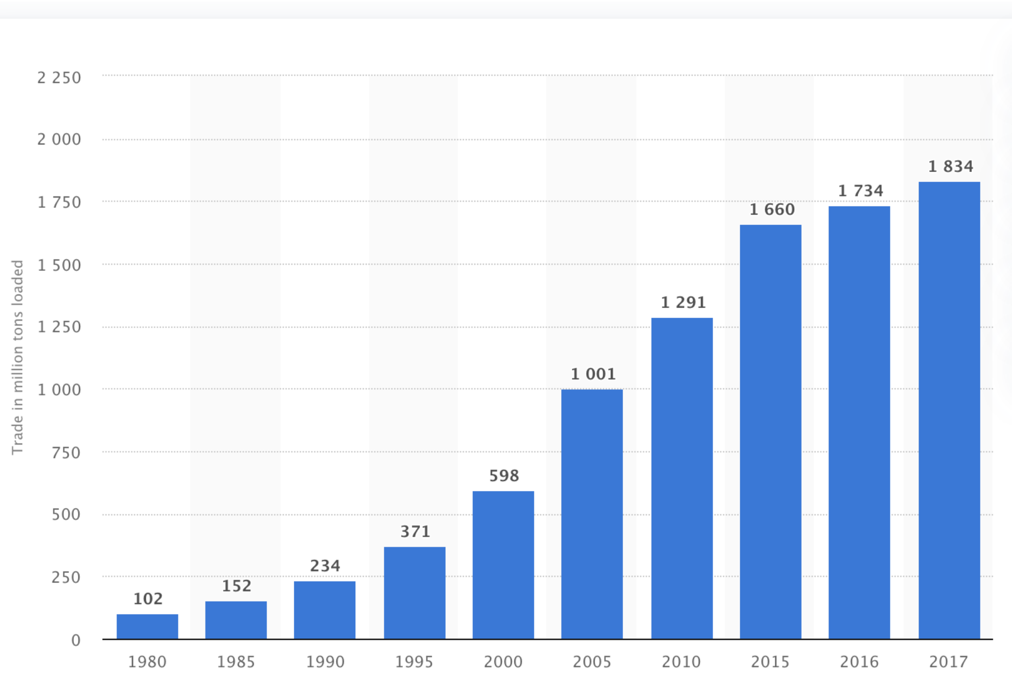



*Figure 2-5: World Seaborne trade carried by container ships from 1980 to 2017 (in millions tonnes loaded). Statistica 2020.*

# Aviation

Airplanes are the means of transportation with the highest emissions per passenger kilometer (see Figure 2-6 below) and an extreme intensity of emissions per time unit. Moreover, airplanes do not "only" have CO2 emissions, in addition they also produce non-CO2 emissions which may have similar heating effects than CO2 emission. With multiple passengers per car, an electric car or even a bus or train, the emissions are much lower. Moreover, by being much faster, air travel gives people the option to travel longer distances than they would by car and so considerably increase their travel-related emissions in absolute terms.

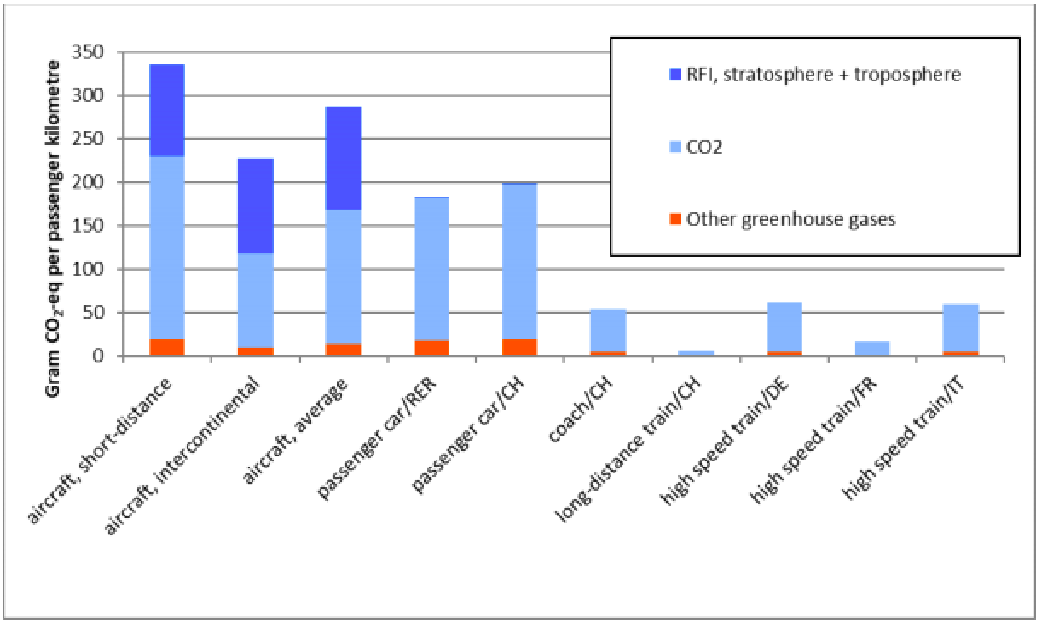



*Figure 2-6: Global warming potential per passenger kilometer for planes, cars, coaches and trains* (Jungbluth and Meili 2018). *The BBC reported comparable statistics* (Timperley 2020).

## Aviation in Switzerland:

The aviation sector is growing faster than any other sector in mobility (see Figure 2-7). About a third of the distance is traveled by airplane, 8’986 km of 24’849 km to be exact (FSO 2019d). Aviation leads to climate change through two different pathways. One pathway is through the emission of carbon dioxide from fossil fuel combustion. In Switzerland, at least about 12% of CO2 emissions are from aviation, worldwide only 2-2.5% (BAZL, n.d.)(Die Bundesversammlung 2019a). The second pathway is from short-lived greenhouse gases - primarily water and particles – coming from high altitude combustion. These can combine to form persistent contrails, which may have a significant warming effect. There are, however, great uncertainties when it comes to analyzing the impact of non-CO2-factors of aviation, which makes it difficult to quantify the total impact of airplanes on the climate. In 2015, the WWF attributed to aviation 18% of climate warming effects in Switzerland (WWF, n.d.).

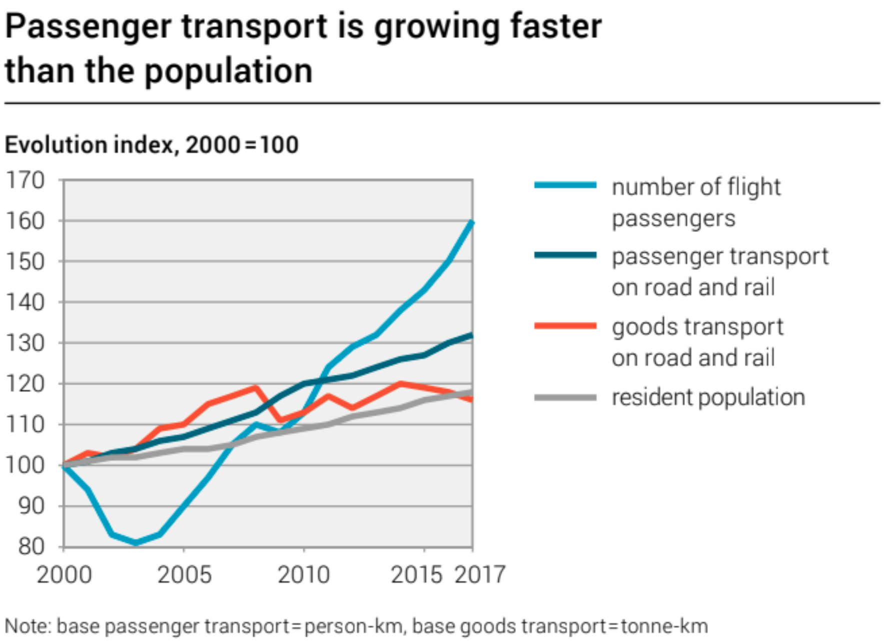



*Figure 2-7: Growth Flight Passengers* (FSO 2019d). *The number of flight passengers has grown by over 60% in the last two decades, much more than the population and other modes of transport have increased. The decrease in aviation from 2000-2003 was due to the 09/11 attacks.*

In 2018, aviation fuel made up 9.7% of Swiss energy consumption, a total of 1’858’000 tons aviation fuel (SFOE 2020), resulting in 5.74 million tons CO2 annually, on average, about 0.8 tons per person (Die Bundesversammlung 2019a). This has to be compared with the total current emissions of 5 tons per citizen (not including imports, which are adding another 6 tons), and the federal target of 1 to 1.5 tons per person by 2050 (FOEN 2018). As a reference, an economy return flight to New York produces about 2 tons CO2 (myclimate, n.d.).
In 2018, 77% of air passengers had destinations in Europe (FSO 2019d); the most prominent reasons are fast travel time and convenience (FSO 2019d). Hence, very often people choose flights over alternatives, even if they are available. Swiss citizens take about 0.8 trips a year, split into 0.1 for work and 0.7 for leisure/holidays. People with higher income fly much more than poorer people (FSO 2019d), meaning privileged people cause much more harm with their lifestyle than the rest of the population.

## Technological Options

At the moment, there are very limited technical possibilities for making flying carbon dioxide neutral. Due to its high energy density, kerosene will probably continue to be the primary energy source for aviation. Since electrical batteries are too heavy and biofuels cause additional problems such as land conflicts and deforestation as well as hydrogen fuel cells use too much space in airplanes. Synthetic fuels made from renewable energy is the most promising option for the next decades. However, it is a technology that has to be still tested and implemented in the coming decades. One of the biggest global challenges will be to produce enough surplus renewable energy to synthesize such fuel. It is unlikely that significant quantities of synthetic fuel would be produced in Switzerland, due to relatively weak solar and wind resources, and issues of land availability.

## Change in Consumer Behavior

Flying has become very affordable. While it used to be a privilege, flying is now seen as a necessity to maintain a particular lifestyle. The decreased cost of flights in the past decades, triggered a significant increase in flights for leisure as well as jobs requiring flying multiple times per week. A deep change in the consumer behavior will be needed to achieve the goal of net-zero CO2 emission by 2030.

The reasons for aviation's low cost are its speed -- which reduces labor and capital costs per passenger kilometer -- and its efficient infrastructure requirements relative to ground transportation, for which road and rail networks need to be built and maintained. Moreover, flying benefits from fiscal exemptions and other indirect subsidies. The long-term goal is to make aviation clean. In the meantime, there is a need to drastically reduce aviation and long-distance transportation in general.

# Policy Measures: Ground Transport

## Policy 2.1: Re-Prioritization of the Traffic System

An adjustment of Art. 88 in the federal constitution accompanied by the establishment of local planning processes should be established by 2021 in order to ensure pedestrians and cyclists will get the infrastructure they need to move safely and fast.

### Description

The most sustainable ways of transport are walking and biking. Even if just in 2018 article 88 (Schweizerische Eidgenossenschaft 2016) was adjusted in favor of cyclists, it does not at all go far enough. It is crucial to have a network of safe, fast and direct connections on national, cantonal and communal levels for both pedestrians and cyclists. Today the car is often first in planning. First comes the road, then the space left is divided amongst pedestrians and cyclists.

The constitution should ensure that there is a re-prioritization in planning for the traffic carriers as following: 1. pedestrians, 2. bike, 3. public transport, 4. rail, 5. road, 6. air. An adjustment of article 88 (Foot, hiking and bicycle paths) supports a development so that cycling and walking will be given the value it deserves. Such a change needs to be binding not only on national, but on cantonal and communal level. The above mentioned prioritization should be the basis of all projects (construction site, reinstatement work, new construction, crossroads, traffic lights, traffic concepts, traffic space design). The process needs to be adjusted to local needs and include the specific needs of the people.

Besides framing a change on a high level, locally adjusted solutions are crucial in order to make change happen. By realizing local planning processes on communal level, traffic space should be redesigned to spaces of living for humans. As each commune, each city is different there is no single solution that can be adapted anywhere. Not regarding how to design the process, nor what needs to be done. The above described re-prioritization may serve as a guideline. Furthermore, all political and legal frameworks and programs treating traffic (Cantonal constitutions, municipal constitutions, federal sectoral plans, cantonal/communal structure plans, mission statements, projects) need to be adjusted towards a re-prioritization of traffic modes.

### Financing

The National Roads and Agglomeration Fund (NAF/FORTA/FOSTRA) will be adjusted as suggested in policy "Freezing federal road capacity". Money no longer used for building road capacities for motorized individual traffic, will partly be used in order to finance a safe, fast and direct network for pedestrians and cyclists.

### Impact

A re-prioritization of the traffic carriers is necessary on all levels: in cities, neighborhoods, single streets and so on. Thereby quality of stay and quality of living can be increased tremendously. By re-allocating space that has been taken up by cars, and making it available to people, new livable city centers, neighborhoods and residential areas are developed. It can be expected that people tend to stay in their surroundings more often and satisfy more of their needs within their close surroundings. The energy demand for and the impact of mobility will decrease. Cycling and walking will be safer and more attractive. People will switch to these modes of transport.

### Social Compatibility

Changing mobility habits are favorable for everyone. To name some examples: On an individual level, more physical movement leads to healthier and happier people, as well as lower health care costs. An increase in the quality of stay leads to busy streets and enlivened cities and therefore is also good and favorable for local businesses. Neighborhoods with more public, more green space and slower forms of mobility are safer for children and are inviting to relax.

## Policy 2.2: Reallocation of Existing Infrastructure

The introduction of a legal regulation on cantonal and communal level to reallocate 50 percent of the existing infrastructure for private cars in public spaces to pedestrians, cyclists and public transport and car sharing until 2030, should lead to a traffic revolution.

### Description

Rolling and standing motorized individual traffic uses a lot of space. Imagine a person walking around carrying a wooden frame of the size of a car. Silly, no? Often people sit alone in their car, claiming a ridiculous amount of space for themselves. Naturally. Cyclists often do not have separate lanes to comfortably ride from A to B. Pedestrians wait at crossroads and face high curbstones with a walking frame or pushchairs. Here and there you find a tree, or some square meters of lawn in cities. Green spaces are rare. During rush hour public busses queue in line with private cars. Kids play between parked cars. By introducing a legal regulation that obliges communities and cantons to reallocate space, this could be changed. The goal is:

- Elimination of legal obligations for building parking-space.
- Introduction of the principle of equidistance (distance to reach a private car, needs to be no shorter than to public transportation).
- Less space for motorized individual traffic, more space for foot, bike and public transport.
- More green space, recreational space, public space.
- Separate lanes for bikes, public transport (also on highways), car sharing.
- Provide charging infrastructure for e-mobility (bikes and cars).
- Central car parking facilities, replace scattered parking spaces taking up public space.
- Parking spaces for motorized traffic are charged everywhere, always from the first minute on.
- Covered and sufficient parking facilities for bikes are provided.
- And more.

### Financing

Expected costs are moderate, as the principle is not to build more and new infrastructure but reuse the existing one.

### Impact

A new mobility is possible. The basis will be laid for a green mobility. People are being expected to switch to other forms of mobility. Cars parked further from home (exception for people with limited mobility) will induce an increase in use of public transport but reducing convenience of having car parks right in front of our place compared to public transports that often require a few minutes walking. Living areas will be liberated from parked cars and traffic. Traffic caused from seeking a parking lot will be eliminated. Thus, in densely populated areas this will lead to more space for people and a higher quality of life.

### Social Compatibility

The elimination of the dominance of the car in all areas of our lives leads to new qualities. Kids can play safely in the streets, people meet outdoors. People reclaim the streets.

# Policy 2.3: Introduction of a New Smart Multimodality for People and Cargo

Two key offers can lower the barriers to switch from the private car to a way of combining different means of transport in the best way possible. The introduction of a hub-system all over Switzerland and a close-mesh of car- and bike-sharing offers, make it easy to change. In freight transport the introduction of hub-systems will supersede road transport.

### Description

Public transportation is already today more convenient than driving a car - on certain routes. Indeed it is often not faster or cheaper. The variety of different means of transport should be utilized, in order to always use the best option climate wise and at the same time increase passenger comfort to facilitate switching. Mobility will be seen as a whole, and offered as public service. Owning a private car is no longer necessary. By introducing a close-mesh offer of car-sharing possibilities, it is more convenient to share and it is cheaper than owning a private car. The advantages of digitalization can be used in a smart way, in order to make sharing more easy.

Today there is more or less a net of roads/ways for each mode of transport. There are roads for cars, lanes for busses, ways for pedestrians, lanes for bicycles, tracks for trains. These systems are mostly planned besides each other. If the different modes of transport would no longer be taken each on its own, but seen interrelated, each one could be used there where it makes most sense. Cars are of little use within a city, but might be the best choice for remote places. A hub-system would allow people to switch from one to the other mode of transport easily, and always use the one that is the smartest choice. A journey must not be made with one single mode of transport, but switching between is easily possible. Following preconditions are necessary for a functioning hub-system and support multi-modality:

- Compatibility of public transport and bike: There needs to be attractive and enough offers to transport the bike with public bus, or train.
- Smart use of Digitalization: Use of booking systems, apps to reduce climate impact: e.g. bus on demand/reservation.
- International connection: Switzerland is no island. One needs to think mobility across borders. There need to be connection points to neighboring countries.
- Cargo sorting stations and direct railway access: What applies for people, applies for cargo. It needs to be reloaded: from road to rail / from road to bike (inner city). Infrastructure to connect central sorting and storage factories to railway network.

- Parking infrastructure: Parking outside city centers with rental bike stations/ access to railway.

Sharing needs to be more attractive than owning. The private car slowly loses importance for younger generations. The convenience of using and owning a private car needs to be reduced, as this comfort for one person today comes at the cost of the society as a whole. Where a car still makes more sense, than keeping up capacities of public transport that are not utilized efficiently, car-sharing is key. These offers need to be placed at sparsely populated areas where few people live and at hub-stations. In urban areas foot, bike and public transport are favorable. Moreover cargo bikes have a great potential, when it comes to short distances that need to be covered transporting for example groceries or kids. However not everybody needs to own a cargo bike. The availability of a cargo bike sometimes renders the use of a car unnecessary. The same applies for bikes in general. There is big potential especially in urban areas to complement public transport with an attractive bike sharing offer. In order to foster (cargo-)bike-/ and car-sharing and introduce it at the right spot the following preconditions need to be given:

**Car-sharing**

- Close-mesh offer: The offer needs to be big enough in order to be more attractive than a private car. For a transition phase cars can be placed within cities. In the Long term, shared cars should also be banned from the city centers and be placed where it makes most sense to have a flexible offer. Either there are fixed stations, or a free flow system combined with an app, showing where the next available car is.
- Important role in mountain regions: The private car often seems indispensable in mountain regions. Especially in mountain villages car-sharing this could be a smart way to reach public transport and simply switch at the next station. This offer needs to be supported in the form of a public service.
- Framework: This system needs to be set in place by communities, cities and cantons. Private public partnerships are an option, especially energy suppliers (synergy peaks energy supply and demand, combined with the storage in e-vessels).

**Cargo-bike-sharing**

- Lower entry-barriers: The offer needs to be visible, handy and known. People have to get used to cargo bikes. It might take offers for free trials, or even guided courses.
- Easy-access: Cargo-bikes need to be placed where they are needed. This can be near shopping facilities or where many families live.

**Bike-sharing**

- Where there is little or a lot of public transport: Bike sharing can be useful either in dense areas (cities) to complement the offer of public transport, or where there is little offer of public transport (remote, mountain areas).

## Financing

User pays principle.

## Impact

A different mobility culture is being fostered. Cars are less frequently privately owned and are shared effectively or replaced by bikes or cargo-bikes (Less cars, lower use of space). Moreover, smart multimodality results in less GHG intense forms of transportation for commuting, leisure and goods.

## Social Compatibility

Maintenance is divided (less time per user, than private car/bike) meaning more free time per person.

# Policy 2.4: Car-Free Cities

From 2025 all major cities in Switzerland are car-free. The already existing offer of public transport in the city and the proximity of everything allows it to cover all mobility needs by foot, bike and public transportation. The distribution of goods will largely be handled by cargo bikes.

## Description

Individual motorized traffic should be banned from cities' urban areas. Alternatives (foot, bike, public transport) taking less space for traffic and leaving more space for life, take over. Motorized traffic is only applied for the exceptions of supplies for the population and businesses, keeping up public services, public transportation, as well as mobility for people with disabilities. Communal constitutions need to be adjusted accordingly. Whilst the public transportation for people in many cities already is on a high level, the system for a non-motorized distribution of goods needs to be expanded. Cargo bikes play an important role. Today trucks and delivery vans drive right into the city. In the vision of a car free city, all goods possible are reloaded at hubs at the city border. These hubs ideally are also connected to the railway system. Trucks and trains are unloaded there, the goods are loaded onto cargo bikes, which overtake the fine distribution within the city.
Imagine a city that is no longer built around streets for cars, but built for humans: Clean air, little noise, save surroundings, a space where humans meet.

## Financing

No financing required.

## Impact

Space is being reclaimed by the people. New utilizations of the space are open for collaborative processes.
Cities will be safer for bikes and pedestrians.
Increase in air quality and sound pollution leading to higher quality of life.

## Social Compatibility

Quality of life for inhabitants and quality of stay for visitors in cities increases tremendously. Exceptions (e.g. for people with disabilities) allow everyone to participate.

# Policy 2.5: Suspension of Federal Road Construction

In the chapter cross-sectoral policies a moratorium on new infrastructure until 2030 is being proposed (see Policy 1.1). This general moratorium on new infrastructure includes buildings and roads and targets the emissions from construction work. A suspension of federal road construction for motorized individual traffic, would also break the vicious cycle of more roads leading to more traffic. The establishment of a suspension of federal road construction (including new motorway junctions) by 2021 in the federal constitution by an adjustment of Art. 83, is therefore an important step that needs to be established as soon as possible.

## Description

The motorized traffic leads to more than 30 percent of total GHG emissions in Switzerland (FSO 2018). Traffic showed an increase in the past and can be expected to increase strongly in the future if nothing changes. The increase in traffic cannot simply be explained by population growth. Numbers show that traffic grows stronger than population (FSO 2018). Especially on federal roads (DETEC 2018). Current federal politics foster an expansion of road capacities. The problem: More roads lead to more traffic. Motorized individual traffic has more than quintupled since 1960. Meeting that fact by building new roads and increasing capacities is a vicious cycle. Therefore, financing for planning and extension of federal roads through the National Roads and Agglomeration Fund (NAF/FORTA/FOSTRA) should be suspended immediately. A reassessment and adjustment of the STEP (Strategisches Entwicklungsprogramm Nationalstrassen) is necessary.

## Financing

The NAF/FORTA/FOSTRA was established in 2017, in order to secure financing for maintenance, extension and elimination of traffic bottlenecks of federal roads, as well as supporting projects such as new tram lines and pedestrian and bicycle lanes. In total 3 billion CHF are available. Maintenance will be even more expensive than included in the budget. A big share of this money will not be used for the initial purpose, if a suspension of federal road construction is being decided, therefore it could be invested in climate-conscious forms of mobility (see policy “Improve capacity for walking and biking” and “Introduction of foot-/ and bike tax release”) and projects for noise remediation.

## Impact

A suspension of federal road construction leads directly to a decrease in GHG emissions (road construction, which is CO2-intense, will not be done), in the long run a switch to more climate-friendly forms of traffic can be expected. The most important impacts are in fact that the growth of supply driven traffic (infrastructural induced traffic) as well as further soil sealing and the loss of green space can be avoided.

## Social Compatibility

There is a positive overall effect on quality of life (noise, air quality) to be expected, of which all people and especially residents near roads profit.

People working on road work might face higher unemployment rate, therefore accompanying measures will be taken to facilitate professional reintegration. These measures are described in the chapter on economic and political structures (see Policy 9.1).

# Policy 2.6: Prohibition on the Sale of Fossil Vehicle Fuel and Fossil Electricity

The sale of fossil vehicle fuels and fossil electricity will be prohibited by 2030. This policy assures that only renewable energy will be used in mobility and provides an additional incentive for people to avoid purchasing new ICE vehicles prior to 2025.

## Description

A prohibition on the sale of fossil-based light vehicle fuels will aid the decarbonization of road traffic and support the transition to electric cars. The ban of fossil electricity assures that electric mobility will be fueled exclusively with renewable energies. Thus, the CO2 intensity of electric vehicles will be reduced drastically (PSI, 2018). As we describe in Policy 2.7, sales of new ICE vehicles will cease in 2025. Five years later, a prohibition on the sale of fossil fuel will go into effect.

For heavy vehicles and industrial and agricultural vehicles, there are no technological alternatives to liquid fuels yet. Thus, waste based as well as biofuels and synthetic fuels from renewable energy sources that have proved at least a 50% reduction on GHG, will be used for such vehicles. This is an interim solution until other technologies such as hydrogen-powered or heavy BEV that achieve higher GHG reductions are available on the market. We expect that the price of the fuels for the interim solution will raise the demand and speed up the development of these better alternatives (hydrogen and BE).
The result of this policy will provide an additional incentive for people to avoid purchasing new ICE vehicles before 2025. It will also result in an accelerated retirement of ICE vehicles still on the road in 2029. It can be predicted that the cost of non-biogenic synthetic fuels (from renewable energy sources) will be quite high, making it unattractive. Hence, an innovation friendly competition of different powertrain and energy carrier technologies is established.

## Financing

Renewable energy has a higher price than fossil energy. Thus, to manage the shift from fossil to renewable energy in the mobility sector, the stakeholder may for example use levies on their fossil fuel or electricity to subsidize renewable energy. Therefore, mobility will become more expansive.

## Impact

This policy will accelerate the transition to electric cars and fossil-free fuels. Moreover, the transport sector has to become more efficient and find alternative transportation systems than heavy vehicles, since these fuels will be more expensive. Furthermore, with the shift towards renewable energies, more than 70% of the $CO_2$ emissions are reduced.

## Social Compatibility

It is expected that the acceptance for a shift from fossil to renewable energy in the mobility sector is high, because the pure energy costs are low, and the individual mobility or specific applications are not prohibited. Only $CO_2$ emissions are prohibited.

However, the accelerated phase-out of ICE vehicles will have a negative consequence for people purchasing new ICE vehicles in the final years they are available. However, by announcing this in 2021, the effects will be mitigated, as it will allow car buyers to avoid this consequence by purchasing a BE vehicle even as ICE vehicles are available. The ICE cars bought before the policy is put in place will have to run on alternative fuels beyond 2030.

## Questions and Uncertainties

The synthetic fuels for heavy vehicles need to be produced from renewable energy sources. Moreover, the factories to produce synthetic fuels still have to be built and further developed.

# Policy 2.7: Prohibition on the Sale of New Internal Combustion Engine Vehicles

In Switzerland, by 2025, light vehicles (weighing less than 3.5t) with internal combustion engines (ICE) will be banned from the market. It will be prohibited to sell new vehicles with ICE. Heavy vehicles (>3.5t) with ICE will be banned by 2030, supported by an interim quota system starting in 2025.

## Description

The sale of new internal combustion engines, including hybrid electric (HEV), plug-hybrid electric (PHEV) light vehicles and buses with ICE, will be prohibited. This policy is going into effect in 2025; this would match the timing of a similar sales prohibition in Norway and allows for further market developments of battery electric vehicles (BEV) in the next five years. Nowadays, BE vehicles already cost only slightly more than comparably equipped gasoline cars, with total ownership costs that are already lower. The high-speed charging network is being rapidly developed, making it currently possible, for example, to drive from Zurich to Geneva, take a half-hour break, and return to Zurich.

In contrast, 2025 is probably too soon to mandate an end to the sale of heavy diesel vehicles, first because the market for electric local heavy vehicles has developed more slowly. Second, for heavy long-distance vehicles, there is still technological uncertainty concerning choices between batteries, fuel cells, and overhead wires, since the sector has to date developed far more slowly. For these reasons, the technology prohibition on new heavy ICE vehicles should go into effect in 2030, rather than 2025 as with light vehicles. Because 2030 may be too far in the future to stimulate immediate investment, it should be supplemented with an interim quota. Starting in 2025, each company selling heavy vehicles would have to sell at least 10% of those vehicles that are either battery-electric or hydrogen-powered. The quota would rise by 10% each year, reaching 50% by 2029, and then jump to 100% in 2030.

## Financing

This policy leads to low-costs for the government. The consumers need to put up with higher vehicle prices. However, the combined sale, operating, and repair costs of BE are already lower than for ICE cars.

## Impact

Passenger cars are responsible for 75% of the domestic CO2 emissions of the mobility sector. On average, passenger cars in Switzerland will be exported or turned into scrap after 14 or 15 years of driving. Hence, after this period, the vehicle fleet will be mostly renewed. Moreover, a functioning circular economy for batteries and vehicles must be established by 2030.

## Social Compatibility

The most substantial current barrier to electric car diffusion turns out to be the limited availability of overnight residential charging. People who rent their parking space, or park their car on the street, face a significant convenience barrier, and so far have been extremely reluctant to purchase electric vehicles (Marc A. Melliger, Vliet, and Liimatainen 2018). However, with less ICE on the roads, traffic noise will be substantially reduced and promotes the quality of life.

# Policy 2.8: Prohibition of Heavy and Overpowered Passenger Cars

Reduce the number of large SUVs and overpowered passenger cars by limiting curb weight and maximum power to values of 1.5t and 100kW.

## Description

Progress in fuel consumption of passenger cars often is at least partly compensated by heavier vehicles with more powerful powertrains. Moreover, comparing the new registered Swiss and European vehicle fleets, we see a difference in 20% standard CO2 emissions. This gap reflects the more reasonable motorization of European passenger cars. To stop this development, curb weight and maximum power of passenger cars in Switzerland will be limited to reasonable values, e.g. 1.5 t and 100 kW. This still allows companies to build mid-size passenger cars, family vans but reduces the number of large SUVs. Such vehicles should only be allowed with a special permission and a corresponding additional CO2 reduction measure.

## Impact

The amount of gCO2/km of newly purchased cars in Switzerland will be substantially reduced.

## Social Compatibility

Since, mid-size passenger cars and family vans can still be built there are no restrictions for bigger cars if needed

# Policy 2.9: Implementation of an Environmental Steering Levy and Road-Use Tax

The current gasoline and diesel tax will be supplemented by a road-use-tax. Annually, this tax will be levied individually, based on vehicle weight and kilometers driven.

## Description

Currently, taxes on gasoline and diesel fuel provide the funds for road construction and maintenance, whereas electric vehicles pay virtually no tax. There will be a major revenue shortfall with the switch to electric mobility.
Hence, we propose a road-use tax, based on vehicle weight and kilometers driven per year, and phased in over five years, from 2022 to 2027. It is to be collected each year and enforced through the regular vehicle inspections for both electric and the remaining ICE vehicles. To match an adequate cost of car driving, the tax should be based on the cost of building and maintaining road infrastructure (which will significantly decrease due to the moratorium on infrastructure (Policy 1.1), suspension of federal road construction (Policy 2.5) and a general shift in transportation) and the external costs of driving an electric vehicle, i.e. from the particulate matter coming from tire wear, and from added congestion. The Swiss Federal Office for the Environment will assess these costs.

On top of the road-use tax, an environmental steering levy would be raised, for fossil-based gasoline and diesel vehicles (including boats and ships). This environmental steering levy is intended to aid in this transition and set a monetary incentive to reduce fossil fuel usage. The price of the steering levy is aligned with the cross-sectoral GHG pricing (see Policy 1.2). Hence, in 2021 the price will be at around CHF 120 per ton emitted CO2eq and will then increase gradually by CHF 45 per year to reach CHF 525 in 2030.
One additional benefit of the road-use tax is that it will avoid the so-called "fueling-tourism", whereby Swiss drivers go to neighboring countries to fill their tanks. Fuel prices will be comparable, since the proposed environmental tax will at most match the road-tax on fuels in neighboring countries, removing the incentive to cross the border for fuel.

## Financing

The road-use tax will fund the maintenance of the road network, in continuation with the current gasoline tax. The revenues of the environmental steering levy will be used to finance other climate mitigation measures or be redistributed to the population and the economy. Regions would receive different sums, depending on their potential for adaptation. Hence, rural and mountainous areas would receive higher rebates (Filippini and Heimsch 2015).

## Impact

An environmental tax on its own is likely to do little to halt the growth in light vehicle use, as we know that demand is highly inelastic (Havranek, Irsova, and Janda 2012). Therefore, the tax is supplemented by other policies making the alternatives to light vehicles use even more attractive than they are now.

## Social Compatibility

Anyone driving an ICE is affected by this policy. Moreover, people living in rural regions and in the alps are substantially affected, since there are less alternatives to substitute cars (Filippini and Heimsch 2015).

# Policy 2.10: Decrease the Number of Home Delivery Services and Switch to Bikes

## Description

Between 2000 and 2018, the number of motorized delivery vehicles has increased by 65%. In comparison, the number of heavy trucks has decreased by 2% (FSO 2018). The main reasons for the growth in delivery vehicles are an increase in home delivery and the low taxes for these vehicles. In order to limit the number of delivery vehicles, we suggest applying LSVA and PSVA (Heavy vehicle charges) not only to heavy vehicles but to all motorized delivery vehicles.

Moreover, we introduce a fixed delivery tax of 15 CHF for each consignment. This policy will decrease the number of consignments and encourage group distributions. Furthermore, this policy tackles single article deliveries and unnecessary consumption, if free delivery after a certain price is the case. However, companies are freed from this tax, if they deliver goods by bike and partially freed if they deliver with alternative GHG neutral means of transport.

### Financing

The revenues should be used for other policies such as improving public transport or subventions for GHG free delivery services.

### Impact

This policy will reduce the number of deliveries and encourage grouping deliveries. It will discourage single item orders. Furthermore, it will encourage customers and companies to group the deliveries and not send article per article. This will reduce the overall traffic and pollution created by delivery vehicles that have been drastically increasing in the past years.

## Policy 2.11: Limitation of Commuter Deduction

A reduction of the commuter deduction (dt. Pendlerabzug) to a maximum of 2000 Swiss Francs coupled with a faveolization of foot and bike by 2022, as a clear sign that commuting in general but especially by private car will be less fostered.

### Description

In 2017 52% of all commuters in Switzerland have been using a private car (31% public transport, 15% bike or foot) (FSO 2019b). The choice of where to work and where to live is a personal one, influenced by personal preferences but also the affordability of housing, tax levels and reachability of working place. Wrong incentives need to be removed. The cost of mobility is assumed to play a role regarding the choice of how far to live from work for some people. Keeping the current situation on the apartment renting market in mind (high prices in city centers), people with low income face lower flexibility in terms of choosing where to live. Some can simply not afford, living e.g. in city centers. This problem needs to be tackled (see social compatibility).

Swiss people said yes to "FABI" (dt. Finanzierung und Ausbau der Bahninfrastruktur), this led to a limitation of tax deduction for commuting. Since 2016 there is a limitation at 3000 CHF of costs to plead in the tax declaration concerning federal tax. The regulations in the cantons vary strongly. This was a first step, but it does not go far enough. As a basic principle all incentives for a spatial separation of work and life need to be eliminated. From 2022 on the commuter deduction will be limited to a maximum of 2000 Swiss Francs per person and year in federal and cantonal tax. A general deduction of 1000 Swiss Francs can be made anyhow, another 1000 Swiss Francs can only be deducted if at least 80 percent of the ways to and from work have been by foot or bike. Walking and biking are climate-wise the most favorable ways of transport. The introduction of an additional deduction of 1000 CHF supports a climate-conscious choice for the journey to and from work. In order to claim this deduction a standardized confirmation of the employer confirming that the employee has at least 80% of the time chosen to walk or bike to work, is sufficient.

### Financing

There will be a significant amount of additional tax revenues as overall less commuter deduction can be claimed. Tax revenues from people with high incomes, which will be used in order to support people with low income using public transportation (see social compatibility).

### Impact

People living closer to where they work are rewarded, as well as the ones using foot or bike. Long ways to work will no longer be subsidized. Wrong incentives are eliminated. It can be expected that people tend to prefer working closer to where they live. This measure is expected to reduce emissions from commuting.

### Social Compatibility

The deduction in the form of a fixed sum, leads to the situation that lower incomes profit more from the possibility to deduct commuting costs than people with high incomes. The abolition of this social balancing mechanism would need to be compensated elsewhere.

Today different exceptions for the use of a private motorized vehicle are granted (no public transportation, time gain of more than 90 minutes a day, use on demand of employer, public transport not possible due to illness or frailty (medical certificate). The possibility to deduct the full 2000 Swiss Francs will only be given for the exception of someone not being able to use a bike or walk to work (medical certificate) all other reasons drop out.

# Policy 2.12: Reduction of Maximum Speed

A reduction of maximum speed in Swiss road traffic law by 2021 will lead to a reduction of greenhouse gas emissions per km driven and changing mobility behaviors.

### Description

No other measure has an effect as immediate as this, is as cheap as this and bears such big potential for a reduction of CO2-emissions. The faster one drives, the more greenhouse gas is emitted. The air drag does not increase linearly but quadratic. This means the faster one drives, the more energy is needed. By a simple measure of reducing maximum speed, less GHG is emitted. The maximum speed will be reduced as following:

- Highway: 90 km/h (today 120 km/h)
- Motorway: 80 km/h (today 100 km/h)
- Rural: 70 km/h (today 80 km/h)
- Urban: 30 km/h (today 50 km/h)

This takes an adjustment of signalization, especially based on Art. 108 Abs 2 lit.d SSV (SR 741.21) respectively possible adjustments of legal fundamentals (SVG SR 741.01, SSV SR 741.21, VRV SR 741.11). It must be implemented for roads on all levels: federal, cantonal and communal.

Reducing maximum speed has not only the direct impact of less GHG per km driven, but also leads to a change in mobility behaviors. Over time, ways got longer, because moving around got easier and faster. The reason for this is an increase of travel speed due to the extension of road and rail infrastructure. Whilst travel time stayed the same, people cover longer distances. Meaning that people tend to live further away from their place of work and leisure. Lowering maximum speed is expected to reverse this effect.
Finally, lower maximum speed leads to more safety, meaning less and less severe accidents, less noise and traffic flows more smoothly therefore traffic jams and stop and go situations will be avoided.

### Financing

Potential savings due to obsolete noise remediation and the reduction of economic damages regarding health (e.g., noise, fine dust), accidents, and deaths outweigh the cost of re-signaling by far.

## Impact

People can be expected to change their behavior in the short and in the long run. In areas with a high flexibility such as leisure and shopping people will tend to look for proximal alternatives soon, place of living and working will take more time to adjust. There will directly be savings in the fuel consumption and lower GHG-emissions. Numbers of accidents, noise levels can be expected to decrease. A change of the modal split in favor of foot, bike and public transport can be expected. Existing infrastructure will be used more efficiently, with lower speed. The impact is complex, as the effects are complex. A mix of direct effects (less speed) and indirect effects (primary and secondary induced traffic) is expected. To give a number, a study by Pfleiderer and Braun (2012) found that in western Germany, new roads are leading to an increase of traffic by 1% each year, since the system gets faster. It might not seem like a lot, but over the years this number accumulates.

## Social Compatibility

This policy is socially fair: no one has a financial advantage and the additional cost in time is distributed equally, everyone’s day has 24 hours.
The attractiveness of centers, and urban spaces might increase, due to higher costs of commuting. The pressure in the housing market needs to be well addressed by politics. A shift to public transport is expected, as well as people moving to closer places, which leads to more pressure on the housing market in places with a high density of working spaces.

# Policy 2.13: Introduction of a Monthly Car-Free Day

One car-free day per month, breaks up mobility-routines.

## Description

By introducing one car-free day per month people get the possibility to break up their routines and explore other forms of mobility. A different mobility culture can be experienced, as a regular private car user, but also as a non-car driver. State, canton and communities should start to implement this together in 2021. Car-free days are rather a sign, as their direct influence on overall $CO_2$-emissions are low. However, it is important to show that it is not only possible, but in many terms more convenient and favorable to use other means of transport. In combination with promotions for public transport, or free use of bike sharing offers, people get the possibility to get to know alternatives better. The first hurdle can easily be overcome and the way to make it a habit is open. The experience is being expected to be more positive on a Sunday and rather stressful on a working day. Therefore, it is favorable to start with one car-free Sunday a month.

## Financing

None

## Impact

While we predict a minor emissions reduction, this policy mainly aims to change people’s mindset and convey the possibility of a different future.

# Policy Measures: Waterborne Transport

## Policy 2.14: Stop the Expansion of the Rhine Ports in Basel

### Description

The expansion of the trimodal port basin 3 in Basel-Stadt should not be pursued further. In Basel, the construction of a new, trimodal terminal is planned, which will enable the container shipment ship-road-railway. The need for such a terminal is based on the assumption that container traffic to Switzerland will double by 2030 (Gateway Basel Nord AG, 2020). The Rhine ports will mainly be used for importing goods into Switzerland (FOC 2016), whereby logistics "is a growth industry due to the increasing international division of labor" (Canton Basel-Stadt 2020). The expansion of the port of Basel is also described as necessary in connection with the Rotterdam-Genoa axis, whereby the expansion of this axis serves in particular the goal of "promoting international competitiveness" (CODE24, 2014). The trimodal terminal will primarily serve road-rail transshipment and will therefore also take over the functions of the Limmattal gateway, which was once planned without a port connection.

For various reasons, the expansion is not compatible with climate neutrality by 2030 and must therefore be stopped by the project sponsors:

- It is justified with increasing (global) freight transport. However, this is fossil-fueled; it does not make sense to expand the range of services by expanding the infrastructure, since only this will create the conditions for further long-distance (shipping) traffic. Moreover, the existing port facilities have reserves, including in the container area, as the situation due to the low water of the Rhine and the discontinuation of shipping in 2018 shows.
- The main goods handled today are fossil fuels (56%), ores, stones, earths (18%) and consumer goods (12%) - together this makes up 86% (FOC 2016). None of these industries would lead us to expect large increases in transshipment volumes in a climate-neutral society. On the contrary, the production of (consumer) goods needs to be reduced rather than expanded, for example through more durable and socially actually relevant products; at the very least, the increasing production of short-lived consumer goods does not justify an expansion of the Rhine port infrastructure. Also, the (consumer) production of goods is more likely to be relocalized (short distances; climate workshops, etc.) rather than stimulated by global transport.
- In terms of volume, imports dominate exports in the Rhine ports by far. However, it has declined in the period 1998 to 2015(FOC 2016).
- Even the construction itself would be extremely concrete-intensive, without any climate policy urgency. There is no climate impact assessment with regard to the $CO_2$ reduction paths required (see Policy 3.9).
- A no-committee points out further reasons against the trimodal terminal. (Committee No to Port Basin 3 2020).

### Financing

Stopping the planning would mean that large sums of money could be used socially where they would have an effect on climate policy.

### Impact

No expansion of capacities for the import of global goods handled by ship. $CO_2$ effect cannot be clearly defined; but the principle should be fairly fixed: Infrastructure for global transport enables and entails it

### Social Compatibility

No conflicts. However, the Basel-Stadt urban development project (port and urban development) will not be able to be implemented in (essential) parts.

### Questions and Uncertainties

The policy is already addressed by the moratorium on new infrastructure. Since this is an ongoing process, which is being conducted by the project managers with the arguments of a shift of freight traffic to rail and ship, as well as the expansion in favor of a "sustainable" shipping infrastructure, the policy is explicitly addressed here.

# Policy 2.15: Introduction of Standards for Embarked Goods

The introduction of clear standards for embarked goods lead to an exclusion of goods being imported to Switzerland that have been transported by ships being either environmentally or socially unjustifiable.

### Description

Switzerland has little impact on the companies that operate cargo ships, as environmental and social standards of that country apply under which flag a ship is run (Delestrac 2016). By introducing clear standards for ships that unload at the "Rheinhäfen" in Basel it is possible to make sure there are no goods imported to Switzerland in a way that do not correlate with what needs to be respected as a minimum. The standards need to include at least: environmental requirements for the ships and practices on the ship, social standards for the workforce (salary, working hours, etc.). The standards for shipping imports need to be defined and need to pass through the political processes, in order to be set in place the latest in the year 2025.
Moreover some standards need to be apply on the age and condition of the ships, some studies show that new technology could save 30 40% energy

### Financing

Consumers may pay higher prices for regulated goods. Enforcement of the standards is financed within running state budgets.

### Impact

Unethical and environmental damaging practices in shipping will be banned as far as possible from Switzerland. This practice might be used as a role model for an introduction in other countries.

### Social Compatibility

The workers on cargo ships will gain as they profit from better working conditions.

### Questions and Uncertainties

If necessary, in addition, Research and Development for the design, building and operation of environmentally-friendly ships could be supported by the state.

# Policy 2.16: Regulating Motorized Boats and Ships for Private, Public and Commercial Use

The steering levy is applied for boat as for car (Policy 2.9) and a ban on ICE boats is also applied (Policy 2.7). Boats not using energy carriers (wind and human powered boats) need to be preferred as well as boats powered by non-$CO_2$ emission technology (e.g. electricity or hydrogen).

# Policy 2.17: Cap on Tons of Imported in Switzerland

### Description

The quantity of imported products increased dramatically. The million tons of loaded trade has been multiplied by more than 18 in the last 40 years (Figure 2-5). The category with the most imports is "consumer goods". Most of these goods are transported overseas and have a significant climate impact.
The goal of this policy would be to stop the increased quantity of imported goods and lower this cap years after years to reduce (and at least not increase) the emission produced to transport these products and reduce overconsumption.

### Financing

No financing required

### Impact

This policy will impact consumers and companies that will need reduce their consumptions.

### Questions and Uncertainties

The implementation of this policy might be tricky. There should be a priority on goods that are judged as essential. Moreover, since many parties are involved, it might be challenging to implement.

# Policy 2.18: Imposing Standards for Ships belonging to Swiss Companies

## Description

Mediterranean Shipping Company (MSC), the world's second biggest shipping company is based in Switzerland (headquarters in Geneva). However, the standards imposed on its ships are not swiss or European standards but standards of the country in which the ships are registered. In the global shipping network, most of the ships are registered under so-called "flag states" or "flag of compliance" (e.g Panama), states that allow lower standards on ship inspection, certification and issuance of safety and pollution (United Nations Conference on Trade and Development 2020; Swiss Ships 2020; Alphaliner 2020; MSC 2020).

## Financing

No financing required

## Impact

Unethical and environmental damaging practices in shipping will be banned as far as possible from shipping companies based in Switzerland. This practice might be used as a role model for an introduction in other countries.

## Questions and Uncertainties

There is a risk that MSC change its headquarters to another country but it could be seen as an example so other countries apply the same legislation for shipping companies with headquarters in there countries. Moreover, we do not want to encourage this kind of practice by allowing such companies to pay low taxes without respecting ethical values.

# Policy Measures: Aviation

## Policy 2.19: No Subsidies and Tax Breaks for Aviation

### Description

There is a general VAT (MWST/TVA/IVA) exemption for international flights and for most aviation-related services, including food and other suppliers (ESTV 2016). Moreover, unlike car fuels, aviation fuels are mostly exempt from the petroleum tax, which means a tax break of about 1.7 billion CHF annually (Poletti 2018)(EZV 2018). And a part of the tax income collected is even used to subsidize aviation (BAZL 2016). Furthermore, aviation is exempt from the CO2-levy.

The department of defense (DDPS / VBS) finances many airfields, even those it no longer uses (Die Bundesversammlung 2019b). These tax exemptions and subsidies go against the Climate goals and provide an unfair advantage for aviation over alternative modes of transportation.

As a first and immediate measure, all such tax exemptions and subsidies must be cut immediately. Small airports not profitable without funding from the state such as Bern Belp, Lugano Agno and Altenrhein will be closed. The additional tax income should in part be invested in alternatives to aviation (Policy 2.28) and the development of renewable energy projects and the shift to synthetic fuels (Policy 2.20).

### Impact

The VAT rate is 7.7% but might only apply to a part of current ticket costs (some fees might be excluded). Petroleum tax is 739.50 CHF per 1000 L kerosene. CO2-levy is CHF 96 per ton CO2.

For example, a flight from Zurich to New York with Swiss can cost CHF 1628, of which 1594 are taxable in principle, implying CHF 122 VAT. Per passenger, it consumes 132 L of kerosene, implying a petroleum tax of CHF 98. It emits 334 kg of CO2, meaning a CO2-levy of CHF 32. Hence, without these three fiscal exemptions the ticket would cost CHF 1880 instead of CHF 1628, which is 15% more. Some studies assume a price elasticity of flying at -1, others estimate that for low-cost transatlantic flying the value is higher.
Hence stripping these three fiscal exemptions would decrease the amount of flying between Zurich and New York between 5% to 15% (Leandros 2019).

### Social Compatibility

The VAT is a regressive tax, and so are the current petroleum tax and the CO2-levy. They are all flat-rate taxes on consumption and as such hit lower-income individuals stronger, because they spend a higher share of their income than higher-income individuals. Hence the social effects of stripping these tax breaks would be slightly adverse. Therefore, to counterbalance, the measures needed to achieve additional reductions in flying must target higher-income individuals. These could be, for instance, progressive taxes.

# Policy 2.20: Alternative Fuel - Synthetic Fuel from Renewable Energy

For the next decades, synthetic fuels made from renewable energy are the most promising to make aviation clean. While the technology is being developed and tested already, synthetic fuels will only be available at sufficient quantities around 2040. With a fuel quota the fossil fuels will gradually be replaced with synthetic fuels. Only synthetic fuel is allowed after 2030.

## Description

In the long-term, aviation must become emissions-free. Currently, aviation relies entirely on fossil kerosene. This means a total shift to renewable energy sources is required and a way to apply the energy in airplanes.

Battery electric planes face a fundamental challenge in the very low energy density (by weight) of batteries. While prototypes already exist, expert interviews suggest that battery electric planes are unlikely to be certified for commercial flights exceeding 500 km by 2040 (ICAO, n.d.). Hydrogen, by contrast, has a high energy density by weight, but an extremely low density by volume. A hydrogen fuel cell plane would need to look very different, with a very large hydrogen tank. Technically this is realistic, but the fact remains that there are currently no commercial prototypes and reaching a level of technological maturity for hydrogen planes so that they could begin to be used commercially would require at least 20 – 30 years.

For the next decades, synthetic fuels are the most promising. Currently, there are two technologies for synthetic fuel production: power-to-liquid and heat conversion. Power-to-liquid converts renewable electricity such as from solar and wind to split H2O and captured CO2 molecules. Heat conversion relies on concentrated solar thermal energy to split the molecules. Power-to-liquid is more mature and may currently cost as little CHF 2 per liter. Heat conversion is new, but more efficient because it avoids conversion to electricity and expensive electrolysis. While initial costs may be at CHF 2-10, it is likely to become the less expensive option within the decade, with projected fuel costs of roughly CHF 1 per liter. For comparison, jet fuel currently costs CHF 0.60 without taxes. The first two demonstration facilities have gone online in 2019, and one Swiss-based startup (Synhelion, based in Lugano) is planning the first commercial-scale demonstration plant to be ready by 2023 (Synhelion, n.d.).(Detz, Reek, and van der Zwaan (2018) discuss various synthetic fuels and their projected price. ZENID, another startup, plans to produce 500k liters synthetic fuel annually by 2030**,** at a price of about CHF 1.50.

Both Power-to-liquid and heat conversion technologies require large amounts of land for renewable energy collection, although far less land than would be required for comparable volumes of biofuels, or forest carbon offsetting. In the case of heat conversion, the ideal production sites would be in semi-arid or arid environments, where sunlight is stronger and there is less competition with agriculture and biodiversity. In other words, one should not view synthetic fuel production as something that would necessarily take place on Swiss soil.

The main challenge for carbon-neutral flying, then, is to stimulate investment in synthetic fuel production, making possible a complete phase-out of fossil-based jet fuel. It is unlikely that this can happen by 2030, simply because of the investment volumes needed, although 2040 would be realistic though ambitious, but not ridiculous. The current cost of synthetic fuel is also too high to be incentivized with an environmental tax. To stimulate such investment, then, the ideal policy instrument would be a rising fuel quota. Beginning in 2025, 10% of aviation fuel put into planes in Switzerland would need to be synthetic, and this would scale 25% a year to 100% by 2030. By 2030, it will be virtually impossible to produce enough synthetic fuel to keep up even with today's kerosene quantities. Hence, the quota will inevitably force a reduction in aviation until the production quantities scale up. This puts a strong incentive on the aviation industry to quickly develop and scale up synthetic fuel production.

A fundamental requirement is that the energy for fuel synthesis must be 100% renewable. To prevent competition for renewable energy with other sectors, new energy plants have to be built especially for aviation. Further, because the fuel synthesis is not yet at a commercial scale, there is a considerable amount of uncertainty about reachable quantities and prices over the next decades. But given the low initial percentage, the price should not be too strongly affected, and the fixed quota will give some planning certainty and encourage quick investment.

## Financing

Mostly, the changes must be financed by the aviation industry, which will be paid through the tickets by the consumer. To accelerate the development of fuel synthesis, some of the aviation taxes can be used, but only for research purposes. We advise against a subsidy; the quota provides enough incentive.

## Impact

This policy is the only long-term solution that allows aviation while being carbon neutral. Further, synthetic fuels are cleaner, they have fewer impurities because they can be made to be pure hydrocarbon with less particulate matter. While there is significant uncertainty, this could lead to about half as much cloud formation and thus reduce the non-CO2 heating effects.

Since it is a long-term strategy and the technology will not be available on large enough of a scale by 2030, other measures and policies are required. In fact, it is hard to meet the required quota without reducing aviation.
It is fundamental to only allow renewable energy for the synthesis and only allow new energy plants that do not compete with energy production for other sectors. If renewable energy is only shifted from another sector and the other sector then relies more on fossil fuels, the impact of this policy is compromised.

## Social Compatibility

The cost of flying will increase, but since flying is mostly a luxury and not a need, this is justified given the enormous emissions of aviation with conventional fuels This policy is currently the most promising path to clean aviation, even if very ambitious.

## Questions and Uncertainties

Since the technology for synthetic fuels is only just now ready for tests and will take years to be scaled up to commercial levels, it is possible that there will be delays or failures. For a net-zero path, aviation has to be included, even if zero-emissions technology is not available as fast as 2040. Thus, should the technology not be available in the required quantity or fail completely, then aviation has to be reduced or stopped accordingly.

# Policy 2.21: Aviation Taxation

We discuss multiple ways for taxation in aviation. This policy taxes tons of CO2 progressively, over a 4-year period. The purpose is to discourage frequent-flyers which are often the one less affected by raise of prices and to use these revenues for research on synthetic fuel production.

## Description

Price mechanisms such as a tax make sense if one wants to achieve a slight reduction in demand or raise revenue. The more inelastic the demand, the less effect a tax can achieve. Generally, one needs high tax rates to have even a small impact on demand. Taxing fossil fuels alone would not be a sufficient measure to make the transition to synthetic fuels, as they are significantly more expensive. But a CO2 tax could at least make sure the price of flying better reflects the environmental costs. Further, it could raise revenue to be invested in renewable energy generation or other transportation infrastructure projects that would both lower environmental impact and benefit the population.

A flat tax has several shortcomings. Most flights are due to a small, rich and privileged percentage of the population, which will hardly be persuaded to fly less by such a tax. Unless of course the tax is massive, in which case, low- and middle-class people would be totally cut off from flying.

A **Frequent Flyer Levy** (FFL) (Fellow travellers, n.d.) or **Air Miles Levy** (AML) (Carmichael 2019)( progressively tax the number of flights (FFL) or total distance flown (AML) over multiple years. Exponentially taxing the amount of flights (FFL) reduces the number of launches which are especially fuel-intensive and can encourage choosing the train instead of a short-haul flight. Progressively taxing the total distance flown (AML) encourages people to choose closer destinations for holidays for example. The distance flown is directly related to emissions, therefore AML is more closely related to pollution than FFL. The tax is set over multiple years since one should fly at most once every few years, once a year is already too much. It goes without saying that the loyalty programs (air miles) will be prohibited. We propose to measure emissions e in CO2 equivalent (tons), based on CO2 and non-CO2 factors, over a 4-year period. The tax is calculated per flight and added to the ticket price. The tax is determined as c*e*(e+1)/2 CHF. In the first 4-year period, let c=60, and increase it to 120 and 180 in the following periods. For reference, a return trip to New York produces about e=2 tons CO2eq, London about e=0.4 tons. A single NY trip would result in a 180 CHF tax, two trips 600 CHF, and three trips 1260 CHF. Note, that business and first-class seats produce more emissions and are thus taxed proportionally more than economy flights. In fact, business-class has about double the impact and first class three times that of an economy flight (myclimate, n.d.).

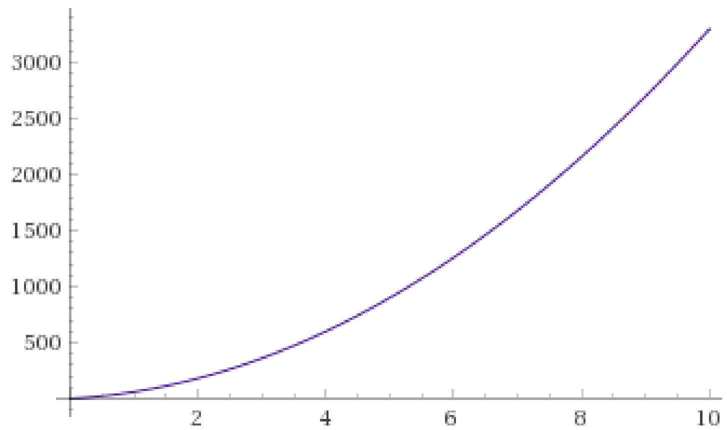



*Figure 2-8: Custom plot for c=60*

**Compatibility with other policies**: If taken in conjunction with an emissions cap policy (Policy 2.22), this policy only has to target frequent flyers. Without a cap policy, taxation may also have to limit the total amount of aviation emissions. This means the coefficient for the tax, c in the above equation, has to be adjusted every four-year period to reach a set goal. The tax may have to be much higher if it has to do all the heavy lifting of reducing demand. The target path is to reduce 10% of current yearly emissions by 2025, stepwise reach zero emission by 2030. Beyond 2030, only flights with synthetic fuel are allowed. It is important to measure emissions before any compensation measures. The goal has to be to make aviation zero-emissions in itself, or very close to it. Given the limitations and uncertainties of compensation technologies, we cannot rely on them.

## Database

Even today, people have to provide their passport-id when booking a flight. In addition, BAZL will have to keep a database with passport-ids and accumulate the emissions for each person. Then the tax can be calculated and added with the sale of each ticket automatically. This data has to be handled carefully to protect privacy, the database should store the minimal data necessary and only provide the current emission e of a passenger to the airlines for the calculation.

## Financing

This policy will pay for its own overhead first. With the income, research and development of alternative propulsion (Policy 2.20) should be supported, and also alternative modes of transportation (Policy 2.28).

## Impact

This policy allows to steer the amount of reductions through the coefficient for taxation. The impact can hence increase every four-year period. Its purpose is to tackle the disproportionally high environmental impact of the frequent flyers. It will reflect the unsustainable nature of a frequent flyer lifestyle in a financial manner.

## Social Compatibility

This measure does not tax people going on a “once in a lifetime” trip very much. It would still be affordable to go on a trip every 4 years. The goal is to make flying exceptional, certainly as long as it creates unsustainable levels of emissions. There may be serious resistance from frequent flyers, but we expect that to be a rather small group, and the demand for frequent flying is not justifiable until zero-emission technology is available. Further, the tax is raised gradually, leaving frequent-flyers some time to adapt.

# Policy 2.22: Emissions Cap

This policy sets an absolute cap on emissions for the aviation sector and is thus the most direct measure to ensure emissions reduction.

## Description

The most direct way to limit aviation emissions, is to set an absolute cap per year and hand out emissions permits. For every flight, the emissions have to be calculated and a corresponding emissions permits obtained. This has to include all types of flights, including airlines, charter flights and private jets. We envision an emissions path of a 10% reduction by 2025 and stepwise reaching zero by 2030.

There are multiple ways to hand out emissions permits. First, they could simply be proportionally distributed to airports based on current emissions, reducing their capacities. The scarcity drives up the ticket prices and will keep up income for the aviation industry despite lower passenger numbers. This may lessen opposition from the aviation industry. Second, the emissions permits could be auctioned by the states to airlines. This means the additional revenue goes to the state and not the aviation industry. These finances should then be used to further alternative propulsion (Policy 2.20) and alternatives to aviation (Policy 2.28).

### Compatibility with other Policies

It is important to measure emissions before compensation. If this policy is taken in conjunction with a Frequent Flyers Levy (Policy 2.21), demand may already be reduced slightly and reduce the auction price of emissions permits. This may have the benefit of making flying once every 4 years affordable while more heavily pricing frequent flying. Note that the zero-emission cap by 2030 will effectively only allow planes with synthetic fuel.

### Financing

This policy has no direct costs, instead it generates revenue which can be used to finance other policy measures.

### Impact

Emissions are directly controlled; reductions can be calculated in comparison to the projected emissions without the policy.

### Social Compatibility

Ticket prices for flying would increase drastically if the limits are set as low as is necessary. Tickets may become unaffordable for many. However, in conjunction with a strong Frequent Flyers Levy (Policy 2.21), some pressure can be taken away from people flying very rarely and shift it to frequent flyers. To increase the acceptability, accompanying measures such as support for alternatives to aviation (Policy 2.28) should be taken.

# Policy 2.23: Ban Short-Haul Flights

### Description

In 2018, 77% of air passengers had destinations in Europe, and the most common reasons for flying are time and convenience, but also a lack of alternatives and price play a part (FSO 2019d). Due to low ticket prices, alternatives on the ground such as night trains can hardly compete. While short-haul flights do save some time, the gains are not justified by the disproportionally high emissions, especially since launches make a significant emission contribution to these flights.

We propose an immediate ban of domestic flights and all flights reachable within 8h with alternatives such as public transport (e.g. Zürich-Berlin and Zürich-London). This ban radius should be increased to 16h by 2025 and by 2030 no short-haul flights in the radius of 24h by public transport would be permitted.
Many short-haul flights serve as connecting flights to long-haul flights. Going to an airport further away for long-haul flights makes sense economically but also ecologically, fewer long-haul flights have to be launched. But these connecting trips can also reasonably be taken by ground transport.

## Financing

None

## Impact

A significant amount of flights would not take place, some passengers would choose alternative transportation or avoid less important travel. Given that most flights are to destinations in Europe, the emissions reductions can be projected to be significant once the ban radius is high enough.

In some countries it may be more advantageous to use short-haul electric planes. They may be available around 2030 for distances less than 500 km. This is especially useful in less densely populated countries where the cost and emissions of the infrastructure of other modes of transportation could exceed that of electric planes. However, flying remains very energy intensive even in the case of electrification. This means that they risk displacing other uses for the limited supply of renewable electricity.

## Social Compatibility

The policy is designed to limit emissions without making travel impossible, in fact it only bans flights that are reachable with reasonable alternatives. The ban radius is increased gradually to allow people to adapt and alternatives to be strengthened.

# Policy 2.24: Ban Private Jets and other Forms of Luxury Aviation

## Description

Most private jets are smaller than regular passenger planes and, while they each use less fuel, they are less efficient in terms of emissions per transport capacity. Some very rich people even use normal-sized jets with hotel-like furniture for private transportation. Private Jets mostly fly below their passenger capacity and often even empty (Harvey 2019). An average private jet journey within Europe emits 10 times as much greenhouse gases as the same journey made by an economy class flight, and roughly 150 times more than an equivalent high speed train journey (Beevo and Murray, n.d.).

Unlike many other things, no one really needs private jets, in fact only a tiny fraction of the global elite gets to use them.
Therefore, we demand an immediate ban on private jets and expect their current users to switch to airline flights. The goal is to also ask the richest elite to take steps to combat the climate crisis and lower their contribution to it and therefore making the other measures more socially acceptable (Leandros 2019). A few exceptions may be made for non-commercial general aviation services in the public interest.

A similar logic applies to flights with helicopters or propeller machines for personal transportation or recreation. This includes taxi-flights, heli-skiing or flights to move mountain bikes uphill. We consider these flights luxury aviation because they provide services nobody really needs or can easily be substituted by less polluting alternatives. As such they should also be banned. Moreover, beyond climate change considerations, all these flights also produce noise and smog.

## Financing

None.

### Impact

The emissions of CO2eq directly saved by this measure might seem marginal, however, put in relation to the low number of people affected, they are very high. Most importantly, enacting this measure would give legitimacy to climate policies that affect larger numbers of people. The indirect impact by virtue of its political messaging is big.

### Social Compatibility

Since only very few are impacted, and only the richest elite, the policy should be very socially acceptable. It also sends a signal that everyone has to adjust, and even more so those with the largest emissions footprint. It is thus compatible with the idea of climate justice and makes the other policies even more socially acceptable.

## Policy 2.25: Compensation of other Climate Change Effects besides CO2

### Description

As already explained, high-altitude combustion does not just emit CO2 but also short-lived GHG, such as water vapor and particulates from jet exhausts. There is considerable uncertainty as to the magnitude of the heating effect, but it could be as large as the effect of the CO2 emissions. Synthetic fuels can have less particulate matter if they are synthesized to pure hydrocarbon, potentially leading to less cloud formation.

To ensure a net-zero goal, not just the CO2 emissions of fossil kerosene but also the non-CO2 emissions for all aviation must be compensated with negative emissions starting from 2030. A government agency like BAFU or BAZL must calculate what aviation service has to compensate to what levels and the aviation service providers must finance the compensation projects. This will lead to a moderate increase in the ticket prices.

While there are safe ways to store CO2 from the air, there are some concerns with all methods of compensation. Therefore, it is important to rely on compensation as little as possible. In the long-term, compensation should only be used to offset inevitable non-CO2 heating effects in aviation. For a detailed discussion on negative emissions, and the guidelines for compensation within this CAP, we refer to chapter on negative emissions (especially see Policy 7.1).

There are multiple ways to implement financing of compensation: either the aviation service providers need to obtain sufficient negative emissions certificates of sufficient quality, or a tax is raised, and the state takes the funds to buy the certificate or invest in compensation projects.

### Financing

The instrument internalizes the cost, the ticket prices will rise accordingly.

### Impact

The CO2 emissions up to 2030 will be compensated and the non-CO2 heating effects offset beyond 2030.

## Social Compatibility

Since it only has a relatively small effect on the ticket price, and internalizes the cost of emissions, this is a very fair policy.

## Questions and Uncertainties

Given the uncertainty about the exact impact of non-CO2 heating effects, these effects must be further studied in order to make exact calculations for compensation.
While synthetic fuels burn a bit cleaner, it is not clear how much. They may be reduced as much as 50% or maybe not much at all (FOEN 2019b). This would continually require negative emissions, even despite CO2 neutral fuel.

# Policy 2.26: General Efficiency Measures

## Description

There are many small improvements that can be employed to reduce fuel usage and hence reduce emissions. In a Nature article, Schäfer et al. (2016) list many such measures, and detail how much could be saved in emissions at what price.
Interestingly, many of the measures would actually save the airlines money. For example, electric taxiing, namely installing an electric motor in the wheels, could save about 2.8% of emissions and save money for the fuel used by the engines running currently. Running on a single engine between the gate and takeoff could save another 2%. Blended winglets and open rotor engines could save even more, as they reduce drag during flight. There is also a lot of potential in airport-management, for example better launch scheduling could allow planes to wait at the gate and only turn on the engines when they are allowed to launch. Better arrival scheduling could allow planes to fly slower instead to circle over the airport until they are given permission to land. Flying slower saves fuel.

Some measures cause additional costs for airlines. Reducing cabin weight can save 1-2% of fuel, thus the maximum luggage weight should be reduced, from today's standard of 20kg to 15kg**.** Unnecessary things, such as duty-free items should be forbidden.

There are studies showing that moderate changes to flight paths could significantly change the non-CO2 climate change effects. Sometimes the flight level can be changed by about 600 meters with a significant improvement of heating through contrails with only a marginal increase in fuel consumption (Katrin Schregenberger 2020). Some of these measures increase costs, for example flights would have to be routed over areas with higher taxes or marginally more fuel would be consumed. Regulations should be put in place to incentivize airlines to choose the flight path with the least climate heating effects.
One possible implementation of flight path adjustments is through *climate-charged toll areas* (Malte 2019). The proposal is to extend today's area fees to include additional fees for climate sensitive areas. Daily, the fees are adjusted according to weather conditions. Some areas are zoned especially expensive to discourage flights over ice, where the condensation and cloud formation is more intense. Airways already calculate flight paths according to real fees to minimize cost, thus the proposal does not require them to change their software to optimize flight paths. The climate-charged toll areas thus leverage areal fees to monetarily motivate airways to reduce the heating effects of their flights.

The fact that many of these measures were not implemented yet, despite potential savings for the industry, suggests that external pressure may be required. For some items, higher fuel prices would be sufficient, which could be achieved with some of the other policies described above. For others, a regulatory approach has to be taken, for example changing procedures around the airport is not up to a single airline. We propose that BAZL has to decide what measures (listed here and more) would be sufficiently implemented due to higher fuel prices and what measures require regulation and put those regulations into law.

### Financing

By airlines themselves.

### Impact

Significant reduction in emissions for a relatively small financial cost.

### Social Compatibility

The small increase in ticket prices is socially acceptable given the reduction in emissions they effect.

### Questions and Uncertainties

The listing here is not intended to be exhaustive. While we do mention some sources, a more detailed list of required efficiency measures has to be produced, put into regulation, and implemented.

## Policy 2.27: Support for People affected by the Decline in Aviation

### Description and Impact

The purpose of all policies above is to cut the GHG emission of aviation. This is not possible without a reduction in aviation until sufficient quantities of synthetic fuels can eventually be produced. If only 10% of today's kerosene quantity is available in synthetic fuel by 2030, this may mean a reduction of 90% of the sector. This will have the consequence that jobs will be lost and aviation employees re-trained for other sectors. To make the general strategy and the concrete policies socially compatible, it is crucial to make retraining available and provide financial aid to compensate the lost salaries.
We also expect some effect on the tourism industry, both domestic and globally.
Many companies have their employees travel by plane regularly. Here we expect that most will find alternatives (more teleconference, train ride, …) over the adjustment period.

Affected groups:

- Aviation industry: Airport personal, pilots
- Business travel: People living far from their workplace, consultants
- Tourism sector

The groups listed above will face higher unemployment rate, therefore accompanying measures will be taken to facilitate professional reintegration. These measures are described in the public program for green jobs (Policy 9.1).

### Financing

See Policy 9.1

### Questions and Uncertainties

There is still an open point on the impact of the reduction of aviation on the tourism sector outside of Switzerland.

# Policy 2.28: Support for Alternatives to Aviation

### Description

The vision is to have drastic reduction of aviation; therefore, we need to think about alternatives that could allow people to reach most places in Europe without requiring aviation.

The counterpart should not be that people use their car to drive to destinations they would have flown, for single passenger ICE vehicles the balance is not much better than for planes. To prevent this issue, a convenient public transportation and train system should be put in place to effectively connect major destinations. Travel time is the main reason (67%) (FSO 2015) why people choose aviation rather than other means of transport. Therefore, we should tackle this issue by improving efficiency of other means of transport (train, night trains, bus, etc.).

To achieve such goals, studies will be run to determine the major needs to reduce the need of aviation: which cities are not well connected, which destinations are more needed, etc. Based on these studies, investment will be done to support the more impactful measures.

Some of the measures could be:

- Developing new night train rides
- Developing railways for destination that are not well connected
- Improving booking websites: harmonized European digital platform to allows easy planning and booking of train tickets, international train tickets can be bought 6 months in advance (today max. 3 months which is an additional barrier for booking train ticket rather than plane tickets)
- Improving bus network for destination not reachable by train

Once flying will get more expensive (by taxing its environmental impact), everything else will fall in line. Making aviation less attractive might be enough to increase the demand for alternatives such as night trains without necessary need to promote it (we do not want to make it too attractive so people travel more, we want people to change the means of transport).

### Financing

The financing of studies and impactful projects will be covered by the tax on aviation.

### Impact

This policy will help to develop alternatives to aviation. The impact will be to reduce aviation by offering better alternatives to aviation. The impact will also be to improve accessibility of regions that are currently not well deserved.

## Social Compatibility

This policy will improve the social compatibility of other aviation policies and improve transportation systems at an affordable price (cheaper than aviation) and therefore allow people to continue to travel even if the price of the aviation drastically increases.

# 3 Buildings and Spatial Development

# Vision

In our vision of a climate-neutral future, not only the existing buildings will be converted to being climate-neutral in terms of energy. The society will be reorganized in such a way that a life without greenhouse gas emissions is natural, that gives more joy and creates more purpose between us humans in comparison to our present, often loud, ruthless and rushed "being driven".

In the buildings sector, greenhouse gas emissions and other waste are prohibited, both during construction and operation. All materials and resources are recycled, reused or can be returned to nature. Property and ownership rights are also adapted in such a way that the residents have a much greater say in the design of their living environment. Wherever possible, living is organized non-profit (e.g. cooperatively) because with real estates no profit is made any longer: Living is a basic right, not a commodity. All new buildings are built as plus energy houses and serve at the same time as CO2 storage.

Wherever constructional development is necessary, it is condensed in places that are well connected to public transport - preferably in the cities. However, very few additional buildings are needed, since both commercial properties are used more efficiently through new ways of working and the amount of private space per person is decreased. This is because diverse neighborhoods (for 300 - 800 people) are being created in the cities and in the villages, whereas as many things as possible such as rooms, infrastructures, workshops, services for daily needs are shared and maintained together (commons). Needs that do not have to be satisfied in every neighborhood are organized in community centers, district centers or citywide. This joint organization makes living affordable for everyone, significantly reduces the amount of private space needed and makes everyday life much easier. Much is also changing at the regional level: Workplaces are far less concentrated in the large agglomeration centers such as Zurich, Basel, Bern, Lausanne or Geneva, but are more evenly distributed throughout the area (and of course well served by public transport) - in keeping with the credo of a city of short distances. On average, the daily commuting distances are in this way becoming shorter. Where many commuting distances are within walking or cycling distance, the streets are also becoming a place to live and to meet. Because local life is so exciting, varied and worth living, recreational traffic is also decreased. Our cities and villages are less sealed and better adapted to global warming. Trees, green roofs and facades, as well as water elements such as streams and ponds, contribute to cooling the local climate and food is planted in the heart of our settlements as a supplement. In general, there are more synergies between urban, peri-urban (around the cities) and rural areas. The potentials of the different areas of action are well utilized everywhere: Climate neutrality is lived everywhere - although in very different ways according to the respective local conditions.

All developments that were still necessary are extremely economical in their use of soil: Valuable soils remain unsealed, so that they are not only available for food and goods production but can also resume their role as carbon sinks once agricultural practices have been adapted. Diversity in flora and fauna is increased significantly as a result of greater structural diversity in the entire settlement area, whether built on or in the landscape. Nature is healthy and is becoming increasingly richer, more beautiful and more climate resilient itself, thus - together with us - reducing CO2 on a large scale!

Our quality of life will increase due to the better climate-neutral buildings, the solidarity in the neighborhoods and the new connection to nature and agriculture. Our living is happier, more active, more communal and healthier. - Many people used to associate the terms "sustainability" or "net 0" with "less allowed" and "more musts". Today we understand: Our consumption-intensive, structurally conditioned individualism actually meant above all great loneliness, pressure or stress to raise funds and exhaustion of resources. We are all more relaxed now, because the necessary material "less" has become a life-enhancing "more". We recognize that we can create, share and enjoy many things together, instead of despairing and relinquishing in solitude.

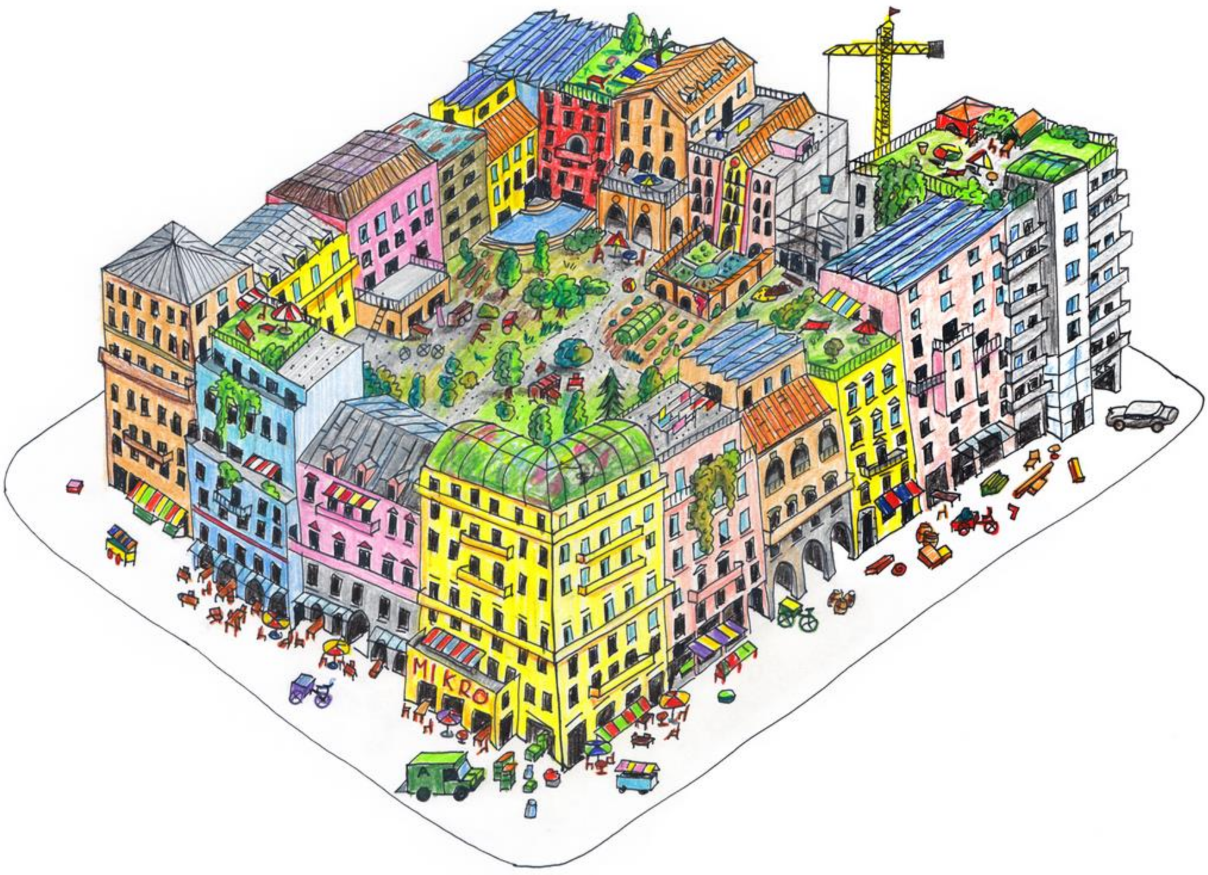



*Figure 3-1 In a condensed perimeter block neighborhood (approx. 100 x 100 m floor space, up to 8 floors), approx. 500 people can live and partly also work.*

# Current situation

## Buildings and Architecture

### Emissions

The construction, renovation and operation of buildings are responsible for around 30% of all CO2eq in Switzerland, 40% of which is caused by the building materials used and around 60% attributable to operations (Gauch et al. 2016).
About two thirds of building emissions come from private households (heating and hot water), one third from industry and commercial buildings. Although the energy demand per capita for heating and hot water has fallen continuously (Roost et al. 2018), Switzerland has still very high per capita emissions in the building sector.
A large proportion of this is heating and hot water, which, despite a decline in the use of fossil fuels, are still powered mainly by oil and gas (60%). Even today, defective heating systems are often replaced by new oil heating systems. Overall, around 60% of all newly installed heating systems are still based on fossil fuels (Federal Statistical Office).

### Grey Energy

Grey energy is the amount of primary energy required for all upstream processes, from raw material extraction to production, processing and disposal, including the necessary transport and auxiliary materials. The resulting greenhouse gas emissions are significant. In today's new buildings, grey energy accounts for approximately one quarter of the total primary energy used for construction, operation and mobility. At 40 to 50 kWh/m2 , this is a large share in the energy balance compared with the energy required for space heating and hot water (Energie Schweiz 2017).
In the case of zero- or plus-energy houses, the share of grey energy is of course even more significant and must also be significantly reduced for a real net zero solution.

### Construction activity

Although Switzerland is already very densely built-up, there is still a lot of building activity, driven by population growth and a changed amount of space used per inhabitant. This is mainly due to more individual dwellings and older people who have a higher demand for space. The average living space per person in 2018 was 46m2 (FSO 2018), for persons over 65 years even at 70m2. Construction activity is expected to remain at a high level in the coming years (approx. 45.0 million m3 per year).

Although today's standard for new buildings is much stricter, especially in terms of thermal insulation and energy consumption, building permits will continue to be issued for buildings without renewable energy production and with fossil fuel heating systems. The CO2eq emissions caused by construction are usually not even included in the energy balance of the houses, so that concrete, metal and glass continue to dominate, causing excessive CO2eq pollution.

### Refurbishments and Renovations

The rate of energy-related refurbishment of existing buildings is currently around 1%. In order to achieve the climate targets, the rate would have to be significantly higher, at around 10% per year from 2021 to 2030.

It should also be noted that building components have different lifetimes and need to be replaced at different times during the entire life of the building. There are no meaningful statistics on the amount of grey energy used to replace building components. In addition, the annual amount of demolition material from buildings is also important, which is currently estimated at around 16 million tons and is expected to increase further.

## Legislation and Standards

More than 140,000 paragraphs and over 20,000 EN standards and recommendations and, respectively, guidelines regulate construction activities and buildings at federal, cantonal and municipal level or through associations and clubs. For example, the CO2 Ordinance is at federal level and zoning is regulated at municipal level. Emissions can be influenced by legislation, e.g. through SIA 2040 Life Cycle Assessment or the CO2-levy on fuels, which has been increasing the price of fossil fuels since 2008. The levy currently stands at CHF 96 per ton CO2eq and could rise up to CHF 230. Two thirds of the proceeds of the levy will be redistributed to the population (via health insurance) and the economy, whereas one third will be used for innovation . However, the measures did not really lead to a significant reduction in emissions.
Due to this structure, changes in the law are very laborious and rarely fast. Therefore, a number of voluntary measures and incentives for rehabilitation have been introduced and more are planned. In addition, regulations from the financial industry could also have an impact on real estate, as the largest real estate owners in Switzerland are pension funds that have clear guidelines for their investments. On the other hand, it is often precisely pension funds that only build exactly according to regulations and do not incur additional costs for energy-related renovations.

## Planning Phase

The tendering and planning of construction projects takes a long time, so much so that today's construction sites are based on plans that did not take climate change into account. However, it is precisely in the early planning phases that the framework conditions for the construction project are defined and the strategic decisions are made, which are also decisive for the expected CO2 direct and indirect emissions.

In addition, construction methods and housing structures have a major impact on local ecosystems and mobility. Here too, we are still not thinking in terms of systems, but are looking at each building and each construction phase isolated. This chapter has the aim to show how the construction and operation of buildings need to be changed in such a way that houses and cities are transformed from CO2 emitters to CO2 sinks, having an additionally positive impact on our environment and way of life and are also available and affordable for all sections of the population.

# Spatial Development

## Land use

The recent decades have been characterized by strong urban development in Switzerland. Land use statistics reveal that between 1985 and 2009, settlement and infrastructure areas increased by 23%, leading to the conversion of 584 $km^2$ of open land into newly built-up areas. This corresponds to a surface larger than the total area covered by Lake Geneva, or an increase of 0.8 $m^2$ per second (FOEN 2017). This evolution took place mainly at the expense of agricultural areas, which decreased by 5.4% in the meantime. This means that over these three decades, roughly 1.1 $m^2$ of agricultural land disappeared every second (Fig. 3-2). This implies that less and less agricultural land is available for local food production. Should this situation lead on the long run to an increase in food imports, it could possibly affect Swiss carbon emissions. In fact, food imports account yearly for 9.3 million tons of CO2eq and represent about 60% of the total greenhouse gas emissions of the Swiss agricultural and food industry (2011 data, (D. Bretscher et al. 2014)).

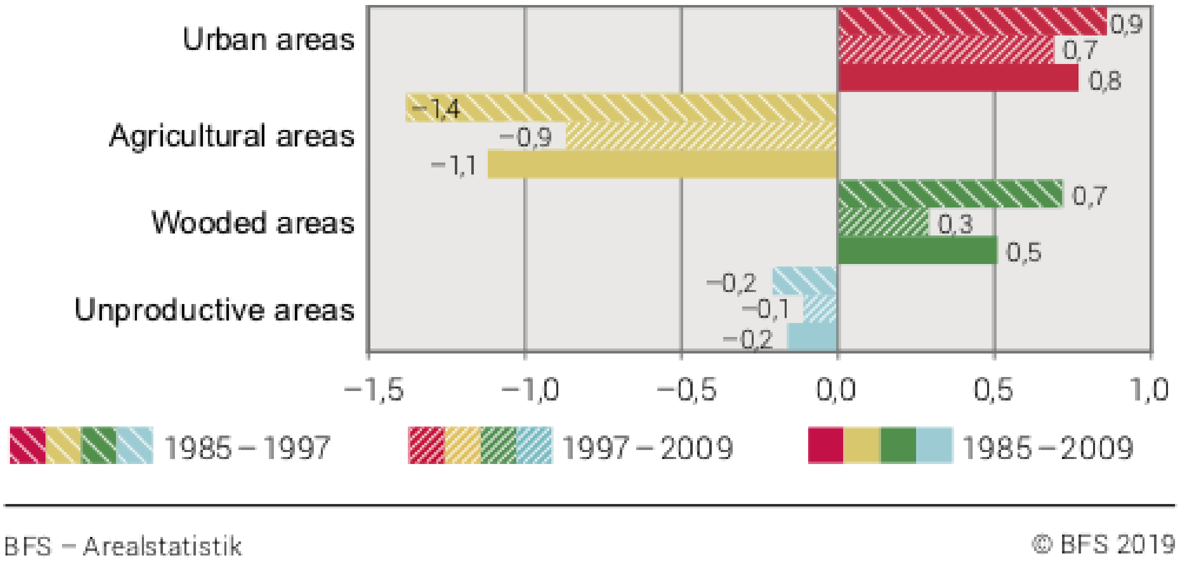



*Figure 3-2 Evolution of land uses 1985-2009 (in m2/s)* (FSO 2019a).

## Soil

Fertile soils are a prerequisite for the production of low-carbon local food, and it is essential to ensure their long-term protection. However, soils are more than two-dimensional surfaces supporting food production and the construction of roads, buildings and other infrastructures. They represent invaluable ecosystems and provide numerous lesser-known services such as e.g.: Carbon sequestration, water filtration and nutrient retention (Baer and Birgé 2018). In particular, soils are a key component of the global carbon cycle, since they regulate carbon exchanges between plants, the atmosphere and the pedosphere. Depending on climatic conditions, soil properties and land uses, soils may in fact act either as sinks or as sources of greenhouse gases (GHGs) (Ng 2019). In Switzerland, for example, the national research program NFP 68 recently concluded that Swiss soils store about 7 times more carbon than the atmosphere (Hagedorn et al. 2018). However, it also states that the carbon content of arable land has been decreasing over the past decades because of land use changes and agricultural management practices. In the same vein, a publication of the European commission recently stated that “if current trends continue, soils are likely to go on releasing large amounts of CO2 in the atmosphere, adding to ongoing climate change and cancelling out savings in emissions made by other sectors, such as industry or transport” (European Commission 2011).

## Legislation

In order to limit soil consumption and promote inward urban development, the federal law on spatial planning was partially revised in 2014. The new legislation is currently being implemented at municipal level: Compact urban development is implemented through infill redevelopment and densification, and developers as well as landowners are encouraged to use land more economically through a new tax levy. Concurrently, undeveloped building zones are reduced in size and reallocated between urban and rural areas.

In parallel, new instruments have been developed to encourage regional cooperation and cross-sectoral planning. For instance, *agglomeration programs* aim to better coordinate urban and transport development in order to reduce traffic load. However, much remains to be done in this respect. To name but one example: Around 4 million Swiss people commute daily between their home and their workplace (FSO 2019c). In doing so, they travel 30 km on average (round trip), and 52% of them use their private car to this purpose (FSO 2019c). Unfortunately, current policies tend to involuntarily increase commuting patterns by concentrating new infrastructures in agglomeration centers. Therefore, the ratio between job and housing opportunities (employment density, i.e. number of jobs per 100 inhabitants) tend to be higher in urban core areas than in smaller urban centers and suburban locations (Setz, Frank, and Suter 2019). Consequently, a large proportion of workers are forced to commute every day between their suburban homes to their workplaces in agglomeration centers. New approaches are urgently needed to reduce these commuting movements and their associated $CO_2$ emissions by better balancing the job/housing ratio within agglomerations.

# Policy Measures Buildings

We propose a package of different measures for the building sector. At the same time, the CAP also proposes cross-sectoral policy instruments that will also contribute to decarbonization in the building sector. They are explained in detail in the chapter Cross Sectoral Policies.

## Policy 3.1: Ban and Replacement Obligation for Fossil & Electric Heating Systems

### Background

Still 60% of residential buildings are heated with oil or gas and fossil heating is still widely used in industry. At the same time, not all fossil heating systems are replaced by renewable energy systems at the end of their service life. And even if this were the case, it would take about 20 years (average life span of heating systems) until the building sector would be largely CO2-free in operation. Previous control instruments such as the CO2 tax and the building program were based almost exclusively on financial incentives. They were and are not able to ensure the necessary rapid transformation from fossil to renewable heating systems. It is therefore imperative that there are regulatory requirements for changing heating systems.
If politics had not ignored climate science for 30 years, it would still be sufficient to establish a gradually decreasing emission limit value (kg CO2 per m2 of energy reference area), which would apply at the time of the heating system change. (This approach is being pursued with the current revision of the CO2 law and is also the basis of the REDEM initiative.)

However, if decarbonization is to be achieved by 2030, we must ensure that:

- Fossil and direct-electric heating systems from 2011 onwards will be replaced by a renewable system before the end of their roughly 20-year service life;
- Fossil and direct-electric heating systems built before 2011 should be replaced by a renewable system at the end of their service life (but no later than 2030);
- Every heating system installed in a new building is renewable;
- In the case of particularly high thermal energy or heat output requirements (old, uninsulated buildings), additional renovation measures are triggered on the building envelope and/or heat output in order to limit the waste of scarce and valuable renewable energy sources.

### Description

This can only be guaranteed to be effective with a regulatory legal requirement with the following key points, which come into force on 01.02.2021.

- Legal obligation to replace all or part of fossil-fueled and direct-electric heating through a re-newable system in the building stock for all types of buildings
    - **favored variant a)** for all heating systems equally by 31.12.2030 at the latest; an equal utilization of capacity by trade, manufacturers and suppliers is guaranteed by financial incentives (see below)
    - **alternative variant b)** for all heaters graded according to service life (heaters built up to and including 2000 must be replaced by 2021, 2001-2002 by 2022, 2003-2004 by 2023, etc.)

    - **alternative variant c)** a combination of the two, which is more regulatory than a) and allows more individual flexibility than b) with financial incentives (e.g. a three-year window for each heating system, depending on the age of the building, with decreasing compensation the longer the heating system is in operation)
- Legal prohibition of new heating systems based entirely or partially on fossil fuels in new buildings of all types (renewable heating requirement)
- Legal requirement to reduce the final energy demand of particularly inefficient buildings by energetic renovation of the building envelope (e.g. to at least GEAK/CECB/CECE class E) and/or - if an air-to-water heat pump is to be used - by replacing/expanding the heat output system to reduce the flow temperature to max. 40°.
- Hardship clause for the obligation to replace existing systems and renovate the building envelope: If it turns out to be technically almost impossible or financially absolutely unreasonable to fulfill the above conditions, then exceptions can be granted and/or additional subsidies can be granted.
- Heating financial compensation for system replacement costs and non-amortizable investment (NAI) due to premature replacement of the heating system through a subsidy amount graduated according to the age of the heating system (the younger the heating system, the higher the NAI and the higher the subsidy amount); for details see Policy 3.2.
- Financial compensation building envelope for the partly high investment costs and non-amortizable investments (NAI) due to premature renovation of a building component; for details see Policy 3.2.

**Which energy source is really sustainable?**

**Wood** releases just as much $CO_2$ during combustion as was bound during the growth of the tree. However, it is not sustainably available in unlimited quantities and must therefore be used primarily for applications where few alternatives to decarbonization are available (e.g. high-temperature processes in industry). Furthermore, the thermal use of wood, e.g. in EFH wood pellet heating systems, results in comparatively high emissions of pollutants. Wood heating systems are therefore not very suitable for densely populated areas. In any case, the best use of wood for climate protection is material and not energetic - e.g. as construction or furniture wood. Because this way the bound wood remains as long as possible far away from the atmosphere. Energetically only wood should be used, which is not or no longer materially usable or arises as waste, e.g. in sawmills.
**For biogas and renewably produced gas** (methane, hydrogen) the same applies: It should be used primarily for material and energy uses for which there are few decarbonization alternatives available so far (e.g. industrial processes, ocean shipping, etc.). For space heating and hot water, we must hardly waste the very limited quantities available for the time being.
**Heat from waste incineration** is only climate-friendly if it is non-fossil waste. A net zero heat supply can no longer take into account waste heat from the incineration of fossil waste from 2030 at the latest, because the fossil share in waste must be reduced to almost zero in the interests of climate protection and the circular economy.

## Financing

This compilation serves as a very rough estimate of the additional financial requirements (compared to business-as-usual) to cover the upfront costs and non-amortizable investment costs for heating replacement:

- 1.2 million fossil and direct electric heating systems across all sectors/building types (very rough estimate)

- additional investment costs compared to a pure 1-to-1 replacement of CHF 30,000 on average across all sectors or building and heating types (very rough estimate)
- in addition, investment costs that cannot be amortized due to premature replacement of heating in half of all heating systems amounting to CHF 10,000 on average across all sectors or building and heating types (very, very rough estimate)
- **Total: CHF 48 billion for the ten years from 2021 to 2030 (around CHF 5 billion p.a.)**

For counter-financing or financial support for building owners see Policy 3.2.

## Impact

The introduction of the above measures would reduce current emissions from the building sector from 12.6 Mt CO2eq/a to almost completely by the end of 2030. The other policy instruments in this chapter - such as the Climate Fund are mainly of a flanking character: They increase acceptance and social compatibility and/or reduce the costs of regulatory requirements. They only have a CO2 reduction effect of their own if they lead to climate protection measures that are not required by law or before they become mandatory.

## Social Compatibility

About half of the owners of buildings with a fossil fuel heating system (businesses as well as private households) have to replace it prematurely, which means that investment costs cannot be amortized and have to be written off prematurely. In the interests of fairness, these additional costs should be largely covered by the general public (e.g. through the GHG-levy). In addition, there are investment costs for the system changeover to a renewable heating system, which are usually higher than a one-to-one replacement (i.e. from oil to oil, from gas to gas). These are usually more than offset over the life of the heating system by the lower operating costs but can be a challenge in terms of liquidity and willingness to pay. This also applies to the high costs of a building envelope renovation. In both cases, there is a need for funding offers for particularly affected, financially weak households (and companies). For details see Policy 3.2.

## Questions and Uncertainties

- How do we minimize private and social costs through premature replacement of heating systems?
- Do we need further flanking measures to limit the overuse of wood for energy purposes and to take account of the prospect of a decline in waste heat from waste incineration?

# Policy 3.2: Climate Fund

## Description

The climate fund is similar to the existing building program in Switzerland, with improvements in the following aspects:

- The total available funding volume must be significantly increased compared to today. It is not trivial to determine the required amount a priori. An estimate would be possible if plausible approximations of the additional financial requirements of the renovation measures were available (see “Financing” in Policy 3.1).

- It is imperative that the funding criteria include those remedial measures:

- Which have the greatest impact on climate protection in terms of quality assurance (above all changing the heating system from fossil to renewable) and
- Which are prescribed by law (see Policy 3.1) *and* could cause social hardship (e.g. facade renovation due to high upfront costs), or
- Which are *not* prescribed and are hardly ever taken voluntarily (due to a very long payback period or lack of cost-effectiveness over the lifetime of the component) and
- Which do not involve any counterproductive uses in the overall system (e.g. scarce biogenic energy sources for space heating/hot water, where other solutions would also be possible).

- The support rates for the various rehabilitation measures must be increased. They should be based on the following criteria:
  - In the case of *compulsory* refurbishment, they must take into account the age of the systems concerned in the case of early replacement of heating systems/components: For instance, the younger the heating system to be replaced early, the higher the Investment costs that cannot be amortized and the higher the aid rate.
  - In the case of *voluntary* refurbishments, the subsidy rates must be so high that the owners subjectively perceive them as a relevant subsidy contribution. Only then will they act as a de facto incentive for those who would *not* have carried out energy efficiency improvements anyway. (This also reduces the deadweight loss effect, because with low subsidy rates only those who would have renovated anyway due to other reasons (e.g. climate protection) will take advantage of the subsidy.
  - In both cases, the rates could also be graduated to a certain extent according to the respective climate protection effect: The higher the effect on reducing the final energy demand and the lower the life-cycle emissions of the new component, the higher the subsidy rate.
- In addition, hardship clauses (or similar) are needed to ensure that in technically difficult cases and where the costs are not socially acceptable, the support rates can be increased further.

It makes sense for the Climate Fund to remain at federal level, as this is where the revenues from the GHG-levy are pooled. Building owners should have access to the same promotional offers regardless of the canton in which they are located. In particular, the level of subsidies should not depend on the extent to which the canton in question provides additional funds of its own (see Financing). The above changes should take effect simultaneously with the entry into force of the regulatory requirements (see Policy 3.1).

## Financing

The funds for the buildings program should continue to be financed to a large extent by the proceeds of the further increasing CO2 levy, because this is in line with the polluter-pays principle and is budget-neutral. For this reason, it does not seem appropriate to continue the existing mechanism (basic amount from the confederation from the CO2 levy, supplementary amounts from the cantons from their respective budgets). In the past, this has led to very low promotion budgets in many cantons and a lack of constancy in the promotion offer. It would seem sensible to set the share of subsidies from the federal CO2 levy at a level that, in combination with the other instruments, would allow the remediation and climate protection goals to be essentially achieved, so that there would be no dependence on the fluctuating willingness and ability of the cantons to provide subsidies. The additional funds required for this purpose can (hopefully) be generated from the rising revenue from the increasing CO2 levy. For social equalization, a large proportion of the tax revenue (⅔?) must continue to be redistributed to the population and companies.

## Impact

The climate protection effect directly attributable to the support program will probably be quite small. This is because, essentially, financial support is provided here for remediation measures that are prescribed by the above-mentioned regulatory requirements and therefore have to be carried out anyway. The funding instruments are primarily of an accompanying nature: They increase acceptance and social compatibility and/or reduce the costs of the regulatory requirements. They only have a CO2 reduction effect of their own if they lead to climate protection measures that are not prescribed by law or before they become mandatory.

## Social Compatibility

In principle, the funding instruments serve to increase the social acceptability of other instruments (among others Policy 3.1).

## Questions and Uncertainties

No open questions.

# Policy 3.3: Promotion of Bio-Based Building Materials

## Description

**To promote production, supply chain and usage of bio-based construction materials, in alignment with a recent proposal from the French government (Nelson 2020), any new construction project in Switzerland must contain at least 50% wood or other organic materials like hemp or straw by 2022.**

By employing bio-based materials, technologies and construction assemblies with high carbon storage capacity and low embodied carbon emissions, we can create a durable, human made, global carbon pool while simultaneously reducing GHG emissions associated with building sector activities. Cities built from bio-based materials, such as engineered timber and bamboo, can serve as constructed carbon sinks (Churkina et al. 2020). Storing and maintaining carbon in these densely constructed carbon pools will help replenish the terrestrial carbon storage, thereby reducing current atmospheric CO2 levels and offsetting future emissions. Primary building superstructure is the heaviest share of overall building weight and therefore has the greatest capacity for carbon storage. Redirecting roundwood from use as a fuel to long-lived products would be the most beneficial for climate change mitigation. Bio-based building materials can also be readily applied to other components and systems that make up contemporary building assemblies such as interior finishes, thermal insulation, and interior and exterior furnishings (Wiprächtiger et al. 2020). Fast in growing bio-based materials, e.g. hemp and straw, have considerable potential for temporary carbon capture and storage when used as thermal insulation for the renovation of existing facades as well as in new constructions (Pittau, Habert, and Iannaccone 2019). Besides being less impact-intensive in production, wood and cellulose fiber insulations have the additional advantage of being made of waste materials. In comparison to other engineered carbon sinks, the option of storing carbon in buildings has obvious benefits. It takes advantage

of evolving construction processes that will occur in any case and serves as a substitute for mineral-based structural materials causing high CO2 emissions.
The share of bio-based materials in construction in Switzerland is currently low. Only 14% of all primary building superstructure is being built of wood (Holzbau Schweiz, n.d.). Insulation materials are dominated by oil-based and mineral-based materials with bio-based insulation materials as niche applications.

### Financing

Materials from renewable sources are in Switzerland generally more expensive than mineral and oil-based materials. Using materials with lower environmental impacts is therefore currently often related to higher costs. With increasing expertise as well as demand and supply chain of bio-based materials, it is expected that bio-based materials become cost-competitive with other non-bio-based materials as seen in other countries, e.g. Sweden, where wood-based constructions are cheaper compared to steel/concrete-based constructions.

### Impact

In addition to the availability of forest resources, this transition will require changes in building codes, retraining the construction workforce, expansion of manufacturing capacities for bio-based products, and downscaling production of mineral-based materials. The transition will lead to downscaling of cement, steel, aggregate, limestone, and iron ore mining and production.

### Social Compatibility

A precondition for achieving higher harvest levels and maintaining carbon storage in forests is preserving forest sustainability and continuing re-forestation efforts. Increased demand for timber in construction would have to be supported by a strong legal and political commitment to sustainable forest management and robust forest certification schemes.
Biogenic materials, if not produced from waste, may however produce adverse impacts with regard to land use and eutrophication.

### Questions and Uncertainties

The fundamental difference in using timber for long-lived products rather than biofuels is the fate of carbon after timber harvest. While all carbon contained in 1 t of timber is emitted to the atmosphere when timber is burned, this carbon will be retained on land if timber is converted to long-lived wood products. In the latter case, carbon has a potential to be stored on land indefinitely once technologies are developed to process and safely landfill unrecyclable wood from demolished buildings.

## Policy 3.4: Expert Commissions to Develop the Net Zero Compatibility of Existing Laws and Building Regulations

### Description

Building regulations today sometimes make it difficult to build and renovate with climate-friendly and sustainable technologies and materials or indirectly prevent better solutions. Examples are regulations on the minimum number of parking spaces for individual traffic, insufficient consideration of life cycle

analyses for specifications in the insulation sector, or the existence of single-family house zones (see info-box).
Building laws should be adapted at the national, cantonal and municipal level to allow net zero to be reached quickly. In order to work out which regulations need to be adapted, expert commissions (architects, builders, executors and, if necessary, administrative representatives) should be formed at national, cantonal and communal level to make proposals for the necessary changes.
Such revisions would then have to be incorporated into the respective legislation via political processes.

**Examples**

Minimum number of parking spaces for individual traffic
In Basel-Land, there is a requirement for 1.3 parking spaces for apartments and 0.5 for workplaces. Such regulations result in the promotion of individual transport with private cars and prevent the realization of innovative mobility concepts aimed at reducing $CO_2$ emissions. In addition, they also increase the energy-intensive excavation volumes caused by the underground car parking that has become necessary.

Cantonal energy laws
Based on the SIA 380/1, cantonal regulations which set requirements for components of the building envelope are issued. The requirements relate to the energy transmission, and this in turn influences the heating and cooling needs during operation. Since the focus is on heat transfer coefficients and not the entire life cycle emissions are considered, sometimes false incentives are given for materials. More attention needs to be paid to the energy input for product manufacturing and its lifetime as well as its recyclability or $CO_2$ storage capacity.

Guidelines and recommendations of private organizations
Information sheets and recommendations from organizations can be used to enforce private interests in a non-democratic way, if they are linked to security aspects. For example, the Advisory Center for Accident Prevention (insurances) can define massively stricter regulations through its leaflets on railings, without weighing up the goods. Or the SIGAB guideline 002 (glass industry) defines where LSG/tempered glass should be used. These recommendations (and many others as well) must now be implemented, as courts will refer to them in case of doubt. If owners do not want to take any risks, some buildings have to be retrofitted intensively.

Tax incentives
Vacancies are subsidized in certain cantons through tax breaks.

## Financing

Expert commissions could be set up at the respective level without high costs.

## Impact

No directly measurable effect on greenhouse gas emissions would be possible here. However, the measure is nevertheless necessary and helpful to promote sustainable decarbonization.

## Social Compatibility

This measure should have no negative effects.

## Questions and Uncertainties

How can it be ensured that the proposals are also promptly implemented politically?

# Policy 3.5: One-Stop-Shop Advice Centers

## Description

In order to achieve decarbonization of all buildings by 2030, extensive retrofitting of the existing building stock is required. Many homeowners and tenants will be affected by this. In order to facilitate the conversion to carbon-free buildings, independent one-stop-shop advice centers should be set up for those wishing to retrofit, with information on technologies, measures, procedures, costs, financing and subsidies. Such advice centers must be set up in all cantons and larger cities. Several cantons already have such centers, but they should orientate them more towards climate compatibility.

The canton of Aargau can serve as a model: Under the name "energieberatungAARGAU" (Energy Consulting Aargau), the canton operates a central contact and information point to answer questions and offers support on topics such as energy efficiency or enforcement of cantonal energy legislation. The consulting services are divided into 3 areas:

- Consulting for individuals, industry, businesses and service sector
- Consulting for communities
- Information events

Private individuals thereby have the possibility of getting a rough analysis and rough answers to questions within the range of the building technology and/or the building envelope by means of a consultation. In order to ensure the correct realization during planning as well, a planning consultation is offered: Before the planned project comes into the detail treatment, respectively to the execution, together with their partners like architects and/or building services planners, owners can have their project checked by energy consultants for energetic optimizations and the efficient and sustainable use of energy. The impulse consultation "renewable heating" shows how heating systems in residential buildings can be replaced by sustainable and ecological heating systems. And with the GEAK/CECB/CECE. Furthermore, property owners receive an analysis of the energy status and efficiency of their building. The condition is indicated on the energy label in classes A (very efficient) to G (low efficiency). Thanks to this wide range of services, all questions of homeowners and tenants can be answered professionally.

## Financing

In principle, consultations that result in the reduction of CO2 emissions in the building sector are already subsidized by the confederation from the revenues of the CO2 steering levy. In addition to a basic contribution to the cantons, the latter finances the services with ⅓, the remaining ⅔ are reimbursed by the federal government. All of the above-mentioned offers are already financially supported in the canton of Aargau. Additional funding or coverage of the total costs would further encourage this.

## Impact

Information is key to the success of a rewarding implementation. It is important that homeowners and tenants know their options so that they can make the right choice at the right time. In addition, questions such as financing the implementation and legal hurdles can be addressed in advance.

## Social Compatibility

It should not be expected that such a consulting offer is socially incompatible. Particular attention is to be directed towards the owner-tenant dilemma, whereby the tenants only retain an insufficient influence on renewals.

## Questions and Uncertainties

No open questions.

# Policy 3.6: Renovation Incentives in Rented Buildings

## Background

The owner-tenant dilemma (also known as user-investor dilemma, split incentive, or principal agent problem) describes the problem that investments are not made because the investor cannot achieve a reasonable return on his investment in the long term. The user, on the other hand, would profit from the (lacking) investment, but does not have to pay for it. However, because the landlord can largely pass on his investment costs under Swiss tenancy law (see above), the owner-tenant dilemma is not a direct obstacle to retrofitting. However, the cost-benefit constellation leads to landlords not feeling a strong retrofitting incentive even with strongly rising energy costs (e.g. by a CO2-tax, see Policy 1.2). In order to change this - i.e. also to promote energy-efficient refurbishments that are not required by law (see Policy 3.1) and at the same time provide tenants with protection against excessive energy costs, corrections need to be made to the extent of which energy costs are passed on to tenants (see below).

## Description

**Usage related allocation of energy costs**

Currently the tenant bears the full costs for space heating and hot water. However, this is only partially on the basis of services used. Because not only his behavior, but also the building characteristics (which can be influenced at best by the landlord) affect at least the space heat requirement - on average similarly as strongly as the behavior. A solution in which the tenant pays only a part of the room heating costs (e.g. 50%) depending on the energy consumption and the rest (e.g. 50%) is paid as a lump sum. The lump sum is based on the room heating requirements of an average building. It should be gradually reduced in order to reflect the increasing public expectations regarding the efficiency standard of buildings. The owner of a building that consumes an above-average amount of energy or does not meet the respective efficiency standard (e.g. a certain GEAK/CECB/CECE class) pays a higher contribution to the room heating costs than he receives from the tenant as a lump sum. This gives him a direct incentive to reduce these costs through energy-related renovation measures, as he can keep 50 centimes of every franc saved in energy costs for himself. The tenant benefits of this because he or she no longer has to bear the full energy costs for particularly inefficient buildings. At the same time, he or she retains a certain financial incentive to reduce the energy consumption that he or she can influence by making changes in behavior (ventilation, room temperature, etc.). The previously applicable provisions in tenancy law (OR Art. 257b (Bundeskanzlei, n.d.) and VMWG Art. 4 (The Swiss Federal Council 2018)) must be adapted accordingly.

**Further Measures**

A number of measures are equally suited to protect the interests of tenants and to increase the rate of energy efficiency retrofitting (in this way reducing GHG emissions). However, they would have to be worked out in detail before they could be implemented. This includes:

- The increase of the funding rates in the buildings program (see policy 3.2): This makes the buildings program attractive also for those owners who do not want to retrofit anyway. They are now also taking energy-related retrofitting measures. The subsidies reduce the allocated costs and are thus passed on to the tenants.
- A GEAK/CECB/CECE obligation for new rentals: This gives tenants transparency about the energetic quality of the apartment and the approximate expected service charges (whereby the latter are of course additionally determined by user behavior). In this way, landlords get a reason and an incentive to think about energy improvements of the building.
- An extension of the consumption-based heating and hot water cost accounting ("VHKA") to all new buildings as well as all existing buildings where the heating is being renovated: It strengthens the polluter-pays-principle in the allocation of energy costs, because thereby the influence of the user behavior can be taken into account. At the same time, it serves as an incentive for the tenant to save energy. Ideally, the energy cost billing is designed in such a way that the tenant partly pays it according to consumption, size and location of the apartment and partly as a gradually decreasing flat rate (see above).
- A rent reduction right in the event of failure to renovate: This would have a de facto effect similar to the above-mentioned flat-rate energy cost allowance, which is based on a high efficiency standard.

A claim for retrofitting on the part of the tenant if a gradually decreasing upper limit for energy costs is exceeded. This could - in addition to the regulatory requirements discussed in Policy 3.1 - act as a private law retrofitting requirement for rented buildings.

## Financing

Most of the measures mentioned are associated with little (or no) additional investment costs. In some cases, such as the expansion of the VHKA/DIFC/CISR, the additional costs for equipment, maintenance and annual billing are covered by the savings in energy consumption. This is shown by before/after comparisons of buildings retrofitted for VHKA/DIFC/CISR, which show a significant reduction in consumption due to the VHKA/DIFC/CISR savings incentive.

## Impact

The additional climate protection effect of the various measures cannot be quantified without precise knowledge of their exact design and the framework conditions (what other instruments are in effect). In principle, the same applies as for the funding instruments (Policy 3.2): The climate protection effect that can be attributed to the incentives under the tenancy law will probably be quite small. This is because most clean-up measures will be based on regulatory requirements. They will have their own CO2 reduction effect if changes in behavior are encouraged and investment climate protection measures that are not (yet) prescribed by the regulatory framework are initiated.

## Social Compatibility

**General remarks**

In Switzerland, the landlord is allowed to allocate most of the expenses for energy-related retrofitting to the rent. Energy-efficient retrofitting of buildings often results in the rent increasing more than the ancillary costs decrease. The consequence is that the cost of living rises. It is true that tenants benefit from a professionally carried out energy-efficient retrofitting mostly through higher living comfort (less draught, no mould growth, better sound insulation). But that does not help those tenants, whose living costs are at the limit of the socially acceptable. It is therefore an important concern to make the

framework conditions for energy-efficient buildings retrofitting to a level as socially acceptable as possible, without compromising climate protection goals.
The greatest socio-political relevance is probably the phenomenon that real estate is often emptied of its tenants when it is completely retrofitted, and in this case the rent can be freely determined after the retrofitting, so that - depending on the market situation - it is significantly higher than the old rent. In such cases the housing costs increase the most. However, this correlation is not primarily linked to energy-related building retrofits. Especially retrofitting for energy efficiency can usually be carried out without having to empty the building. It is rather the "luxury renovations", which concern bath, kitchen or even the living space division, which require a notice of vacancy. Those have little to do with energetic retrofitting, but rather represent some landlords' strategy in order to be able to implement disproportionate rent increases even under the current tenancy law. If energetic retrofittings usually do not require emptying a building, it is of little use to disburse subsidies for energetic retrofittings (see Policy 3.2) only if the building has not been emptied. This would probably only prevent a few emptyings.

In principle, the tenancy law measures serve, among other things, to increase the social acceptability of other instruments (including Policy 1.2 and Policy 3.1). Some measures relieve tenants of some of the financial burden, while others are more likely to place a burden on landlords.

### Questions and Uncertainties

No open questions.

# Policy 3.7: Digital Material Archive and Component Market to Support Circular Material Cycles

### Description

Sustainable infrastructure must be built in such a way that all resources needed for production are fully reusable. This means that the materials used should no longer just be used and then disposed of, but should be reused, recycled, composted, etc. ("urban mining and recycling"). In this way, the share of grey energy can be significantly reduced. In order to promote carbon-neutral and carbon-storing constructions, instruments that enable circular material cycles are needed, such as building component material markets and digital building component archives.

- Component markets and storage halls should be built regionally at logistically sensible locations. This could be done on a cantonal level.
- A national digital building component archive can link the markets and provides a good overview of supply.

There are already such platforms and facilities for recycling of building materials (e.g. www.madaster.com, www.salza.ch or www.oogstkaart.nl). A Swiss platform could therefore be created based on the experience of existing initiatives. Such a digital archive of building components could be created by the public or private sector.

Fundamental changes are needed to enable comprehensive circular material cycles for building construction and civil and underground engineering:

- Planning for use and reuse, including recording of components and materials. The information stored today (construction plans, cadastral plans) is not sufficient to enable the recycling of building materials in the sense of a circular building economy,
- Modularization and grade of purity, i.e. new materials and new designs will be necessary.

A digital building components archive and component markets are not sufficient for this fundamental renewal of the building industry, but together with other policy measures (e.g. standards, purity and documentation, as well as research and promotion of new sustainable building materials and techniques) they can make an important contribution to this transformation.

## Financing

The costs of creating and operating a digital building components archive are manageable.
The costs of setting up and managing storage halls could be financed from the revenue of the products sold.
The costs of registering the components and reusing them could lead to additional costs for the building owner. These could be compensated however at least partly by the sales and/or use of existing construction units.

## Impact

The grey emissions from buildings are considerable. Recycling reduces the demand for raw materials and consequently the grey emissions as well.

While the average share of embodied GHG emissions from buildings following current energy performance regulations is approximately 20–25% of life cycle GHG emissions, this figure escalates to 45–50% for highly energy-efficient buildings and surpasses 90% in extreme cases (Hondo 2005)

## Social Compatibility

A digital material archive and component markets would not have any significant negative social impacts.

## Questions and Uncertainties

No open questions.

# Policy Measures Spatial Development

Any social action has a spatial dimension. Conversely, spatial development and spatial planning only indirectly influence greenhouse gas emissions. For instance, although good coordination of settlement and transport development aims at a society with less traffic, the possible savings effects cannot be quantified directly. Rather, spatial development is concerned with qualitative questions, which are, however, highly relevant for the discussion of a climate-neutral future (cf. Vision): How do we organize ourselves as a society in space, how do we shape it, what ideas, hopes and expectations do we attribute to it? Practically all of the policies related to spatial development are directly related to policies from other subject areas (e.g. mobility, economic and political structure, agriculture, etc.) or are described in the specific chapter instead of here.

Spatial development is relevant at all levels of scale. Today, the design of development processes in spatial and urban planning has a great responsibility for the production of space. Such development processes are generally coordinated by the planning authorities (e.g. for cantonal and communal structure plans, zoning plans, proposals maps, as lead authorities for infrastructure planning, etc.). Since the 1990s, there has been a strong strategic tendency towards project-based planning. Hence important planning decisions are often not taken at the higher levels of society (confederation, cantons, city-wide) – they often remain merely vague here – but are (spatially) shifted backwards, e.g. to the level of site development. However, it is precisely here, at the level of concrete local development, that major restrictions on innovative approaches are applied as well (e.g. alternative traffic organization, massive reduction and re-organization of parking spaces etc.), as isolated solutions do not seem feasible in the context of competing cities and a lack of legal prerequisites. On the other hand, solutions at spatially superordinate level (community-wide, canton-wide) that attempt to counter the prevailing way of life, do quickly fail due to the competition among cities, too. Nevertheless, the local level plays a central role in social transformation – since it is only here, at the level of encounters and everyday life of people, that practices can be reinvented and lived. Whether in neighborhoods, in (car-free) districts, but also in the entire city with its surrounding countryside and its importance not only for recreation and leisure, but also for the production of agricultural goods for the cities.

The policies listed below address the facets of climate protection, climate adaptation and climate justice in different ways. On the one hand, they have a rather restrictive character (e.g. Climate Impact Assessments for Planning, Projects & Stock Development), on the other hand, they have an enabling character (e.g. Creating frameworks for development processes towards climate neutral cities and communities).

In addition, for a climate-neutral Switzerland, a number of other policies in the area of spatial development are beneficial or necessary, but since their effects are rather indirect, they are not described in detail here. The following are examples of such policies:

- Enabling the re-localization of today's (globalized) production processes by securing land for commercial and industrial production: This will facilitate, for example, the re-appropriation of production-consumer relations and increase social resilience by reducing global dependencies. Last but not least ⅔ of Swiss $CO_2$ emissions are imported into Switzerland as "grey emissions" in the form of goods, services and products.
- If additional living space is required to counteract any housing shortage – and other mechanisms for moving closer together or reducing the specific living space requirement have been exhausted (cf. other policies, as well as: conversion of office workplaces, housing exchange, relocation assistance, etc.) – then it is important to build on the existing buildings (re-

densification and interior development). High building density creates the conditions for good pedestrian accessibility, as well as for high density of encounters and experiences, which contribute to the creation of attractive and livable urban spaces and neighborhoods.

Spatial development measures for adaptation to climate change (from the danger of landslides due to permafrost's thaw to heat stress in cities) are not discussed further here. A policy merely refers to the synergies with climate mitigation measures.

# Policy 3.8: "Soil Index Points" to Secure High Soil Quality for Local Food Production and for a Limitation of Carbon Loss

## Description

Spatial planning aims to coordinate and operate a trade-off between different land uses, in order to steer spatial development. Municipalities and cantonal authorities apply the instrument of soil index points to ensure that new infrastructures are built primarily on low-quality or already degraded soils. By doing so, soil quality becomes a key driver of planning decisions and high-quality soils stay available for the local production of low-carbon and renewable goods (e.g. food, raw materials, building materials, fuels). In addition, carbon-rich soils remain unsealed and can be managed in order to limit carbon loss or even act as carbon sinks in the long run. Where necessary, the legal basis is adapted accordingly.

**Goal and procedure:** Soil index points allow to consider soil quality in spatial planning decisions, secure local food production, limit carbon loss, and foster inward urban development. The instrument works as follows (Grêt-Regamey et al. 2018):

- A soil index is developed to assess the quality of the unsealed land across the country. Different criteria are considered and aggregated in this index, such as for example: "suitability for agricultural production", "carbon content", "potential for carbon sequestration"
- At cantonal level, the sum of the soil index points is then calculated. An annual cap is set to limit the yearly consumption of soil index points on the cantonal territory.

Until now, the legislation has rather focused on the quantitative aspect of soil protection (i.e., on the reduction of land consumption) and on the preservation of the most fertile soils through the designation of crop rotation areas. Few guidelines exist to account for soil quality in cases where land development is unavoidable or paramount for the general interest (e.g. to build infrastructure for the production of renewable energy). Soil index points aim to tackle this issue and include soil quality in spatial planning decisions in order to protect high-quality soils. However, soil index points should not replace other important criteria (e.g. accessibility, proximity to already built-up areas) to decide on the location of new building zones. Rather, this instrument should allow soil quality to be taken into account along with quantitative criteria (e.g. total area in ha) when weighing up the interests at stake (Grêt-Regamey et al. 2018).

**Justification and link to other policies:** The Climate Action Plan provides for a moratorium on new infrastructures until 2030 (see chapter Cross Sectoral Policies, Policy 1.1). However, exceptions are planned for key infrastructures that support decarbonization. Such facilities include, for example, renewable energy power plants. The construction of these infrastructures will require the building-over of additional land area and it is thereby crucial to ensure the protection of the qualitatively best soils.

**Responsibilities:** The instrument was originally developed to be implemented at municipal level. To ensure stricter implementation, the management of the soil index points could be delegated to the cantons, under supervision of the confederation.

**Time period**: As soon as possible. The instrument requires nationwide soil data and the aggregation of soil function maps into a soil index (Gmünder 2016). Such decision-making tools are not yet available and have to be developed first.

## Financing

The development of soil index maps will be supported by the federal government and the cantons.

## Impact

- Preservation of soil quality (Gmünder 2016). By doing so, it ensures that high-quality soils remain available in the long run for the local production of low-carbon and renewable goods (e.g. food, raw materials, building materials, fuels). In addition, carbon losses are reduced, and soils may be enabled to act as carbon sinks in the long run;
- Economical and sustainable use of the soil by using both qualitative (e.g. suitability for agricultural production, carbon content, potential for carbon sequestration) and quantitative (e.g. total area in ha, proximity to other developed areas) criteria to select the location of new building areas.
- To reduce soil carbon emissions and even enable carbon sequestration, new land management practices such as the rewetting of peat soils or residue management are urgently needed (see Policy 6.31). As a prerequisite to such actions, the use of soil index points in spatial planning decision-making is key to prevent high quality soils from being built over and to concentrate new building zones on already degraded soils.

## Social Compatibility

In order to meet the growing demand for living and working space without a massive extension of urban areas, spatial planning should aim at high-quality inward urban development.

## Questions and Uncertainties

Soil index points are not yet used in Switzerland. However, the implementation of the instrument is currently being discussed in specialist circles. Abroad, soil index points have been used successfully for several years, e.g. in Stuttgart (Grêt-Regamey et al. 2018).

# Policy 3.9: Implementation of Climate Impact Assessments for Planning, Projects & Stock Development

## Description

The goal of 2030 net-zero-compatibility is to be demonstrated by the planning authorities by means of climate compatibility tests for all current and future spatial planning projects in accordance with the polluter-pays principle. The same applies to essential structural developments within the framework of existing planning laws - whether in existing building zones or in areas with development plans / special building regulations.
For the implementation, the possible legal leeway is to be fully exploited or the necessary legal and regulatory prerequisites are to be created (e.g. in the Environmental Protection Act and the Ordinance on Environmental Impact Assessment); in particular, besides assets, planning must also be taken into account.

Existing environmental law already provides for the option of tightening existing emission regulations if it is clear that they are harmful (Art. 11) (The Federal Assembly of the Swiss Confederation 1983). With regard to the climate emergency and its urgency, the existing procedures of environmental impact assessment are to be extended or supplemented in such a way that
a) $CO_2$ is substantially and comprehensively considered as a significant emission (including grey emissions and emissions from site-related mobility),
b) the reference to installations is extended to include planning (as known for years in Europe as Strategic Environmental Assessment (SEA) and discussed in Switzerland as "environmental impact assessment" ("Wirkungsbeurteilung Umwelt") and in some cases already binding at the cantonal legal level.
c) the threshold values are lowered (e.g. System sizes not only from 500 parking spaces upwards) and
d) the realization of projects under existing planning law is also subject to an examination in the context of approval procedures with regard to climate impacts.

For smaller projects, the climate compatibility assessment does not require a complete material-law examination of all other environmental issues. It must be proven under material law that effective climate protection (2030 net-zero-compatibility) is achieved with planning and project and is not undermined. Corresponding legal bases (lowering path / $CO_2$ budget) are to be created for this.
In order to be able to carry out the verifications in a simplified way, it is recommended to provide appropriate planning and calculation aids.

**Justification and link to other measures:** The CAP plans a moratorium on new infrastructure until 2030 (see Policy 1.1). Exceptions are planned, however, for certain new buildings and facilities that promote decarbonization, as well as for developments in existing infrastructure (renovation and conversion). Here - as well as where any legal claims should stand in the way of the implementation of the moratorium - climate compatibility assessments are required to ensure that such projects are 2030 net-zero compatible.
The planning law currently applied in Switzerland permits a wide range of constructional developments. However, at the time of the adoption of the respective planning laws (zoning regulations, special building regulations) by the political bodies or the sovereign, the question of 2030 net-zero-compatibility of the plans was not included in the consideration processes. On the one hand, there is a lack of political awareness of climate issues, on the other hand, there is a lack of legal foundations.

**Responsibilities:** It is of the Federal Council: Adaptation of legal foundations and preparation of planning and calculation aids; planning authorities for the execution of the verification (planning authorities and applicants); enforcement authorities.
**Time period:** Immediately. The preparation of the documents will take some time. Until then, individual proofs can be used without the corresponding planning tools, or a certain moratorium applies until the corresponding proofs can be provided.

## Financing

If interventions (planning or construction projects) affect the climate, the polluters are responsible for sufficiently demonstrating that the interventions are not harmful. The costs for the proofs are therefore to be paid by the intervening parties.

## Impact

The climate impact of planning is increasingly acknowledged and is becoming a central criteria for it. Climate impact assessments provide decision-makers (in politics and public authorities, the sovereign) with the necessary basis for decision-making regarding greenhouse gas impact. Without them, it is not possible to make well-founded decisions about the climate compatibility of a project.

## Social Compatibility

As long as it cannot be proven by climate impact assessments that projects are compatible with effective climate protection (2030 net-zero-compatibility), developments will be limited to existing buildings and infrastructure. (see Policy 1.1 "Moratorium on new infrastructure").

## Questions and Uncertainties

How far does an appropriate adjustment of the UVPV/OEIE/OEIA (Verordnung über die Umweltverträglichkeitsprüfung/ Ordonnance relative à l'étude de l'impact sur l'environnement/ Ordinanza concernente l'esame dell'impatto sull'ambiente) by the executive alone already suffice? Which legal adjustments would have to precede this? How can a CO2 reduction path be specified in concrete terms: on a sectoral or subregional basis throughout Switzerland?

# Policy 3.10: Creating Frameworks for Development Processes towards Climate Neutral Cities and Communities

## Description

Municipalities provide the necessary resources for socially initiated, local negotiation and design processes (rooms, material, possible information channels, possible remuneration, etc.) with the aim of implementing climate-neutral cities, municipalities, communities, neighbourhoods and public spaces. Where there is no initiative from the citizens for such design processes, the municipalities themselves become active in initiating these processes and, if necessary, accompanying them.

**Justification and link to other measures:** For the transformation toward climate-neutral cities, the initiatives emanating from existing institutions are obviously not yet sufficient. In particular, there has been too little willingness to take decisive action. It can also be assumed that the municipal administrations do not have the resources (personnel, knowledge, etc.) necessary for such processes. At the same time, the transformation will not be able to take place entirely without the existing institutions or completely bypass them. But how and with whom can the transformation to a climate-neutral future be shaped locally? How can neighborhoods, quarters, and public spaces be transformed so that they promote and encourage a climate-neutral life for all? In this context, the diversity of concrete situations in Switzerland will not allow for the one correct format or the one suitable form of institutionalization of alternative negotiation arenas. One could think of future workshops, climate assemblies or other cooperative discourses and large group-oriented processes. It is important, however, to establish and cultivate corresponding processes locally.

Municipalities - as bearers of the public interest - basically have a central function here. However, if they cannot (or do not want to) fulfill this function, they are at least obliged to provide the resources necessary for such processes. This can include - in recognition of their commitment - rewarding those who play a decisive role in shaping these processes.
Just as possible formats, settings and forms of institutionalization cannot be generally prescribed, the principles by which such processes are oriented cannot be generalized. Nevertheless, various principles can serve as orientation for such processes:

To be searched for / tried out are:
- Dissent clarification
- Consensus orientation (consensus: no serious, justified objection)
- Discourses that are binding in terms of content and not arbitrary; commitment to a net zero orientation by 2030 and the consideration of climate justice. In addition, questions of climate adaptation and ecological functionality (protection of species) should be central.
- Sufficient appreciation of the commitment (time / remuneration).

To be avoided are:
- Forms of "strategic integration”. Bernd Sahler identifies them as follows: Discussion rounds are convened by government representatives; They select the facilitators, the mediators, the chairpersons of the meeting; The topics and discussion points are determined by the mediators; There is no "equality of arms" between the two sides from the outset; The persons and groups involved are not granted the right to make decisions (Wilk and Sahler 2014).
- forms of a "simulative democracy" (Blühdorn 2013), which protects vested interest and with which the existing, unsustainable order of injustice is secured through democratic procedures.
- Forms of selective democratization through which exclusively or predominantly groups with strong articulation (e.g. politically, financially, symbolically and culturally powerful groups) have their say and minority positions are structurally disregarded.
- Strict orientation towards consensus, since this favors the danger of a unity of content, and marginalizes disputes; Deviating or weakly articulated positions through an implicit pressure of silence.
- Solidification of processes due to permanent (paid) positions of power.

**Responsibilities:** Committed people / users (residents, businesses, etc.), communities.
**Time period:** Immediately; To be maintained

## Financing

Different for each process. For small municipalities, it should be possible to apply for financial assistance (cantonal, federal). Funds are provided from climate funds or newly created transformation funds.
Municipalities and institutions must make rooms available free of charge (community rooms, schools, church rooms, etc.).

## Impact

High; corresponding processes are to be designed in such a way that they have a multiplication effect on site as learning and design processes at the same time; innovation processes and municipal change management lead to the feasibility of solutions that previously lacked majorities.

## Social Compatibility

Is among other things the result of these processes.

### Questions and Uncertainties

It is currently not clear in what dynamics such processes will be implemented. They could be made a prerequisite for the approval of municipal planning guidelines; However, the focus should be less on formalization than on the quality of the processes. What incentives communities have for participating in such processes should be examined locally. One possibility is to link them to questions of climate adaptation, which is an effective method of bringing climate protection issues into focus. (Böschen et al. 2014)

# Policy 3.11: Creating Frameworks for Walkable and Livable “Cities of Short Distances”

### Description

Municipalities and private individuals help to ensure that favorable conditions for livable "cities of short distances" are provided locally. They do this by creating suitable conditions on three levels: spatial planning (availability of land), infrastructure (inviting footpath networks) and supply-side (promotion of a variety of local service offerings). Here, walking is particularly encouraged ("walkable city").

**Justification and link to other measures:** The "city of short distances" provides the framework for an alternative (local) mobility culture by avoiding traffic (shorter distances), shifting it (compatible modes of transport such as walking / cycling) and improving it (greater urban compatibility than car traffic). Contrary to frequent assumptions, however, it is not primarily created by a mixture of uses, density, good public transport or attractive outdoor spaces, but rather by low speeds or high spatial resistance (see various policies of the WG Mobility, as well as Policy 3.13) (J. Müller and Lange 2016). Walking is not only the most climate-friendly form of mobility, it also has no negative consequences, neither for urban coexistence nor in terms of other effects on the "environment". Walking therefore plays a major role for a world that wants to get by with far less resource throughput for transport. In addition, walking is healthy in many respects, is available to everyone, costs nothing, brings people into conversation, etc. Walking is part of the promise that resonates in the model of the "city of short distances" - but it must be designed concretely. This requires measures on three levels: spatial planning, infrastructure and supply. These measures are intended to replace today's forced mobility in terms of the choice of means of transport with the possibility of walking. We speak of forced mobility when, for example, everyday mobility needs and routes cannot be chosen voluntarily due to the conditions of the area, but instead require certain means of transport.

1. **Spatial planning requirements**: A large part of today's traffic volume is generated by leisure and shopping traffic (about commuting see especially Policy 3.13). Spatial planning can promote short distances. This can create favorable conditions for small-scale recreational activities, e.g. by providing a good quality living environment or good accessibility of recreational areas on foot, by bicycle and by public transport. Furthermore, shopping on foot is to be encouraged. To this end, the availability of space must be managed: on the one hand, by restricting large-scale (and usually decentralized) retail trade, and on the other hand by enabling and promoting small-scale or pedestrianized supply structures. The future use of family or leisure gardens (allotment gardens) - which today are often "only" used for leisure activities - must

also be seen in the light of their importance for local supply. This does not imply that urban forms of future agriculture can contribute to a full supply, but it does mean that they will become more important in the future, also with regard to the knowledge of producing one's own food. Accordingly, spatial planning should aim for a perforation of the city in which areas for allotment gardens / common-gardening gardens are within walking distance (walkable perforation).
2. **Infrastructural requirements**: High-quality places to stay and meet as well as attractive footpath networks will be created. For this purpose, people on foot are consistently prioritized (see WG Mobility, e.g. when crossing roads), in order to ensure a dense, coherent network of footpaths with few detours and obstacles for everyone.
3. **Supply-side requirements:** A rich offer of local-community usages is created, which promote the social organization on site (village, city, district, quarter...) and in the neighborhood. Here are conceivable for example:
    - Exchange and loan stores;
    - Climate workshops or repair cafés (see Policy 9.2);
    - Co-Working jobs (which promote new working models);
    - Rooms for neighborhood, neighborhood-related and social organization;
    - Urban Gardening (commons; within walking distance).

Cycling is also central to the "city of short distances", which is not the focus here (see WG Mobility). However, the measures described here are almost always in line with a bicycle-friendly city.
**Responsibilities:** Public authorities; landowners. On the supply side, the public sector can contribute to and stimulate corresponding offers with funding programs, platforms, low-cost loans, financial/spatial support, etc.
**Time period:** As of now. The effectiveness unfolds over time.

## Financing

To be clarified in individual cases.

## Impact

The measure has a positive effect on different levels:
- Reduction of emissions (CO2, noise, pollutants, fine dust, etc.) by promoting non-motorized traffic instead of motorized individual traffic;
- Greater social resilience due to the possibility of satisfying needs locally, for which there was previously either no supply, or which were satisfied through consumption or at another location, as well as through smaller-scale structures (e.g. neighborhood stores), which lead to a greater structural diversity of supply;
- Strengthening of sociality and community spirit on site;
- Health promotion / health prevention through increased walking and cycling (counteracts diabetes, cardiovascular diseases, various types of cancer, depression etc.).

## Social Compatibility

Given. Strengthens social cohesion / community building.

## Questions and Uncertainties

None.

# Policy 3.12: Designing Development Processes to Develop the Specific Potentials of Peri-urban and Rural Areas

## Description

The transformation to a climate-neutral society must include not only urban, but also periurban and rural communities. All of them bring along different characteristics, challenges and potentials for the current and future climate-neutral functioning of society. In order to make the respective potentials known and useable, periurban and rural communities also start community development processes with a special focus on the aspect of climate neutrality and their specific spatial conditions.

**Justification and link to other measures:** Many of the challenges of a climate-neutral transformation are related to questions of the usage of space and the spatial division of labor within Switzerland. Different locations differ fundamentally in terms of building density, social density, use, availability and quality of open space, supply situation, social infrastructure, etc. A climate-neutral Switzerland will not be dissimilar to the present one in terms of the existing buildings simply because we do not have the resources to completely reconstruct the existing buildings. Functional and potential analyses can reveal the potential of the existing building stock, its (partial) conversion, rededication, renaturation, redensification, creative or social transformation, etc. Thus, even single-family home areas have their own potential compared to areas with high building density, such as the possibility of significantly increasing the degree of self-sufficiency - by means of food and the production of renewable energy. Cooperatively organized village shops, communal forms of care (old people, children), shared mobility, etc. are just some of the possible topics.
Community development processes must specifically sound out appropriate conditions in order to activate such specific spatial potentials, with the aim of increasing resilience in periurban and rural areas (e.g., to stabilize village structures) and readjusting the "urban-rural" relationship (model of solidarity-based agriculture, regional leisure activities, de-centralized economics).
Corresponding processes should also take into account questions of climate adaptation. Where actors become aware of their own potential exposure to climate warming, they are also more open to climate protection measures.
**Responsibilities:** Actors in peri-urban and rural communities
**Time period**: Immediately

## Financing

Communities.

## Impact

The measure has a positive effect at various levels, albeit rather indirectly and in the medium term:

- Raising awareness of climate issues in relevant communities;
- Increasing social resilience in peri-urban and rural areas;
- Strengthening of sociality and community spirit on site.

## Social Compatibility

Given. Strengthens social cohesion / community building.

### Questions and Uncertainties

None.

# Policy 3.13: Compensating the Unequal Workplace-Share to Create Regions of Short Distances

### Description

In their spatial planning policies, municipalities and cantons ensure that the number of jobs is balanced in order to counteract the current overhang of commuters into the dense urban centers of the agglomerations.
**Justification and link to other measures*:*** The employment rate describes the ratio of jobs to inhabitants or of employees to the working part of the population in a certain area. If this ratio is balanced (i.e. there are as many jobs as there are job seekers), then this favors a "traffic-saving" coping with everyday life - i.e. "short" distances. Today's commuter surpluses, however, necessarily mean "long" distances. In Switzerland today, all agglomeration centers (especially the big cities) have a significant surplus of jobs (in the order of 10,000 to 100,000 people/day), which means that commuting distances are long. A considerable proportion of these commuting distances are made by car (Federal Statistical Office (FSO) 2017). Polycentric distributions of workstations lead to shorter distances on average (Einig and Pütz 2007).
In this respect, two aspects are important with regard to a "city of short distances":
a) It does not result from a mixture of small-scale uses, even if this is often but incorrectly argued in area or district developments;
b) The far more relevant factor for short distances is the spatial resistance: The higher the resistance, the shorter the distances (cf. various policies in chapter Mobility aimed at reducing speed, stopping the expansion of the national highway, etc.).
For large cities with a commuter surplus, a development in the direction of equalizing the number of jobs means a stop to the establishment of further jobs in these cities. There are also locations outside of large cities that are well served by public transport and that may offer additional jobs.
A shortening of distances can also be achieved by exchanging jobs within the current settlement structure (job exchanges already exist for this purpose). However, this does not compensate for the structural surplus of commuters caused by the unbalanced employment situation.
**Responsibilities*:*** Planning authorities (municipalities, cantons); If necessary, the federal government within the framework of approval procedures for cantonal master plans.
**Time period*:*** Immediately.

### Financing

None, since this is an ongoing planning task.

### Impact

The measure has a positive effect on different levels:

- In tendency decreasing traffic volume for commuting to work
- In relieving the pressure on the housing market

## Social Compatibility

Is given; defuses social tensions by easing the pressure on the housing market.

## Questions and Uncertainties

No open questions.

# Policy 3.14: Establishing Housing-Policies to Enable a "Just Transition"

## Description

The housing and rent policy actors implement appropriate packages of measures to ensure that the transformation to a climate-neutral society is not slowed or even prevented by the effects of low-carbon gentrification. This includes measures such as:

- Regulations to curb unjustified rent increases;
- A tenant protection clause in case of housing shortage;
- The financing of retrofits by owners, not by tenants, in combination with public funding (see e.g. the successful "Vienna Model"),
- The inclusion of the tenants for retrofitting measures;
- Regulations on cost transparency for rents and land/property prices;
- Efforts for a municipalization of the housing stock, and/or promotion of cost rent by building cooperatives (transfer of municipal land in the building law);
- Advantages for those players in the housing market who newly commit themselves to a public welfare orientation (cf. the approach of a "New Common Public Benefit" discussed in Germany);
- Regulations for shares in socially responsible housing prices.

**Justification and link to other measures*:*** A sufficiently good housing supply of the population stands in a multiple tensions field to questions of carbon neutrality and spatial planning.

- Building retrofitting: Energy-related retrofitting measures can be used by the landlord to directly displace the original resident population (through complete renovation and new occupancy by people from a different socio-cultural context).
- Rising mobility costs: Tense situations on the housing market can lead to further displacement effects - not only in high-priced cities such as Geneva, Zurich or Lausanne - as soon as previous commuters want to move back to the conurbation centers because the costs of commuting are rising.
- Increased attractiveness of urban living environments: The re-urbanization that has been observed in the urban housing market in recent decades due to increased (inner-)city attractiveness (urban renaissance) can be further intensified by measures for climate neutrality (e.g. by an increasing quality of life due to the transformation towards car-free cities or districts).

The transformation toward climate neutrality must not fail or be delayed because of its implementation. Since housing is a basic need and a basic right, any threat to this basic right is likely to be met with considerable social resistance. A society that takes climate protection seriously would be unwise if it did not simultaneously take seriously and address the obstacles that could effectively prevent or delay climate protection. A "yellow vest phenomenon" in the area of housing must be avoided at all costs,

so any potential effects on residents - displacement by renovation measures, rising mobility costs or the attractiveness of the living environment - must be addressed as part of intra-societal climate justice. A housing policy strategy tailored to the local context with a package of housing and rental policy measures must be developed.
**Responsibilities*:*** All housing policy actors (municipalities, cantons, federal government, tenant associations, etc.), but also apartment owners and housing developers.
**Time period:** Immediately

## Financing

Per measure/ bundle of measures; From regulatory, to subsidies, tax benefits for public welfare orientation, to the transfer of housing stock into municipal ownership.

## Impact

Prerequisite for a successful transformation of the society.

## Social Compatibility

Housing and rental policy framework conditions are a central prerequisite for a conversion within a useful period (aspects of "climate justice" & just transition).

## Questions and Uncertainties

A legally adapted framework needs broad political support.

# 4 Industry and Service Sector



# Vision

Industry and the service sector are taking their responsibilities in tackling the climate crisis. We can finally consume the products and services we need for a good quality of life, without worrying that our consumption is fueling the climate crisis. Innovation of sustainable technologies and materials and their implementation is being promoted. We have a functioning emissions trading system with a very limited number of certificates and a reduction path with a net 0 target for 2030. Synthetic substances harmful to the climate will be banned or replaced. A market such as Amazon is considered obsolete and will be replaced by a platform where only zero-emission products are traded. Ambitious action plans will be drawn up by all producing-entities as early as 2021. Many of the measures will already be implemented in the coming years. It is thus becoming increasingly clear that change is possible and what our world will look like after 2030.

# Current Situation

## Emissions

Overall, the service and industry sectors are currently responsible for just under 24% of Switzerland's greenhouse gas emissions (FOEN 2020b).
The service sector contributes mainly through heating emissions, which can be estimated at approximately 4 million t CO2eq (FOEN 2020d).

The industry sector causes emissions firstly due to the consumption of fossil fuels and secondly to industrial processes that emit CO2 and other greenhouse gases (B. Meier et al. 2018):

- The consumption of fossil fuels caused an average of about 5.0 million t CO2 in the years 2014-2016. The most energy-intensive sectors are cement production, chemistry and food processing, which together account for over 90% of these emissions.
- In the same time span, industrial processes generated an average of 4.1 million t CO2eq. Around 85% of these greenhouse gas emissions come from cement production (50%) and the consumption of hydrofluorocarbons for cooling and air conditioning units (35%).

The thermal processes of the Swiss industry and service sector can be divided into 3 temperature levels: Space heating (up to approx. 70 degrees flow temperature), low temperature process heat (up to approximately 120 degrees) and high temperature process heat (up to over 1’400 degrees). According to the study "Renewable energies in industry" by the Swiss Federal Office of Energy, there are technical solutions for substitution for both space heating and low-temperature process heat. Only in the case of high-temperature process heat is it currently not possible to replace all processes with renewable heating systems, as CO2 is sometimes indispensable for the process.

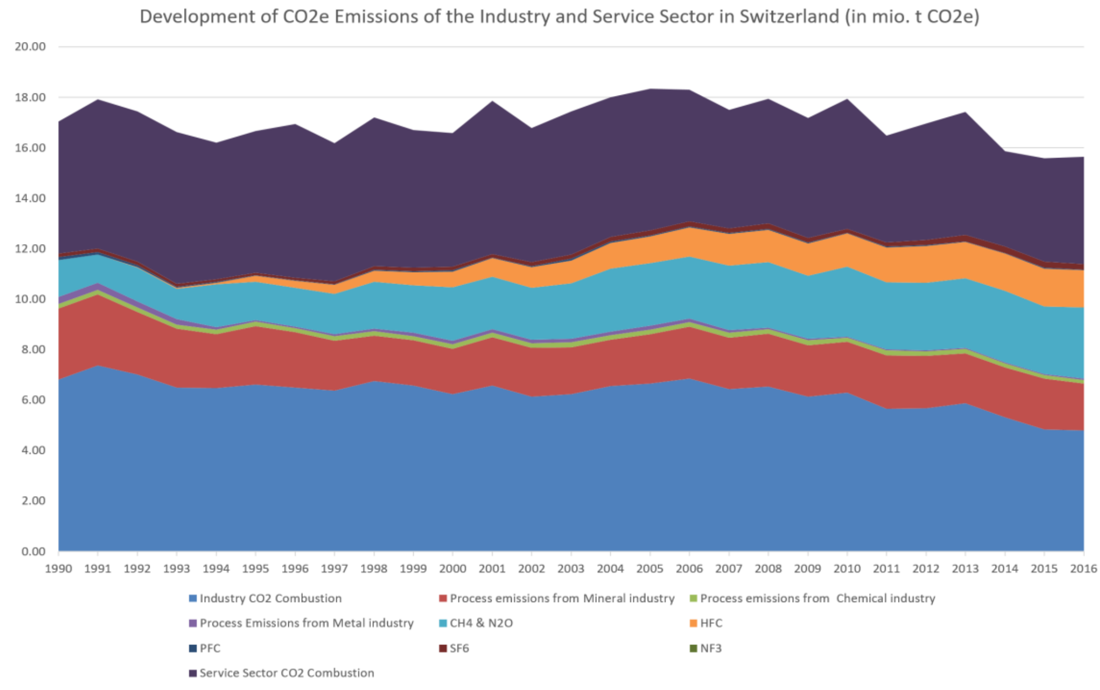



*Figure 4-1: Development of emissions in the main Swiss industrial sectors since 1990 (data from BAFU* (2020d)*)*

# Existing policies

The most important existing climate policy instruments for the industrial sector:

## CO2 Levy

Since 2008, a CO2 steering levy has been imposed on fossil fuels such as heating oil or natural gas. The CO2 law already stipulates that the levy rate is to increase at certain intervals if reduction targets are not met. At present, the levy is CHF 96 per ton of CO2eq. This corresponds to approximately 25 centimes per liter of heating oil. According to the Federal Council, the maximum levy rate should be able to rise to a maximum of CHF 210 by 2030. Two thirds of the revenue from the levy will be redistributed to the population and the economy. The remainder will go to the buildings program and promote the renovation of buildings, and CHF 25 million of the revenue will be made available annually to the Technology Fund. Through this fund, the federal government guarantees loans to companies that develop and market innovative products and processes that reduce greenhouse gas emissions or promote renewable energies (The Federal Council 2017).

Only about 50% of the emissions of the industry and services sector are subject to the CO2 levy, because companies can have the tax refunded, either by participating in the emissions trading system or by target agreements.

## Emissions trading system

Currently, the largest emitters of greenhouse gases in industry, such as producers of cement, iron & steel, chemicals, pulp & paper and refineries are covered by the Swiss Emission Trading System (CH-ETS). Today, these are 54 installations that emit around 5.5 million tons of CO2eq annually. The Swiss ETS has been linked to the European ETS (EU ETS) since January 2020, which means that Swiss companies can buy European emission allowances and have them credited to their account, and European ETS companies can buy Swiss emission allowances. Industrial companies currently benefit from a free allocation of emission allowances and companies participating in the ETS are exempted from the CO2 tax on fuels. Due to the free allocation, the closure of TAMOIL and the use of emission reduction certificates of the Kyoto Protocol, too many emission rights are in circulation. Because the market price for CO2 emission rights was therefore low, the Swiss ETS has so far created *hardly any incentives* for emission reductions (Eidgenössische Finanzkontrolle 2019).

## Target agreements with CO2 levy exemption

Companies can be exempted from the CO2 levy if, in return, they commit themselves to reducing their own greenhouse gas emissions. A study suggests that, for the most part, target agreements do not lead to more emission reductions, but rather subsidize business-as-usual (André Müller and Steinmann 2016).
Approximately 14% of the CO2 emissions of the industry and service sector are covered by such target agreements. It is expected that as the CO2 levy rate increases, more companies will enter into a target agreement.

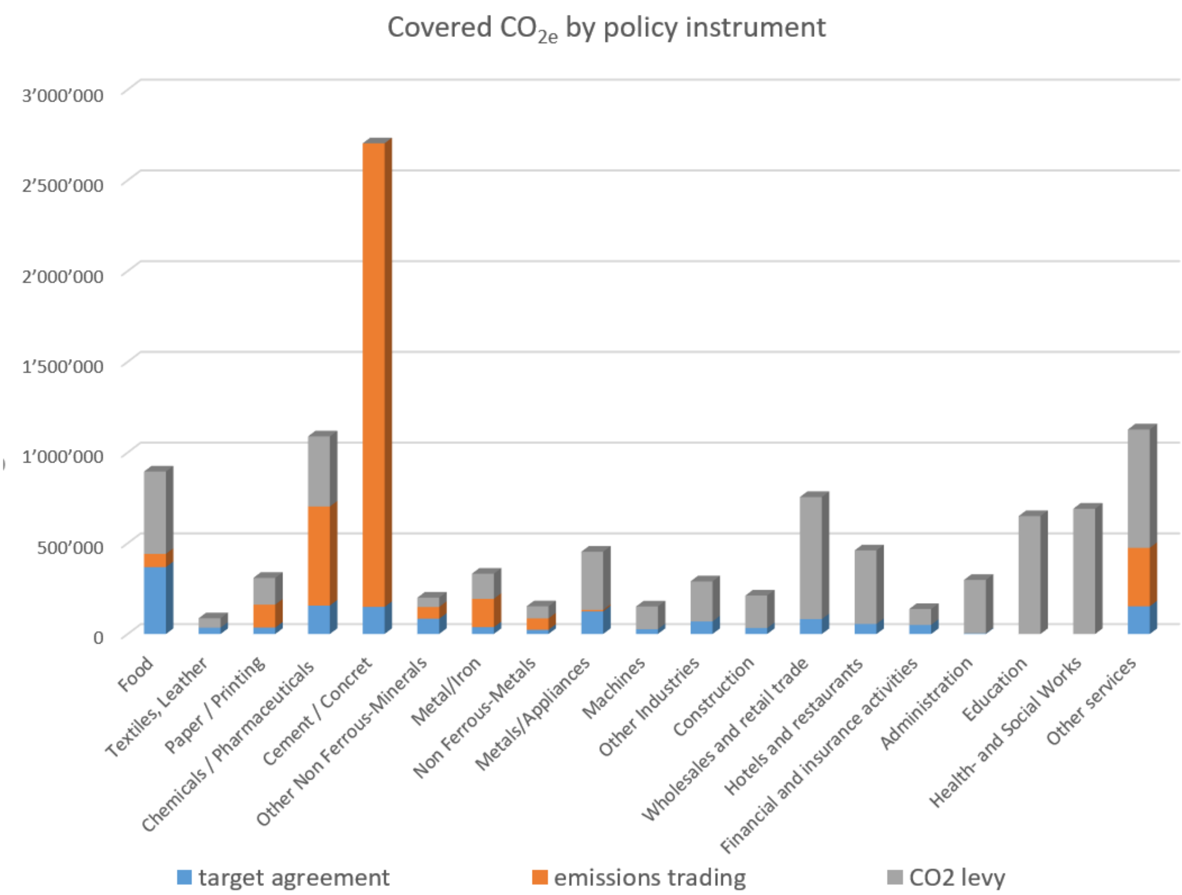



*Figure 4-2: Visualization of the different policy instruments and the emissions they cover*

# Policy Measures

GHG reduction in the industry and service sector relies heavily on certain policy measures covered in other chapters of the CAP, namely the following:

**Moratorium on new infrastructure** *(Cross-Sectoral Policies, Policy 1.1)*
To achieve full decarbonization of the industry sector without at the same time increasing emissions elsewhere through imports, demand for emissions-intensive products and services needs to be significantly lowered. We therefore propose a moratorium on new construction, including buildings, streets and other infrastructure that use GHG-intensive materials (e.g., cement, steel).

**Prohibition and replacement obligation on fossil & electric heating systems** (*Buildings, Policy 3.1*)
Thermal processes as well as space heating in the industry and service sector must be decarbonized rapidly and with no exception. No new fossil fueled heating systems will be installed, and existing ones have to be replaced by renewable energies. This of course also includes the burning of coal.

> It is true that coal has played practically no role in Switzerland for decades and is stagnating at 0.5% of Switzerland's gross energy consumption (SES 2020). Nevertheless, 156,000 tons of coal are still burned in Switzerland every year (BFE 2020), more than four-fifths of it by the cement industry (BFE 2015), which corresponds to annual CO2 emissions of at least 468,000 tons CO2eq.

**Greenhouse Gas Pricing** (*Cross-Sectoral Policies, Policy 1.2*)
While the remaining production shall be transformed to become net-zero-compatible by 2030 we want the market to also adjust the demand for products by internalizing external costs. Both, domestic emissions and emissions embodied in imported goods shall carry these external costs.

**Border carbon adjustment** (*Cross-Sectoral Policies, Policy 1.3*)
To prevent leakage and the export of emissions and to protect Swiss industries, a border tax should be implemented to create a level playing field.

Additionally, we propose the following 7 policy measures specifically for the industry and service sectors:

## Policy 4.1: Ban on Technical Gases with High Radiative Forcing

A substantial amount of emissions in CO2-equivalents in the industry sector are caused by emissions of “F-gases” (more than 10%). Therefore, this policy is a ban on new products and equipment using synthetic substances with a Global Warming Potential (GWP) > 50 (100 year time horizon) for all applications. The production, import and use is banned immediately.

Most of these gases are substitutes of CFCs (Chlorofluorocarbons) that have been banned in the follow-up to the Montreal-protocol that lists them as ozone-depleting substances referring to the ozone layer in the stratosphere. Therefore, the protocol has been amended by the Kigali agreement that aims to reduce the manufacture and use of Hydrofluorocarbons (HFCs) by roughly 80-85% from their respective baselines, till 2045. Developed countries are supposed to reduce their usage to 15% by 2036

(baseline 2019). This phase down is expected to arrest the global average temperature rise up to 0.5 C by 2100.
These "F-gases" are mostly used in small amounts but have a high global warming potential per kg (several 100 to several 1000 times more effective per kg than $CO_2$) with a long lifetime. These substances are used because they have a high stability and favorable properties in terms of toxicity and flammability. This makes them convenient candidates for cooling aggregates (both in cars and professional cooling and air conditioning), heat pumps, cleaning in the high-tech industry (electronics etc.) but also for sprays in the pharmaceutical industry. Alternatives such as $NH_3$, $CO_2$ and a variety of short-lived hydrocarbons are available and cheap. Therefore, there has been no interest from the chemical industry to push them. Users of these alternatives are confronted with higher safety standards for both workers and customers that opens questions of liability and additional investments for housing some of the installations (e.g. ammonia-based coolers).

In Switzerland these substances have been regulated - if at all - in the Chemical Risk Reduction Ordinance (ChemRRV) which has failed to curb the usage of these substances. The regulation today allows for too many exceptions, especially for smaller cooling units.

Usually, bans need exceptions for applications that are not able to get clearance for new substances on a short term, such as medical applications. For such applications a levy of 500 CHF/t $CO_2$eq is charged. This is higher than the usual levy on other greenhouse gases to take into account the long lifetime of the substances involved and the lack of technologies for negative emissions for F-gases. Consequently, there should also be an incentive scheme to avoid the emission of F-gases that are already installed. This could be a financial incentive that old F-gases are bought by a designated entity at a price of, e.g., 200 CHF/t $CO_2$eq and that the gases would be burned for free.

Many cars on the street still use R134a as a cooling agent for their air conditioners. This substance is officially phased out in new cars since 2011 already but is still used to refill systems that leak. The GWP of R134a is 1430 and a typical car may use 700g per fillage which equals 1t $CO_2$eq. Therefore, a new refill would cost 500 CHF in tax if the exception would accept refills of old systems. Therefore, this would be a good incentive to either not refill the air conditioner and stop using it, to properly repair the unit to avoid any further leakage or to replace it with a system using no F-gases anymore.

## Financing

The ban itself is a low cost measure. However, implementation and control requires much more emphasis and staff than what the BAFU and cantons invest today. Also, to deal with exceptions in a strict way needs more experts. The levy for remaining usage may initially pay for the reward scheme for collected and destroyed substances. However, as new sales for exceptions shall vanish the remaining costs will be paid from the levy on GHG and the border carbon adjustment (see chapter Cross Sectoral Policies).

## Impact

Figure 4-3 from the National Inventory Report of the Swiss Submission to the UNFCCC shows how dominant refrigerants became and that the replacement of refrigerants in leaking existing cooling devices is the main source. Therefore, the impact of the proposed policy will depend largely on the effect on replacing existing aggregates. Eventually, if applied in a strict way from 2021 through 2030 the remaining emissions should decline from 1.5 Mio.t $CO_2$eq in 2017 to <0.3 Mio.t$CO_2$eq in 2030. Remaining emissions would include leakage from still existing aggregates filled with HFC, few exceptions where no substitutes exist and the emissions from old PUR foams that have been produced with CFCs or HFCs.

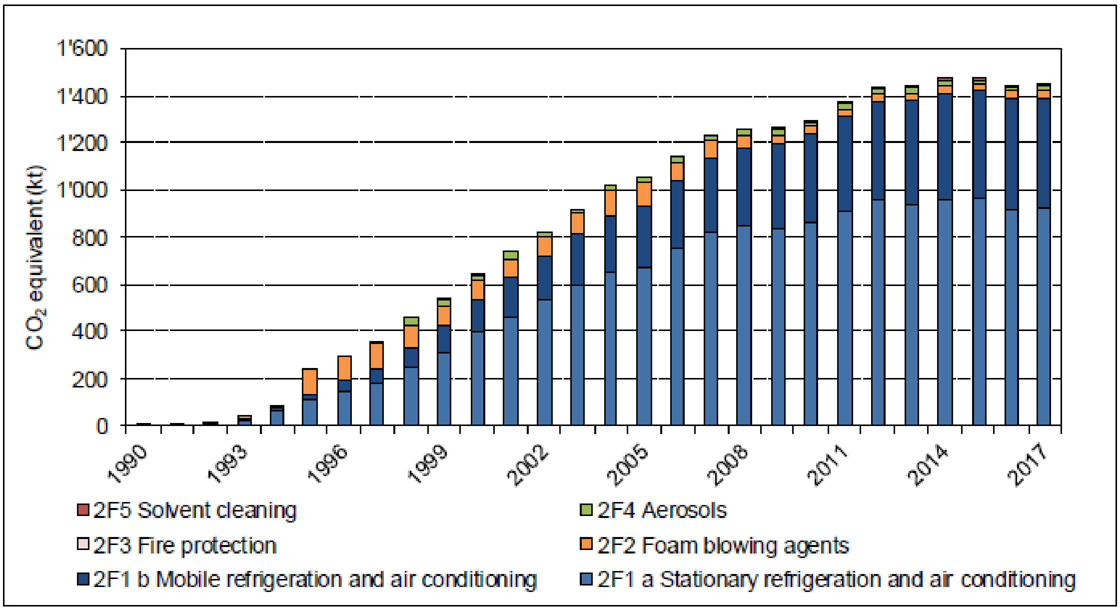



*Figure 4-3 Development of emissions under source category 2F Product uses as substitutes for ozone depleting substances. HFC and small amounts of PFC are used as substitutes for ozone depleting substances. Most relevant today are emissions from the built up refrigerant stock in refrigeration and air conditioning equipment.* (FOEN 2020d)*Social compatibility*

Drugs for special illnesses may be affected by this ban and should be evaluated carefully.
Further, the application of more toxic and more inflammable substances may cause safety concerns if not addressed properly. Therefore, new safety rules should apply in a manner to avoid dangerous workspace situations.

## Questions and Uncertainties

A ban always needs control, including at the border to prevent black imports. This requires skilled personnel to be trained in a short time.

# Policy 4.2: From Emission Trading Scheme to CCS Financing Instrument

## Description

As described in the section on existing policies above, today's Swiss Emission Trading Scheme is weak and not ready for net zero. In practice, there are certain factors that render today's CH-ETS a rather weak instrument:

1. **Cap-setting**: In order to drive emissions reduction, the total cap needs to be set below business-as-usual (BAU) emissions. Given that the Swiss ETS also covers shrinking sectors such as refineries and cement, such structural changes need to ideally be taken into account in the cap-setting process. Adopting the EU cap-setting process, which covers a different set of sectors, did not ensure that allocation in Switzerland was below BAU. In consequence more Swiss emissions allowances were allocated then emissions occurred, which lead to over-allocation and to low prices that provide little to no incentives to invest in emission reduction measures (Eidgenössische Finanzkontrolle 2019). Over-allocation is a global phenomenon that plagued all ETS in particular in their earlier phase, be it in Switzerland, the EU, California, Canada, New

Zealand, South Korea, China, etc. Since the surplus of allowances can be banked in most schemes into future years, prices do not go down to zero, but reducing over-allocation takes time.

2. **Political uncertainty:** Investment in greenhouse gas mitigation will be only undertaken if companies are sure that the benefits will be higher than the costs. Long-term political commitment and long-term price signals as well as liquidity are therefore crucial for a functional market. In the past the scheme did suffer from low liquidity, a missing long-term price signal which was due to the uncertainty of the linking as well as the political debate in Switzerland on the future of the CH ETS.

In order for the ETS to play a role in decarbonization by 2030 the following amendments need to be made:

1. **Cap-setting:** The cap over the years will need to follow the path which is needed for a rapid decarbonization taking the banked allowances into account and leading to net zero emissions from the ETS in 2030.
2. **Accompanying measures:** High greenhouse gas mitigation costs may lead to a reduced competitiveness of some industry sectors and bring the risk of moving plants abroad ("carbon leakage"). Therefore, instruments such as border tax adjustments (see Policy 1.3) need to be put in place.
3. **Restricted linking:** Depending on the developments with regards to reduction of the emission cap of the EU-ETS, the Swiss ETS may need to be fully de-linked or a restricted linking with the EU-ETS needs to be introduced, which allows for Switzerland to restrict the inflow of lower-priced allowances from the EU-ETS if prices fall below a certain threshold.

## Residual Demand for Materials like Steel and Concrete

The first measure is to reduce demand for goods that lead to high CO2 emissions in their production. For many materials, there are substitutes e.g. using wood instead of concrete for most buildings, etc. (see chapter Buildings and Spatial Development).
However, we assume that even with the highest possible level of avoidance, recycling and substitution, also in a decarbonized world there remains a certain demand for goods and materials with inherently high carbon emissions, e.g. for cement and steel to build wind power plants, crystalline silicon for photovoltaic panels, copper to transmit power etc.
New technologies are currently being developed to allow for net zero production of these materials, such as the use of hydrogen or synfuels from renewable power for steel production, or carbon capture e.g. for the geogenic emissions from cement plants. In carbon capture, carbon flue gas streams with high concentrations of CO2 are captured technically at the plant, transported and pressed into underground geological formations, such as saline aquifers.

These emerging technologies pose significant challenges:

1. These technologies are still under development and not yet mature for large scale deployment.
2. These technologies are currently not available at larger scale and are rather expensive (starting at hundred to several hundred CHF per ton mitigated or sequestrated).
3. Some of these technologies bring additional risks, such as the risk of resurfacing of sequestered CO2 from geological formations and related suffocation.

The large-scale research, development and deployment of these technologies requires considerable financial resources. The existing ETS may be a starting point to allow for these technologies to be financed (see also chapter Negative Emissions Policy 7.1).

### Transforming the Emission Trading Scheme into an Instrument to Finance CCS

If the overall cap of the ETS reaches net zero emissions in 2030, the Swiss ETS would not be obsolete, but would evolve into a framework that creates a market for negative emissions. Minimum thresholds of emissions would be removed as a criterion for installations to participate in the ETS. In 2030, the ETS allows companies with residual emission that they cannot further reduce to purchase allowances from companies that have the capacity to implement negative emissions technologies. The costs of these negative emissions may be assumed to be very high, and the ETS provides a regulated market environment that fosters large scale investments in novel negative emissions technologies. In this way, the combination of BECCS technologies, border tax adjustments and an ETS could transform into an efficient market-based instrument to finance expensive technologies to neutralize the “unavoidable” residual emissions left for certain key materials and goods.

### Financing

The consumers of industrial products would pay higher cost for decarbonization for specific emissions intensive goods. Beyond that, the measure will generate substantial revenue to finance other climate mitigation measures.

### Impact

Decarbonization of high emitting Industries by 2030. Impact is expanded internationally through the formation of clubs of countries that commit to steep decarbonization pathways and form common BTA areas.

### Social Compatibility

Higher costs of goods for consumers may be expected. This may require compensation for low income households (e.g. from carbon levy revenues). Further, there is the need for measures to support just transition, e.g. for workers in industries with high emissions (see Policy 12.1).

### Questions and Uncertainties

CCS, BECCS and CDR in general will need a significant push to be deployed on a large scale for commercial applications. Not clear if costs can be significantly reduced in the next decades. Transport and storage of CO2 poses significant risks for the local population.

# Policy 4.3: Regulations for the Swiss Commodity Trade

From 2025 onwards, companies based in Switzerland will be prohibited from extracting fossil fuels (namely oil, natural gas and coal), promoting them or providing financial, administrative or technical support for their production.
The Swiss commodity marketplace will have to withdraw completely from climate-damaging raw materials. Individual Swiss companies are heavily involved in the mining of coal, but if Switzerland wants to set an example in climate policy, such activities must no longer be approved.

There is, of course, the danger that raw materials companies will relocate their headquarters to a country without the appropriate regulations. However, this should not be an excuse to tolerate their harmful practices in our own country. Beyond that, the aim should be to soon have similar regulations in place in all parts of the world.

## Impact

The companies concerned will have to limit their activities to carbon neutral raw materials. Switzerland is making it clear to the international community that fossil fuels are no longer socially acceptable and must stay in the ground.

## Financing

Due to the possible emigration of affected companies abroad, tax losses can be expected. These losses can be compensated by a slight adjustment of the cantonal taxes, as these companies are typically located in cantons with low tax rates anyway.
The additional administrative costs for the introduction and periodic review of compliance with the regulation should be included in the budget of the relevant federal offices and tax audit offices. Revenue from penalties for non-compliance will be used to finance other climate protection measures.

## Social Compatibility

Apart from the tax losses discussed above, no negative social consequences are to be expected.

# Policy 4.4: Net-Zero Action Plans for all Producing Entities

## Description

It is assumed that the sector policies for the building sector will decarbonize heating in industry and services already. Electricity consumption, district heating and use of transportation (people and goods) are already covered by other sector policies. All companies that produce additional direct emissions that are not already covered by the other sector policies have to develop net-zero action plans to fully decarbonize by 2030 in line with the reduction path to stay within the carbon budget (see introduction - GHG Budget). These remaining producing facilities – probably several thousand only – must submit in 2021 a net-zero emissions plan. The plans will then be third party verified.

The plans must list all measures necessary to transform the company no later than by 2030 into a net-zero-emission company. The needed transformation measures are listed in three categories:

a) measures that are economically viable with an 8 year pay back assuming that no remaining depreciation costs of existing equipment occur and that external GHG costs are fully internalized following measures 2&3. (net-zero ready and viable)
b) measures that are technically feasible but uneconomic under the conditions mentioned in a), e.g., producing biogas from manure to fuel high-temperature processes. (net-zero ready but uneconomic)
c) measures that lack proven technical feasibility at the scale needed, e.g., synthetic kerosene produced from sun converters (unproven technology)

Concerning type (a) measures, even if new net-zero compatible production facilities would pay for themselves a company could argue that the existing facility is not yet paid off in the books. However, this is part of the investment risks associated by making business. The science is established since 1990 and the global climate policy established in 2015 with the Paris agreement.

Net-zero company plans need to be updated every three years (2024, 2027) and need third party verification. Companies without such plans lose their license to operate.

### Financing

Already now the agencies EnAW and ACT are supported by the government to help companies to draw emission reduction plans. This mandate would be adapted, and the support increased to cover all companies that have to provide a plan.

### Impact

Although the plan itself may already have some impact it is the combined impact with measure 5-7 of this chapter that is relevant. To have such a plan is not only vital for business and investment planning but also mentally. Dividing the decarbonization task in groups of measures and knowing that financial or/and technical support will come may make the challenge more acceptable.

### Social Compatibility

No concerns so far

### Questions and Uncertainties

It is not clear whether enough decarbonization experts and tools are available by 2021. It may be necessary to limit the first period from 2021-2023 to companies with emissions above 100t CO2eq per year or that are already members of EnAW or ACT.
The split of measure into the categories a) to c) is at this time not known, but first guesses are included.

# Policy 4.5: Implementation of all Net-Zero Ready and Viable Measures Incentivized with Early Adopter Bonus

### Description

Companies are encouraged to implement all net-zero ready and viable measures (category a) measures as soon as possible. By 2030 all net-zero ready and viable measures from the 2027 plan need to be implemented. Otherwise their operation license is revoked.

To speed up the implementation companies get an early mover bonus. The difference between the 10-fold emissions of 2020 and the effective emissions from 2021 through 2030 get rewarded by a bonus of CHF 50 per ton of CO2eq. The earlier a company implements all measures the more bonus it gets.
This bonus should also pay for investments that have not yet been depreciated. The money could come from the GHG levy or the BTA net income. Implementation starts 2021 at the pace chosen by the company.

### Financing

The investments would be made by the companies and refinanced by the financial industry, as it is the usual process today. Since the investments pay for themselves, the risks for the financial industry are in principle low. However, companies that struggle for other reasons and will not survive for another 8 years in the view of the financial industry will have troubles to get any new money.

Assuming that half of the decarbonization measures fall under this policy and that they are performed thanks to the early mover incentive already by 2025 then a total of 30 Mt CO2eq at 50 CHF/t need to be rewarded equaling 1.5 billion CHF. This amount can be taken from the CO2-levy or BTA revenue.

## Impact

About 10 million tons of CO2eq per year concern production related emissions. If half of the decarbonization measures concern net-zero ready and viable measures, this means reductions of 5 million tons per year by 2030.

## Social Compatibility

Some companies may not be able to lend the needed investment means because their business model is considered too weak for a safe investment. In some regions (structurally poor, alpine etc.) a closure of such companies would have effects on employment. Most cantons have their own regional banks and can make sure that no companies go out of business that could survive without this policy measure. However, in order to get new companies starting their business the cantonal economic and location promotion institutions should focus on net-zero suppliers. Furthermore. the educational system needs to be adjusted on all levels to provide enough trained employees and experts.

## Questions and Uncertainties

It is not clear whether there are enough trained planners, engineers and installers. Also, the producers of certain equipment may have problems to scale up their production, especially if the demand increases globally.

# Policy 4.6: Support to Implement Net-Zero Ready but Uneconomic Measures

## Description

A specialized unit/agency/foundation investigates all net-zero plans that lists net-zero ready but uneconomic measures (category b). These plans are grouped according to sectors and type of measures and the following groupings are made:

I. Measures that concern sectors/products of very limited future roles. (e.g., upgrade for an oil refinery if oil demand in Switzerland would be close to zero in 2030)
II. Measures that would become affordable if the learning curve continues or minimal critical demand is created.
III. Measures that are likely to stay expensive

The regulation would make sure that companies with (I)-measures have to implement them anyway or close operations of the respective production line by 2030.

For (II) measures the unit/agency/foundation would provide both financial support and relevant purchasing vehicles in order to bring down the cost. “Contracts for difference” that have been used when power from renewables were uneconomic could also be used to accelerate industrial learning curves and ensure fair risk- and cost-sharing between producers and a supporting agency.

For (III) measures the unit/agency/foundation would engage with the concerned companies to analyze the long-term prospects of their products/services and likely global market scenarios including both technological alternatives and product alternatives. Financial and technical support for both process and product innovation and interim support for installing uneconomic net-zero compatible technology would be part of the support package.

## Financing

The money could come from the GHG levy or the BTA net income. This support program is supposed to have a sunset clause, e.g., 2035. It is assumed that the needed support will be reduced thanks to spill-overs from other fast decarbonizing economies.

## Impact

Probably 40% of the decarbonization measure could fall under this goal. This means that around 4 million tons CO2 would be reduced by 2030. The support for type (II) and (III) measures would create positive spill-over on a global level.

## Social Compatibility

See social compatibility of Policy 4.5.

## Questions and Uncertainties

It remains unclear what the split would be in reality and how support in (II) and (III) measures would bring down the costs.
The abortion of type (I) measures may lead to some temporary increase of imports.

# Policy 4.7: Net-Zero Technology Program

## Description

In order to achieve net-zero plans, the creation of new technologies is required such as new energy storage technologies, more efficient technologies for generating energy from renewable sources, a more efficient creation of lab-grown meat for human consumption, the development of more energy-efficient machines or materials which, when applied, lead to a reduction in the consumption of resources and energy.
Companies that depend on the development of type (c) measures to transform to net-zero will be screened for their long-term prospects and then supported to become early implementers of these new technologies.
In order to achieve a quick diffusion, technologies that have been financed with state funds should be shared proactively and their patent protection should be limited.

Of course, it will not be possible for Switzerland to develop the necessary technologies on its own. Other regions, especially the EU, work both on framework conditions (strengthened climate laws to achieve stricter targets by 2030) and allocating relevant resources to the transition (Green Deal Fund). Therefore, cooperation makes sense and may open up large markets. Switzerland is predestined to play a leading role in the development of such technologies given its good education system and existing innovation experience.

A specialized unit/agency/foundation investigates all net-zero plans that list unproven technologies (category (c) measures from policy 4). This should involve existing bodies such as innosuisse, core, and further experts from private industry and universities. These plans are grouped according to the technological barriers that need to be overcome. Based on already running technology initiatives in Switzerland and especially abroad (net-zero steel, CCS, batteries, etc.) the relevance for the Swiss industrial sector and the competence already in place, the technological challenges are selected to become national priority programs or programs to be pushed bilaterally.

These programs would make sure that optimal conditions are provided through all stages including the stages of industrialization. Existing large scale research programs of the format Horizon 2020 are likely to be both too slow and too little oriented towards implementation. Funds from the technology pillar in the EU-ETS revenue scheme may be more appropriate.

Due to the short time until 2030 on the one hand and the often slow and unpredictable avenue of innovation this goal is very pressing, and a large failure rate should be accepted to get enough programs that run in parallel and deliver eventually.

## Examples

**Cement production** is a very relevant source of emissions in Switzerland. Demand will be significantly reduced by 2030 due to a moratorium on new infrastructure (see chapter Cross Sectoral Policies). For renovation however, there is a short term need to equip at least one cement plant with a CCS or/and CCU unit. If feasibility is demonstrated at industrial scale further cement plants could be made climate proof. At the same time, however, demand should be reduced since cement will become much more expensive and will be replaced by other materials or used more efficiently, as has already been demonstrated in pilot projects (NEST at EMPA).
**The chemical industry** is a very relevant user of fossil fuels for its products. Finding substitutes for all purposes or synthesizing them from H2 and CO2 will be a challenge within this short time. To support this change, the chemical industry will also receive specific support from this technology program through (global) competitions using the mission challenge approach or other means to find solutions on a large scale.

## Financing

In Switzerland, CHF 665.5 million was spent on promoting innovation in the environmental sector in 2015. However, around 80% of this amount was spent on basic or applied research. Less than CHF 60 million was spent on industrial piloting and market implementation (FOEN 2020a). Hence, the government’s expenditures to date - especially for the market implementation of green technologies - has been very modest. By contrast, the federal agriculture budget for 2017 was around CHF 3.7 billion (Wehrli and Can 2019). Given the current ecological challenges, it should thus be possible to substantially increase the financial resources for the generation of green technologies in the future.

The money will come from existing funds for R&D, lighthouse projects and export support agencies. In Switzerland the limitation will be the existing scientists and engineers that can work on such innovations. This will keep additional costs below 1 billion per year.

## Impact

The effect of the development of such technologies will not be limited to Swiss companies and households, because the technologies will also be used abroad. The ecological (and probably also economic) effect of the development of such technologies is accordingly large.

If negative emissions and aviation are not considered we estimate that 10% of the needed reductions will belong to this category, which means 1 million t by 2030. However, the potential spill-over globally could be huge and open interesting prospects for the Swiss industry.

As mentioned above, other and larger economies will enter this race as well. So spill-over effects into Switzerland may be significant as well and needed to drive down the cost of new technologies. To be able to benefit from these spillovers, however, it is important for Switzerland to build up a certain amount of knowledge. Only in this way will it be possible to benefit from existing knowledge abroad. A purely free-riding strategy will hardly work in this area, as new technologies in the green sector generally require very specific knowledge that can hardly be transferred from traditional technologies (Stucki and Woerter 2017).

## Social Compatibility

No expected negative effects.

## Questions and Uncertainties

A popular saying argues that innovations are oversold on a short term and underestimated on a long term. Therefore, it remains unclear how fast unproven technology today can be a solution in 2030. The moratorium for new infrastructure may reduce the hazard but post 2030 solutions are badly needed.

# 5 Energy Supply



# Vision

## Introduction and Aim

Three quarters of Switzerland's greenhouse gas emissions are energy-related, mainly originating from the burning of fossil fuel-sources (SFOE 2020). Therefore, the transition to a fossil-free energy supply, the so-called decarbonization of the energy system, is of enormous importance. It is expected that this will lead to an increase in electricity demand, like through the transition to electric mobility and through the deployment of heat pumps for the heat supply of buildings. Power represents the main pillar of a fast and profound decarbonization of the Swiss energy system as electrification directly leads to decarbonization in many sectors. Other sources of renewable energy, i.e. renewable heat and renewable fuels, are covered in other chapters of the CAP.

The following sections will, firstly, estimate future electricity demand until 2030 and 2050 and describe the current political situation. Afterwards, different political instruments will be highlighted, which should precipitate the necessary development of renewable energies together with grid and storage technology. Finally, several technologies and their development potential will be covered in greater detail.

# Future Electricity Demand

The succeeding figures refer to the target year of 2030 or 2050 for the achievement of a complete decarbonization in the sectors of mobility (without international air traffic) and building energy. The transition from today until 2030 or 2050 in the energy source's composition has been linearly presumed, respectively. The large part of the increased electricity demand in 2050 as opposed to 2030 comes from the commitment to electricity from nuclear energy. It has been assumed that the remaining nuclear power plants between 2030 and 2040 will be gradually decommissioned.

It will be differentiated by two different scenarios:

## a) The 'Growth in Accordance with the State' Scenario

The official prognoses of the State will be applied for population growth, movement of goods, people per kilometer, heat demand and so forth. The most important assumptions are:

- Increases in the mileage in mobility according to Wüthrich et al. (2017), with no sufficiency measures.
- The renovation rate in the building sector continues at 1% annually.
- The exhaustion of the whole development potential in accordance with the OFE for hydro energy (which results in an additional 2.2 TWh annually) and biomass (which results in an additional 3.2 TWh annually) for electricity production until 2030, instead of until 2050.
- The exhaustion of half of the efficiency potential in the current range until 2030 (instead of 100% until 2050). This results in power savings of 9 TWh annually until 2030.
- The exhaustion of a third of the wind power potential in accordance with the OFE until 2030 and of the full potential until 2050. This corresponds to a production of 1.5 TWh annually with approximately 300 new wind turbines until 2030 and 4.3 TWh annually with approximately 800 wind turbines, respectively.

For details of the assumptions see (Sperr and Rohrer 2019).

## b) The 'Sufficiency and Efficiency' Scenario

The implementation of sensible measures in other sectors (see chapters on mobility and buildings) can clearly reduce electricity consumption. In comparison to the assumptions made by the State (the "Growth in accordance with the State" scenario), the following modified assumptions were made for the development of energy demand:

- The mileage in mobility declines by 20% until 2030 compared to today in all aspects and, therefore, stay constant until 2050.
- The renovation rate in the building sector amounts to a constant 3% annually from 2020

All other assumptions like, for example, population development or living space have been adopted by the State as it stands and are, consequently, identical with the scenario; 'Growth in accordance with the State'.

# An Estimation of the Additional Electricity Demand

Subsequently, the decarbonization of mobility and the heat production for buildings is being contemplated. The chosen technology-mix is leading to an increase in electricity demand. Table 5-1 shows how strong the production from photovoltaics facilities must be developed with both scenarios, in order to receive a balanced annual budget from electricity. The numbers originate from the, still, unpublished decarbonization calculator of the Zurich University of Applied Sciences, Wädenswil, as well as from (J. Rohrer and Sperr 2018; Sperr and Rohrer 2019; 2018).

*Table 5-1: additional electricity demand from the decarbonization of mobility (without international flight traffic) and of the heat production for buildings like; potentialities for energy savings and the development of the electricity supply without photovoltaics. The difference between demand and potential must be covered either through photovoltaics or through imports. An annual operating figure of 3 has been assumed with the heat pumps (HP).*

| Scenario | Growth in accordance with the State | | Sufficiency and Efficiency | |
|---|---|---|---|---|
| Year: | 2030 [TWh] | 2050 [TWh] | 2030 [TWh] | 2050 [TWh] |
| Cars 100% electric | 14.2 | 15.4 | 10.9 | 10.9 |
| Delivery vehicles 100% electric. | 2.74 | 3.46 | 2 | 2 |
| Truck/LKW 80% elektr., 20% hydrogen | 4.74 | 5.7 | 3.5 | 3.5 |
| Buildings 80% HP, 20% wood / solar | 18.6 | 15.8 | 15.9 | 11.4 |
| Replacement of nuclear power | | 22 | | 22 |
| Total demand | 40.28 | 62.36 | 32.3 | 49.8 |
| | | | | |
| Power efficiency, half of potential | 9 | 9 | 9 | 9 |
| Hydropower | 2.2 | 2.2 | 2.2 | 2.2 |
| Biomass | 3.2 | 3.2 | 3.2 | 3.2 |
| Wind energy | 1.5 | 4.3 | 1.5 | 4.3 |
| | | | | |
| Remaining for PV | 24.38 | 43.66 | 16.4 | 31.1 |

The above known figures concern the annual operating figures. Decarbonization within industry, agriculture and air traffic have not been considered. The transformation and storage-losses would still have to be counted amongst that, concerning a storage of electricity (day/night or seasonal). This concerns battery storage of 10-15 %, pumped-storage power plant of 25-30% and storage in the form of gas at 60-70%.

# Current Situation

## Existing Policies

Switzerland was a pioneer for the development of renewable energy and hydropower was developed early on. Today, Switzerland belongs to the 'late bloomers', with reference to the development of new renewable energies internationally. The strengthened use of renewable energies was constituted in the Energy Act of 1998, but the policy of encouragement was always very restrained. Therefore, Switzerland adopted the success model of the German Renewable Energies Act not until around 10 years later and then implemented it in such a way that the development was strongly limited through financial limitations (the means originate from a limited network supplement). Consequently, mainly waiting lists were established. The phasing out of nuclear power was put into law with the energy strategy of 2050, which was drawn up by the State after the Fukushima nuclear disaster in 2011. However, the replacement with renewable energies has, again, only been addressed hesitantly. The highly limited effectiveness of feed-in tariffs has been limited in time and replaced by one-off investment contributions (again with financial limitation). In the longer term, the 2050 energy strategy relies on imports: the statutory objectives, which are hardly being achieved with the existing measures, can replace no more than half of the omitted electricity generated by nuclear power. Additional demand through electrification over the course of decarbonization is not even considered.

A further development of the Energy Strategy is currently in planning. The Federal Council has started a consultation legislative process for the Energy Law in April 2020, in order to slightly adjust the financial measures. However, the financial constraints are remaining in force, currently at 2.3 centimes grid surcharge per kilowatt hour, which not only finances renewable energies, but also efficiency and water protection measures. One-off investment contributions will continue to be the focus for all technologies. In most EU countries, however, there is a payment for the fed-in kilowatt hour (floating market premiums) for a specific period of time, for example 20 years. This offers a clearly higher investment security than with one-off payments.

Likewise, the revision of the Electricity Supply Act is pending. The tariffing of the network will be an issue there. However, the government, still, does not want to incorporate the topic of distance-dependent network tariffs, where only the network levels that are actually used are to be paid for. Today, a consumer who draws electricity from the neighborhood pays grid charges for all 7 grid levels instead of only for the lowest grid level.

# Policy Measures

In the following, we propose a set of eight policies which we expect to be most suitable to achieve the outlined renewable energy and storage targets. As we do not expect all proposed policies to be promptly adopted, some policies overlap in their scope. However, we recommend the implementation of as many policies as possible to maximize the greenhouse gas emissions reductions that other sectors may achieve thanks to electrification.

# Policy 5.1: Cantonal Electricity Quota

## Description

In order to scale up renewable electricity generation at the necessary rate, appropriate locations for large-scale installations need to be quickly designated and made available for public and private project developers. Therefore, we propose as flagship policy a cantonal electricity certificate trading scheme. This scheme requires cantons to supply an annual quota of renewable electricity which is allocated based on the cantons' population size. Cantons that supply surplus renewable electricity are given certificates which they can then trade with cantons that do not manage to match the required renewable electricity generation.

The advantages of this scheme are fourfold: *First,* the scheme is a simple tool to incentivize all cantons to scale up their renewable electricity generation and to find suitable locations on their territory for additional installations. It also pushes the cantons to adapt cantonal policies and their spatial planning to accommodate such installations as well as improve and accelerate internal (permitting) processes. It may also incentivize cantons to offer additional support to renewable energy project developers, such as feasibility studies, resource information, low-cost financing, etc. *Second*, it takes into account cantons' different renewable energy potentials and offers them the flexibility to choose the technologies most suitable to their conditions. For instance, some cantons offer high wind resources whereas others may rather focus on solar PV. *Third*, it ensures the political support by the numerous mountainous cantons as their potential for renewable electricity generation is generally high and the scheme may thus offer an additional source of income. *Fourth*, it offers the cantons flexibility in terms of the pathways chosen to achieve their targets. They can take local political feasibility into account when deciding which technologies to deploy and where.

## Financing

The policy does not need any financing except to set up the certificate trading system, which corresponds to a small amount and is therefore neglected at this point. In theory, the policy is also neutral to cantonal finances as long as cantons comply with their respective capacity targets. However, in practice, some cantons that do not meet their targets will have to buy certificates from overachieving cantons and thus strain their cantonal finances. To alleviate such cantons, the cantonal electricity certificate trading system could partially replace the existing cantonal fiscal transfer payments. Cantons with net benefits from these transfer payments are often the more peripheral and mountainous cantons with small population sizes. They also mostly offer high renewable energy potential thanks to their high land availability, high wind and hydro power resources as well as solar PV resources in the wintertime. These cantons will thus most likely be overachieving in terms of their renewable energy targets and thus additionally benefit from the certificate trading scheme.

## Impact

The impact of the policy on renewable energy deployment is considered high as it aligns cantonal interests with the national targets. As a reaction to the proposed policy, cantons will create a favorable policy environment for public and private actors to invest in renewable energy installations and thus make sure that the national renewable energy targets are implemented on the ground.

## Social Compatibility

Social compatibility is high as the cantons are given the flexibility to choose how to achieve their targets and thus take actions that are compatible with local political feasibility.

## Questions and Uncertainties

Questions and uncertainties remain regarding the specific design of the policy:

- How are the specific cantonal targets set? We propose to allocate them based on cantons' population size. However, other criteria or a mix thereof are also conceivable, such as economic activity, current electricity consumption, tax revenues, etc. Yet, we deem it important to keep the scheme simple and to base the criteria on easily measurable parameters which cannot be hampered by cantonal policies.
- What happens to cantons with small surface area, such as Basel-Stadt, Geneva or Zug? Are they treated equally, or do they receive an upfront bonus? We suggest that they are treated equally as they represent financially strong cantons. They may have to primarily rely on their rooftop solar PV potential or may offer additional electricity services such as large-scale storage if these are included in the scheme (see next bullet point).
- For what product are the certificates traded, e.g. renewable electricity, renewable energy capacity? Does the product's value change according to the time of delivery, e.g. is electricity delivered at peak time of higher value? Is large-scale electricity storage included in the policy?

# Policy 5.2: Solar Obligation for Suitable Roofs

## Description

Building owners - whether public or private - are obligated to build solar PV installations on their roofs within 10 years if their roofs offer medium, good or very good suitability according to Sonnendach.ch. The size of the installation needs to be adapted to the size of the roof not to own electricity needs. Installations receive a cost-covering remuneration. Exemptions are made for buildings that serve additional purposes, such as buildings declared historic monuments.

To incentivize compliance with the requirement, building owners are obligated to pay an annual fee per square meter of roof surface with the abovementioned quality that is not used for solar PV. The fee continuously increases for the first 10 years. The annual fee cannot be shifted to tenants. Periodically, the capacity additions are monitored and, if necessary, the fee is additionally increased.
We propose a linearly increasing fee from 0 CHF/m$^2$ in 2020 to 20 CHF/m$^2$ in 2030 as one square meter can host an 200W of solar PV with an annual electricity production of approximately 200 kWh. Assuming a remuneration of 10Rp/kWh, this output corresponds to the 20 CHF/m$^2$.

## Financing

The remuneration of the electricity produced by the rooftop solar PV installations is financed by the existing consumer surcharge on the electricity tariff which needs to be raised accordingly. If we assume that existing suitable rooftops may offer a solar PV potential of 24 TWh and that this production is remunerated at 10 Rp/kWh for 15 years, the total remuneration would amount to:

$$24\ TWh/a \cdot 10\ Rp/kWh \cdot 15a = 36 \cdot 10^9 CHF$$

(Note that this amount is not additive to today's expenses for electricity. It partially replaces electricity generation cost from other sources, such as nuclear power or imports.)

Assuming that all the installations are built in 2020 and an annual electricity consumption of 50 TWh, the surcharge which would need to be paid until 2035 would amount to:

$$\frac{24\ TWh/a \cdot 10\ Rp/kWh}{50\ TWh/a} = 4.8\ Rp/kWh.$$

(Note that for simplicity the calculated values are nominal and not discounted.)

As not all building owners may have the capital necessary to invest in a solar PV installation, additional financing options may be provided by the cantons or the federal government or mandated finance institutes, such as cantonal banks, a green investment bank, or a climate fund. One option would be interest-free loans provided by the banks backed by the federal authorities with credit guarantees equivalent to what is being done in the current Corona pandemic. The same could also be done via interest-free increases of mortgages for climate-friendly renovations. Changes in the regulation of mortgages may also help. However, in these cases, the cost-covering remuneration needs to be adjusted.

## Impact

The impact of this policy on solar PV deployment is expected to be very high as suitable roofs will be effectively used. Increasing the non-compliance fee over time ensures rapid increases in solar PV capacity which is necessary to achieve the targets for 2030.

## Social Compatibility

The policy requires building owners to make investments that they are not necessarily able or willing to do. However, financial support can alleviate some of the constraints imposed on building owners (see above). We also would like to point out that a majority of building owners belong to the financially prosperous sections of the population and the design of the policy ensures that the building owners do not lose money. Additionally, a solar PV installation constitutes a very small share of the total cost of a building but adds to its overall value.
At this point, we would like to refer to a similar policy in Switzerland adopted in 1963: The regulation regarding air-raid shelters implemented in the Law on Civil Protection (BABS / FOCP) . This law required every building in Switzerland to either dispose of an air-raid shelter or to pay for one in a different building. Such requirements are thus not unknown in this country. Interestingly, even the construction costs for air-raid shelters have the same order of magnitude than the ones for a solar PV installation (roughly CHF 20’000).

## Questions and Uncertainties

The proposed policy raises many questions and uncertainties some of which are the following:

- Non-compliance fee: Is the fee high enough to incentivize building owners to invest in a solar PV installation? Could the fee be replaced with other incentives for building owners to comply with the requirements?
- Permits: As of now, building owners have to acquire permits to build solar PV installations on their roofs. Should these permits be abolished, or can they be simplified (see Policy 4)?
- Unsuited roofs: What about building owners with unsuited roofs according to Sonnendach.ch? Should they also be incentivized to build solar PV installations? Should they be required to pay the fee?

# Policy 5.3: Competitive Auctions for PPAs for Large-Scale RE Installations

## Description

In order to increase their renewable electricity generation and comply with their mandated quota (see Policy 5.1), cantons will have to make suitable areas available for large-scale RE installations. In case the cantons cannot or do not want to find a project developer or Policy 1 is not implemented, competitive auctions for power purchase agreements (PPAs) should be organized by a central public entity, for instance Pronovo. PPAs represent contracts between an electricity generator and an electricity buyer and define the conditions at which electricity is sold, e.g. the duration of the contract, the price paid as well as the specific product delivered. Experiences from other countries show that competitive auctions for PPAs have been implemented with great success. Portugal, for instance, achieved record-low solar PV auction results in July 2019 with remuneration levels as low as 1.48 EURct./kWh for a duration of 15 years (Rojo Martin 2019). In Germany, various solar PV auctions in 2019 resulted in remuneration levels between 4.80 and 6.59 EURct./kWh for a duration of 20 years and capacity additions of almost 1.5 GW (Bundesnetzagentur 2019).
With the framework conditions for large-scale renewable energy installations are different in Switzerland compared to these countries, particularly in terms of the maturity of the sector, the current political landscape and labor cost, we do not expect similar outcomes immediately. However, we suggest following other European countries' example regarding the design of the auctions: They should be technology-specific, held at regular and frequent intervals, follow a pay-as-bid pricing mechanism, define stringent requirements regarding the viability of the bids, offer long-term contracts of minimum 15 years, and either directly remunerate the produced electricity or pay a premium on top of the market price. If the auctions are designed similarly to our neighboring countries' auctions, we expect more actors to enter the Swiss renewable energy market, including international project developers but also pension funds, which would add momentum to the pace at which new installations are built, increase the quality of the projects, lower the cost and bring us closer towards the 2030 targets.

In case a suitable location is already available for a large-scale renewable energy installation, a location-specific and technology-specific auction can be held. Such auctions are particularly important for installations on parking lots, highway taluses, etc. In the case of location-specific auctions, the respective cantons will provide necessary information, such as wind speed measurements, solar irradiation levels, soil conditions, etc. and all the necessary permits in order to offer a level playing field to all interested actors and speed up the processes.

## Financing

The remuneration of the electricity produced by the rooftop solar PV installations is financed by the existing consumer surcharge on the electricity tariff which needs to be raised accordingly to ensure the timely construction of new large-scale renewable energy installations. Assuming that, by 2030, all of the wind electricity (1.5 TWh/a) and 10% of solar PV electricity (2.4 TWh/a) are acquired through competitive auctions with contracts of 15 years and a fixed remuneration of 20 Rp./kWh and 8 Rp./kWh for wind and solar PV, respectively, the total remuneration would amount to:

$$(1.5\, TWh/a \cdot 20\, Rp/kWh + 2.4\, TWh/a \cdot 8\, Rp/kWh) \cdot 15a = 738 \cdot 10^{9} CHF$$

(Note that this amount is not additive to today's expenses for electricity. It partially replaces electricity generation cost from other sources, such as nuclear power or imports. Neither is this amount additive to the amount calculated for Policy 2 as there are overlaps in the solar PV installations included in the calculations.)

Assuming that all the installations are built in 2020 and an annual electricity consumption of 50 TWh, the surcharge which would need to be paid until 2035 would amount to:

$$\frac{(1.5\,TWh/a \cdot 20\,Rp/kWh + 2.4\,TWh/a \cdot 8\,Rp/kWh)}{50\,TWh/a} = 1.0\,Rp/kWh$$

(Note that for simplicity the calculated values are nominal and not discounted.)

### Impact

The impact of the proposed policy on renewable energy deployment is considered high. As mentioned above, experiences from other countries show how successful competitive auctions can be in terms of acquiring new renewable energy capacity as well as achieving low prices. If appropriately designed, similar results are conceivable for Switzerland.

We also expect the impact of competitive auctions for PPAs to be higher than the impact of auctions for one-off investment grants - the latter being proposed by the Federal Council in the draft for the revised Law on Energy (Schweizerische Eidgenossenschaft 2020a). The reasons for this expectation are twofold. *First*, literature shows that financial investors are sensitive to electricity price risks and consequently increase the risk margin on their investments or are reluctant to invest at all (Salm and Wüstenhagen 2018). As opposed to one-off investment grants, PPAs tackle this problem by offering secure revenues for the produced electricity. *Second*, so far, no other jurisdiction has implemented auctions for one-off investment grants for renewable energy installations. The adoption of such a new support mechanism would thus require interested actors to first become familiar with the scheme and, at best, slow down the scale-up of renewable energy capacity. However, it could also alienate potential project developers and investors and thus hamper the achievement of the targets.

### Social Compatibility

The social compatibility of the policy is high as it reduces costs and ensures the quality of the projects if the auctions are appropriately designed.

### Questions and Uncertainties

Questions may arise regarding the appropriate design of the auctions. However, auctions have been popular and thus well tested in many countries. Swiss policymakers may thus profit from these experiences when designing the auctions.

## Policy 5.4: Simplified Permitting Process

### Description

Permitting is considerably simplified for all renewable energy technologies. Public authorities set up one-stop shops for permitting and limit the process to a few days or weeks. The permitting processes are limited to one governance level, i.e. communes are responsible for the permitting of small-scale installations while large-scale installations are processed at the cantonal level. The possibility to file for an appeal is removed from individuals and limited to associations. The deadline for appeals is considerably shortened. Especially for large-scale installations, lawsuits are only handled by higher-level courts to limit the delays arising from passing through all juridical levels.

For small-scale rooftop solar PV installations, we propose entirely removing the need for permits except in case of buildings that serve superordinate purposes, such as buildings under a preservation order.

### Financing

The proposed policy does not need considerable financing except to align permitting processes in the cantons.

### Impact

The impact of the policy on renewable energy deployment is considered high. The proposed policy primarily impacts the speed at which new installations are added as it considerably simplifies and accelerates project planning and execution. It also reduces transaction costs.

### Social Compatibility

The proposed policy is socially compatible.

### Questions and Uncertainties

Questions and uncertainties arise regarding the definition of small-scale and large-scale installations as well as the specific authority responsible for the entire permitting process. Also, it remains unclear what kind of buildings would need a permit for a small-scale rooftop solar PV installation.

## Policy 5.5: Support Program to Train RE Personnel

### Description

The rapid scale-up of renewable energy capacity will require additional personnel for the planning and mounting of these installations. More specifically, for the peak year 2031, we expect an additional need for 2,500 planners and 17,000 installers (see subsection Personnel Requirements). In order to meet this demand, the federal and cantonal governments will institute and support programs at Universities of Applied Sciences and professional schools (dt. höhere Fachschulen) to train the necessary number of RE personnel, specifically the planners. For the lower skilled job of mounting the installations, the federal and cantonal authorities ensure training programs (e.g. in combination with a public job-program, see Policy 9.1) and provide the necessary boundary conditions to additionally deploy military personnel.

### Financing

The amount of financing necessary to implement this policy is unclear.

### Impact

The impact of this policy on solar PV deployment is considered very high as the rapid scale-up of renewable energy capacity is largely dependent on the domestic renewable energy sector and its capacity to handle the demand. This policy would support the sector in increasing the availability of educated personnel.

### Social Compatibility

Social compatibility of this policy is considered high. The policy combats unemployment in an efficient and meaningful way and provides opportunities for workers in emission-intensive industries whose jobs have been cut in the course of the ecological transition.

### Questions and Uncertainties

Questions and uncertainties remain regarding how timely high-quality education programs for renewable energy planners can be ramped up and suitable candidates found.

# Policy 5.6: Abatement of Grid Charges for all Storage Technologies and Regulation regarding Storage and Grid Stability

### Description

With increasingly intermittent electricity generation, storage and grid stability become important. To support the deployment of various storage technologies, all storage technologies are exempted from paying grid charges. The responsibility to invest in necessary storage and thus ensure grid stability lies with the grid operators. They are free in choosing in which storage technology to invest. Grid operators can transmit the incurred cost for storage and the grid to the electricity consumers.

When assessing measures in the electricity grid, variants for grid expansion, grid reinforcement and grid optimization are compared and the variant that is most economical over the entire planning horizon is implemented. As a rule, the grid should only be expanded if a secure, effective and efficient grid during the entire planning horizon cannot be guaranteed by optimization or reinforcement. Grid optimization can include the control of flexibilities, for example demand-side management, power control of PV systems or the grid-friendly use of storage systems.

### Financing

The cost incurred for storage and grid stability are transmitted to the electricity consumers as is already done today.

### Impact

The impact of this policy on storage deployment and grid stability is considered high as the grid operators can invest in necessary infrastructure timely and in an unbureaucratic manner.

### Social Compatibility

Social compatibility is considered high.

### Questions and Uncertainties

One question arises regarding small-scale storage: Should small-scale storage, such as small batteries to increase household self-consumption, receive support as well?
Also, the grid operators need to be overlooked by a central authority to avoid incentivizing the construction of unnecessary infrastructure.

# Policy 5.7: Promote Open-Space Solar PV

## Description

Open-space solar PV installations are not specifically prohibited in the Spatial Planning Act (dt. Raumplanungsgesetz). However, neither are they specifically encouraged or have a chance of obtaining the necessary permits, see e.g. (Bundesversammlung 2012). We propose that the federal authorities should examine where open-space solar PV could make sense, e.g. above vegetable crops that need shading, and adapt the Spatial Planning Act accordingly in order for cantons, communes as well as private landowners to open up their land for solar PV deployment.

## Financing

The proposed policy does not need considerable financing.

## Impact

The impact of the policy on solar PV deployment is considered moderate. It would take several years for open-space solar PV to be allowed. However, once the regulation is adapted, scale-up of solar PV deployment could happen very fast.
We do not expect the permission of open-space solar PV to have an impact on solar PV deployment on existing buildings as feared by the Federal Office of Energy.

## Social Compatibility

The social compatibility of this policy remains unclear. Careful consideration of social acceptance towards open-space solar PV is necessary. However, positive side-effects of open-space solar PV, such as increased biodiversity (Busch et al. 2019), may increase the social acceptance not only for open-space solar PV but also for other climate-friendly measures, such as the reforestation of unused areas.

## Questions and Uncertainties

Questions and uncertainties remain regarding the type of land that could and would be opened for open-space solar PV and thus the potential that could be tapped into. Also, it remains unclear how quickly such regulation could be adapted.

# Policy 5.8: New Structure of Electricity Tariffs

## Description

Current electricity tariffs include the price for the consumed electricity besides grid charges, taxes and the consumer surcharge for renewable energy deployment. We propose to structure the tariffs in a more market-based manner to reflect future production regimes with higher shares of intermittent renewable energy generation. If structured appropriately, the electricity tariffs may increase energy efficiency and reduce the need for additional intraday storage capacity. On the one hand, the current scheme with high and low electricity prices should be abandoned and replaced with a more flexible scheme. Here, we envision electricity prices that are adapted at least hourly to the current market price. This rewards electricity consumption at peak electricity generation. On the other hand, the grid charges should be imposed depending on the used network level, on the used capacity or combinations thereof. Hence, the consumption of locally produced electricity is incentivized which reduces the need for investments in the transmission grid.

As an alternative to the above proposed tariff structure, we could also envision flat-rate electricity tariffs similar to existing mobile phone tariff structures where a specified amount of energy and grid usage is included in a monthly tariff and the consumer pays extra for additional electricity consumption. The monthly tariff may also be adapted to reflect intraday electricity price fluctuations by including more energy usage at peak production hours. Such a tariff structure may improve energy efficiency. Generally, we deem it important to abandon the current structure of the electricity tariffs as it does not correspond to expected future electricity generation regimes.

## Financing

The proposed policy requires the replacement of current electricity meters with meters that monitor the time of use. However, such a replacement is currently ongoing and would thus not incur higher cost. Importantly, electricity consumers should be allowed to choose where to buy their electricity meter from.

## Impact

The proposed policy incentivizes electricity consumers to align their consumption with electricity production and could thus add to grid stability. Additionally, it would incentivize installations that generate off-peak electricity, such as solar PV installations on façades, as well as intraday storage, such as batteries. It may also incentivize operators of pumped-storage hydropower plants to align their operations with actual consumption behavior and thus add to grid stability.

## Social Compatibility

The proposed policy requires the replacement of current electricity meters for all households as well as behavioral changes as the current pricing scheme will be abandoned. This may court the resentment of some parts of society.

## Questions and Uncertainties

Questions and uncertainties remain:

- Communication of electricity prices: How are the current prices communicated to electricity consumers? Do they know about future prices?
- Self-consumption: How is self-consumption remunerated? Do the grid charges also apply to buildings that generate their own electricity?

# Technologies and Potentials

After estimating future electricity demand and discussing the political action necessary to ensure energy supply in a net zero world, we want to take a closer look at the potentials and technologies necessary for this transition.

# Photovoltaics

*This section as well as parts of the section on future electricity demand were already developed further by the author and published via the Swiss Energy Foundation (see Jürg Rohrer 2020).*

Photovoltaic systems have, by far, the biggest potential for increased electricity production in Switzerland (Sperr and Rohrer 2018), particularly during the short time span of 10 years. In this section, therefore, it will be estimated, how rapidly and strongly the electricity production from photovoltaics in Switzerland could be developed and how, through this, a complete supply of electricity would be possible in the annual budget.

## Potential of PV Roof Surface Area in Switzerland

Studies by (Gutschner, Gnos, and Nowak 2010; Nowak, Gutschner, and Gnos 2007; Nowak and Gutschner 2011) have shown that roughly 30% of the roof surface area in Switzerland would be suitable for the installation of a solar PV installation. In a first approximation the roof surface areas are being estimated by the means of the floor area of 485km2 (Walch et al. 2020). This then corresponds to a modular unit surface of 145.5km2; and assuming the values of 0.188 kWp/m2 and 970 kWh/kWp for said unit one gains 26.5 TWh per year. This potential has been put to use in an online potential calculator for renewable energies per municipality (Eymann, Rohrer, and Stucki 2014).

According to the data of sonnendach.ch roof surface area in Switzerland rated *good*, *very good* or *outstanding* has a PV potential of 77.8 TWh per year. After subtracting 5% to account for protected buildings (Remund, Albrecht, and Stickelberger 2019) one is left with 74 TWh per year. According to a clarification by (Portmann et al. 2019) one ought to subtract 30%. When it comes to flat-roofed blocks of flats, the subtrahend amounts to 58%. These deductions account for chimneys, skylights, terraces, railings, roof structures etc. Since 6% of the gain comes from blocks of flats the average deduction is 32% (94% with 30% and 6% with 58%). These deductions have been defined through expert surveys. However, the exact methods and the raw data have not been published (Portmann et al. 2019). Other studies concluded bigger deductions i.e. around 40-45% (Assouline, Mohajeri, and Scartezzini 2017; Assoulinea, Mohajerib, and Scartezzini 2018; Walch et al. 2020).

Thus, the data from sonnendach.ch results in a roof surface area potential anywhere between 40-50 TWh per year. Due to the aforementioned data, the Swiss Federal Office of Energy (BFE/OFEN/UFE) assumes a potential of 50TWh (BFE, 2018). The solar branch association *Swissolar* calls this the exhaustible potential and finalizes a similar value of 49.1 TWh. However, *Swissolar* assumes that only half of this value can be harnessed in the next thirty years i.e. 24 TWh per year (Remund, Albrecht, and Stickelberger 2019).
A new study conducted by the EPFL (École polytechnique fédérale de Lausanne) put the number of said potential to solely 24.6 (± 9) TWh per year (Walch et al. 2020). Main reasons for said difference, especially concerning the estimates of sonnendach.ch, are thought to be different models of insolation, the machine-aided arrangement of the modular units on the roofs and more detailed calculations of the shading (Walch, Mohajeri, and Scartezzini 2019). Notwithstanding, the immense differences are still not sufficiently explained.

At first sight, the estimates for Swiss roofs seem the cover a wide range i.e. 24.6-49.1 TWh per year. What meets the eye is the high value stated by sonnendach.ch when compared to the others (see Figure 5-1). However, assuming that only half of the potential could be harnessed until 2050 (in compliance with Remund et al., 2019), one gets a similar potential to the other estimates. Nonetheless, further clarifications are suggested.
Since the time horizon of this report refers to 2030 or at most 2050, an exhaustible potential somewhere between 24-25 TWh on roofs seems to be the most trustworthy and sensible estimate. To this figure one can add *Swissolar*'s estimate of 8 TWh for façades. Hence Swiss buildings might be producing 30-33 TWh worth of energy per year.

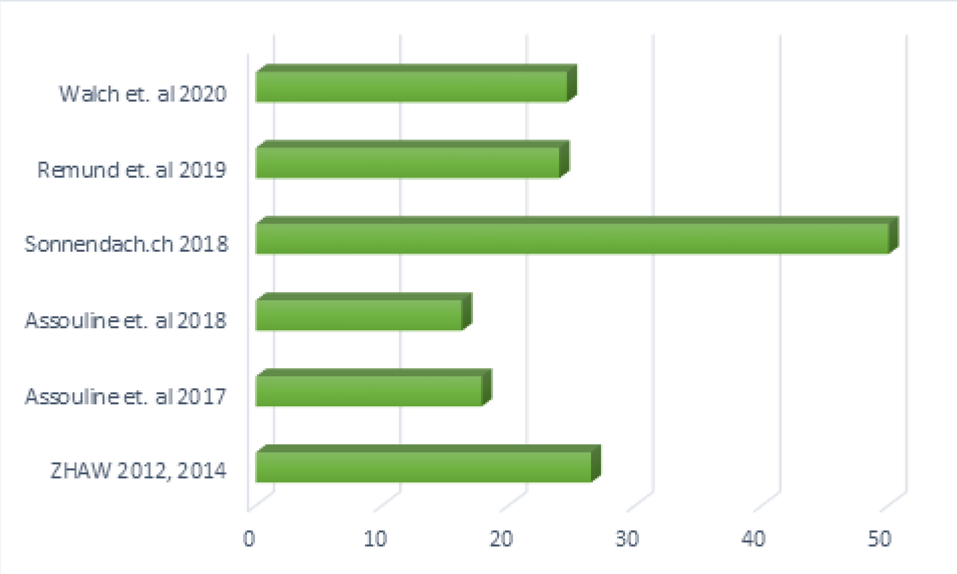



*Figure 5-1 Various estimates for the potential of photovoltaics on the roof surfaces of buildings in Switzerland (numbers in TWh p.a.).*

**Analysis of Solar PV on Roofs**

The size of a solar plant is a decisive factor when it comes to the costs of said structure and, thus, also influences the production costs of electricity. In-detail data has only been published by sonnendach.ch. Hence, the following analysis is based on their information. As long as the factor 0.5 is being used for the number and the surface area resp., the statements should be transferable to the aforementioned trustworthy estimate of the potential i.e. 24-25 TWh.

For the analysis it has been assumed that several roof surface areas of one building would be conflated to one single solar plant. Thus, different surface areas with an identical UUID have been added up and labeled as “solar plant” or “building”.
Furthermore, only roof surface areas with an annual insolation of at least 1,000 kWh/m2 have been taken into account. This is identical with a *very good* or *outstanding* roof surface area.

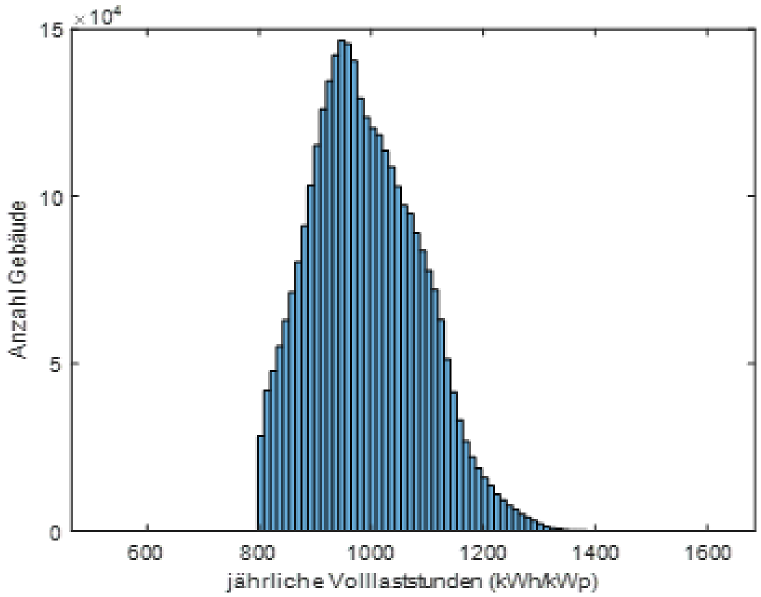



*Figure 5-2: Dispersion of the standardized PV gain among the number of buildings and solar collectors respectively, according to sonnendach.ch. For roof structures a lump deduction of 30% per roof surface area has been included.*

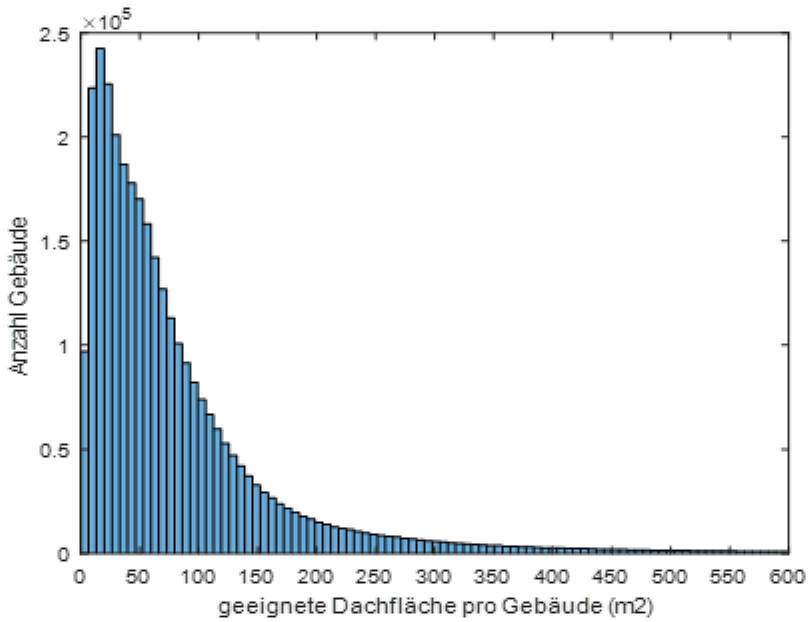



*Figure 5-3: Distribution of the roof surface area according to sonnendach.ch (raw areas without correcting factors as a lump deduction for chimneys, roof structures etc.)*

Figure 5-2 shows the standardized annual gain of the solar collectors on roofs as per sonnendach.ch. Most of the collectors are in the range of 900-1,000 kWh/kWp, as are newly installed collectors today.

Figure 5-3 shows the distribution of the sizes of the roof surface areas from sonnendach.ch, which are usually fit to have PV systems installed. Figure 5-4 shows the annual electricity yield sorted by the size of the installations. The abundance distribution of the annual electricity yield for different categories of PV systems are shown in Table 5-2 and in Figure 5-5, also. As a data source for the categorization the figures from sonnendach.ch, with a lump reduction of 30% of the roof surface area and the gains respectively, have been used. Furthermore, the roof surface areas were also aggregated with the UUID to PV systems.

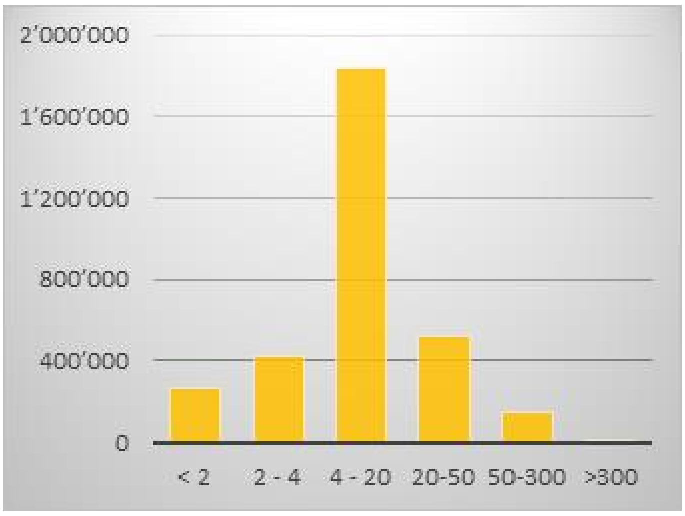



*Figure 5-4 Frequency of different annual gains per solar plant. (Source of data being sonnendach.ch, grouped by UUID with a correcting factor of 0.7 as a lump deduction e.g. for chimneys, roof structures etc.)*

Table 5-2 as well as Figure 5-5 show nicely that typical installations on single-family homes with capacities between 2-20 kWp (10-100 m2 surface of modular units) can produce roughly 36% of rooftop PV electricity. 29% of the potential comes from installations between 20 and 50 kWp and 25% of the potential is being covered by even bigger installations on blocks of flats or on industrial builds.

These bigger installations can be built more efficiently than small ones and, thus, lead to substantially lower electricity production costs. Especially when a lot of solar power must be added in a short time, the political measures should be adjusted to this circumstance. This calls for political measures that will quickly lead to the construction of PV systems on larger roofs.

*Table 5-2: Frequency of the annual PV gains (source of data being sonnendach.ch grouped by UUID with a correcting factor of 0.7 as a lump deduction e.g. for chimneys, roof structures etc.)*

| **Category [MWh]** | **Electricity yield [GWh]** | **Area [km2]** | **Number of plants** |
|---|---|---|---|
| <2 | 329.31 | 2.01 | 266'052 |
| 2 - 4 | 1'232.27 | 7.45 | 424'647 |
| 4 - 20 | 18'945.87 | 111.15 | 1'835'675 |
| 20-50 | 15'156.99 | 90.48 | 520'871 |
| 50-300 | 13'302.59 | 80.61 | 149'218 |
| >300 | 5'578.92 | 33.86 | 8'908 |
| Total | 54'545.96 | 325.57 | 3'205'371 |

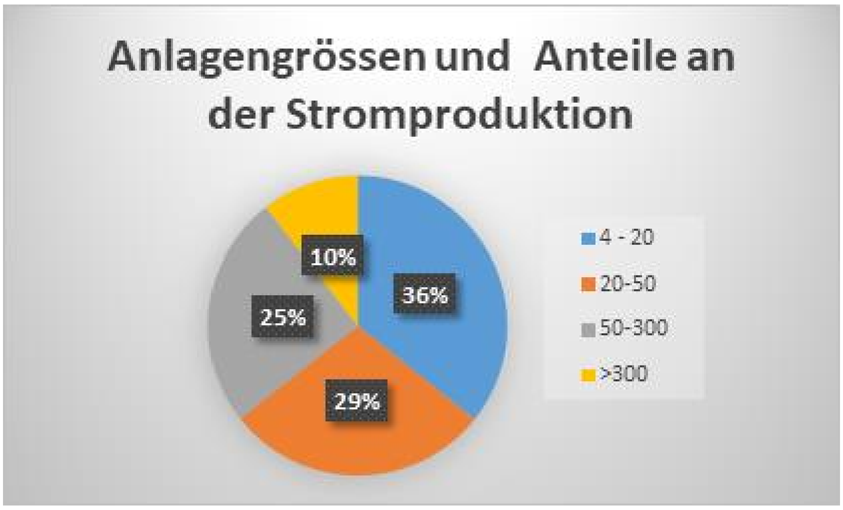



*Figure 5-5: Distribution of the electricity yield correlating with the size of the plant according to Table 5-2. Solar plants with a capacity <4 kWp are not plotted because of their minor part in the production of electricity.*

## Potentials Outside of Buildings

Studies for the assumptions of potentials of the PV-production independent from buildings in switzerland have rarely been published so far. Swissolar and Meteotest assume the following additional potentials, which could be realised in the next 30 years (Remund, Albrecht, and Stickelberger 2019):

| Plant | Potential in TWh | Area km2 |
|---|---|---|
| Streets | 2.5 | 16.2 |
| Parking lots | 3.9 | 25.7 |
| Motorway embankments | 3.9 | 25.7 |
| Total: | 10.3 | 67.6 |

Additionally to this potential on existing infrastructures from 10.3 TWh per year, there is a potential of plants in the lowlands and that mountains that is theoretically only limited by the Area of Switzerland. However, the authors of the study mentioned above assume only a limited potential of 3.3 TWh due to assumptions about the distance of feeding options in the Alps (Remund, Albrecht, and Stickelberger 2019).

## Comparison of Potential and Requirement

According to Table 5-1, there is a requirement of additionally 24.4 TWh PV-Energy per year until 2030 respectively 43.7 TWh PV-Energy per year until 2050 in the scenario «Growth in Accordance with the State». The required PV-Energy was determined with optimistic assumptions concerning the realization of Power-efficiency measures and the expansion of the other technologies for the production of energy (Wind power, Hydropower, Biomass). These requirements in energy are put next to the potentials for PV-energy shown in Table 5-3. In that case, it is assumed that financial and human resources represent no bottlenecks (see also considerations down below) and that the potentials can be fully implemented until 2030 respectively 2050.
To implement the PV-potentials that were identified completely and in a short time span, rigorous political action is necessary. Figure 6 shows the comparison between the demand for PV electricity of around 44 TWh in 2050 and the forecast PV production, assuming different degrees of exploitation of the potential. Even a full exploitation of the PV potential by 2050 on existing infrastructures could not completely cover the needs in the "growth according to the federal government" scenario. In the “sufficiency” scenario, on the other hand, a 70% exploitation of the potential on infrastructures or a full

exploitation of the PV potential on buildings (roof areas and facades) would be sufficient to cover the demand.
So far, only the annual balance of electricity demand and production have been taken into account. Due to the seasonal course of PV production in the Swiss plateau and the high proportion of PV electricity, seasonal electricity storage will most likely be necessary. Regardless of the storage technology chosen, storage and reconversion are associated with losses, so that ultimately the electricity consumption will be higher. In addition, neither any additional electricity requirements due to decarbonization in industry nor for the substitution of aviation fuel have been taken into account.

This makes it clear that consistent sufficiency measures to reduce electricity requirements and / or PV systems on open spaces will be necessary to cover Switzerland's electricity needs in 2050 in the annual balance sheet.
Seasonal storage: A forced expansion of PV systems in the mountains and wind power would reduce the seasonal storage requirements. Otherwise, depending on the efficiency of the selected storage technology, much larger free areas will have to be covered with PV systems.

*Table 5-3: Comparison between the demand per scenario and the potential for PV electricity on existing infrastructure.*

| | in 2030 | 2050 | |
|---|---|---|---|
| Production potential of PV electricity: | | | |
| PV on roof areas | 24.5 | 24.5 | TWh |
| PV on facades | 8 | 8 | TWh |
| PV on parking lots, roads, embankments | 10.3 | 10.3 | TWh |
| Subtotal PV-Production Potential | 42.8 | 42.8 | TWh |
| | | | |
| Scenario «Growth in accordance with the State» | | | |
| Electricity demand from PV | 24.4 | 43.7 | TWh |
| Requirement minus potential | 18.4 | - 0.9 | TWh |
| | | | |
| Scenario «Efficiency and Sufficiency» | | | |
| Electricity demand from PV | 16.4 | 31.1 | TWh |
| Requirement minus potential | 26.4 | 11.7 | TWh |

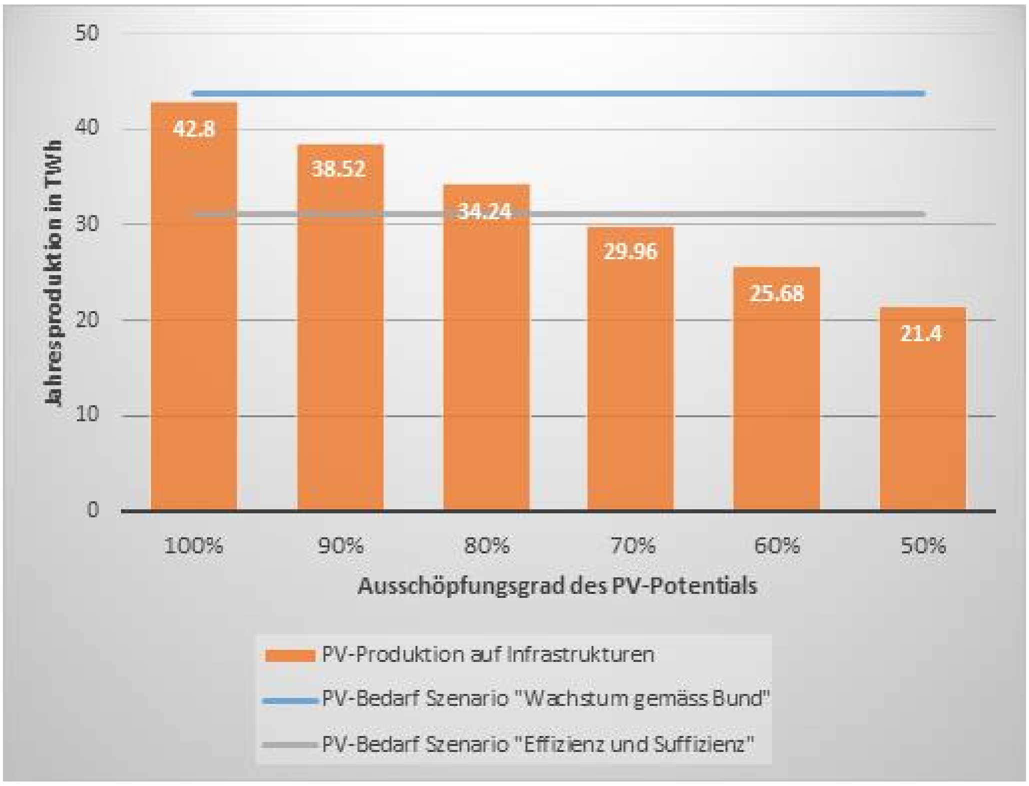



*Figure 5-6: PV electricity demand for the year 2050 ("Growth according to federal government" blue line or "Sufficiency" scenario gray line) and PV production depending on how much the PV potential is effectively used on existing infrastructures.*

## Personnel Requirements and Training of Additional Personnel

The annual rate of expansion of photovoltaics in Switzerland is currently around 350 MW (Hostettler 2019). Additional specialists - especially PV planners - need to be trained to add more quickly. Recruitment and training take time, which is considered the most important limiting factor.

According to the "Strategy for Solar Education in Switzerland", a distinction is made in the solar industry between expert knowledge (3% of employees), specialist knowledge (25% of employees) and basic knowledge (72% of employees) (Portmann et al. 2017). In the case of tenders for PV systems, a distinction is normally made between the hours worked for planning or building the system. Around 17% of the working hours are devoted to planning, the remaining 83% for the construction of the plant (Sperr and Rohrer 2017; 2018). In the following it is therefore assumed that a 1-2 week "apprenticeship" is sufficient for 85% of the work and that only 15% of the work is carried out by well-trained specialist planners. These specialist planners have a solid basic technical education (technical school level or university of applied sciences level), special training lasting around 2 months and additionally at least half a year of work experience in the planning of PV systems.

Due to the necessary training of additional specialist planners, the PV expansion until in 2030 will be limited to approx. 27 TWh (see Figure 5-7). The average investment costs of a PV system in 2020 were CHF 1,200 per kWp, a future cost reduction of the PV systems of 1% per year and a share of the installation and planning costs in the investment costs of a PV system of 30 % are being assumed (Sperr and Rohrer 2017). This enables the costs for the work performed during the construction and planning of the PV systems to be calculated. The gross income per full-time equivalent for planning and installation in the PV industry is CHF 67,000 per year (Huemer 2016). Ancillary wage costs, tools, vehicles, office rent, administration, etc. are taken into account with a factor of 1.5, so that costs of CHF 100,000 are charged per FTE. As mentioned above, the costs for specialist planners make up 15% of the total labor costs for planning and building a PV system. The number of required PV specialist planners in Figure 5-8 was thus determined.

This leads to an increase in the need for specialist PV planners from around 200 full-time equivalents today to around 2,500 full-time equivalents by 2030 (see Figure 5-8). For the peak year 2031, there will therefore be a need of:

- Ca. 2'500 specialist planners
- Ca. 17'000 Workers in mounting

The training of 2,300 specialist planners within 10 years should not be an insurmountable problem. The only question is whether so many people can be motivated for this job. The assembly staff could be temporarily supplemented, for example, by the army or civil service.

For comparison: there are currently around 5 million employees in Switzerland. In sector G, “Trade, maintenance and repairs of motor vehicles”, the transition to public transport and electromobility is likely to result in some redundancies. Currently, 603,000 people are employed there in Switzerland. The approximately 20,000 persons mentioned above represent 3.3% of the employees in Sector G.

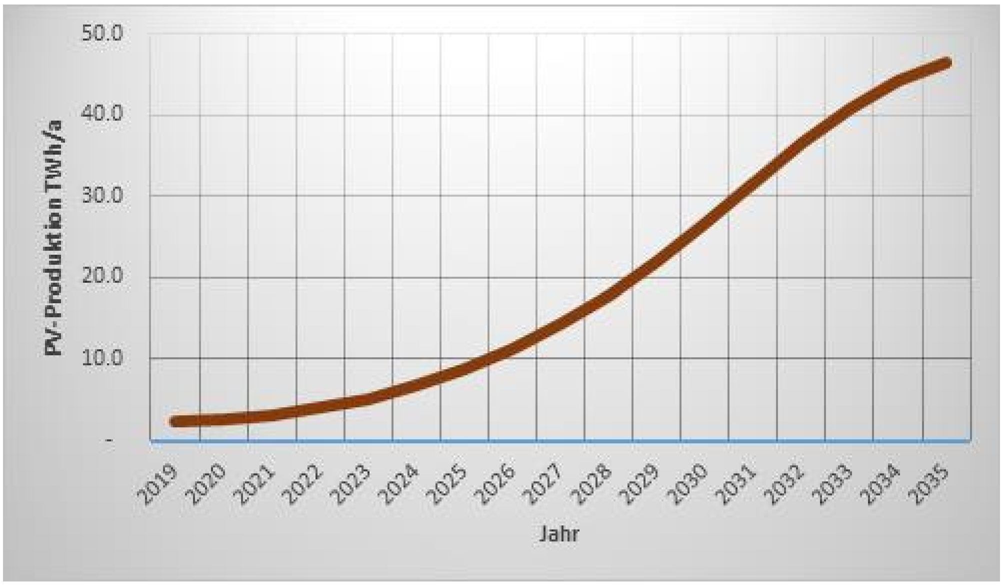



*Figure 5-7: Proposal for a rapid expansion of PV production by 2035.*

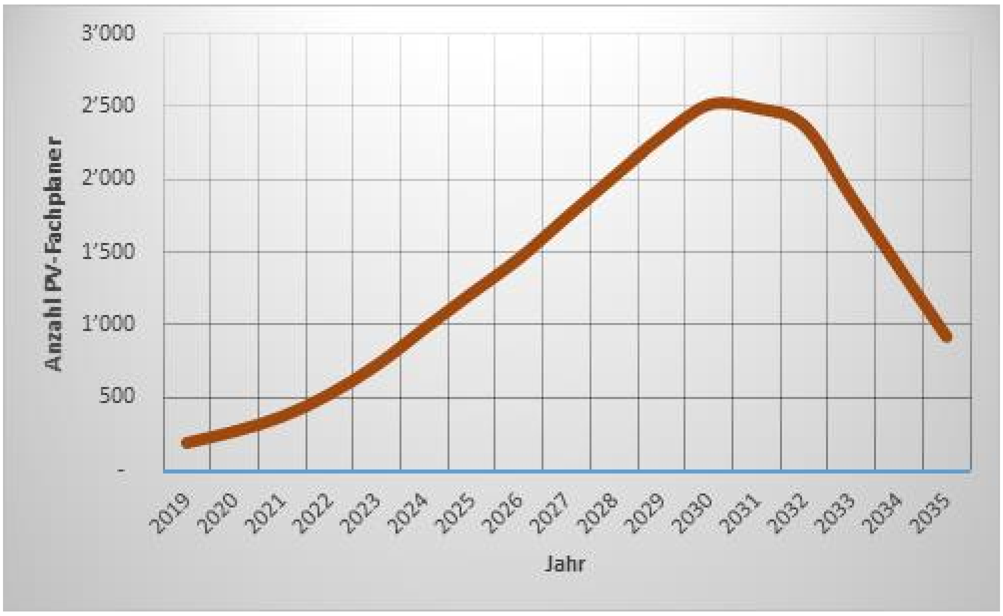



*Figure 5-8: Number of PV specialist planners required to expand electricity production from PV according to Figure 5-7.*

# Wind Energy

## Current Situation of Wind Energy in Switzerland

At the end of 2019 there were 37 wind turbines installed in Switzerland with a total installed capacity of 75 MW. This includes the wind farm Juvent in Western Switzerland with a total of 16 Vestas wind turbines (four V112 and 12 V90 models). The total electricity production from wind energy was 146 GWh – equal to less than 0.3% of the total production in Switzerland. The development of the installed capacity (red), electricity production (dark blue) and expected production (light blue) since 2005 is shown in Figure 9. A further 11.75 MW are expected in 2020, when the wind farm San Gottardo starts production, making a total of 86.75 MW and 42 wind turbines.

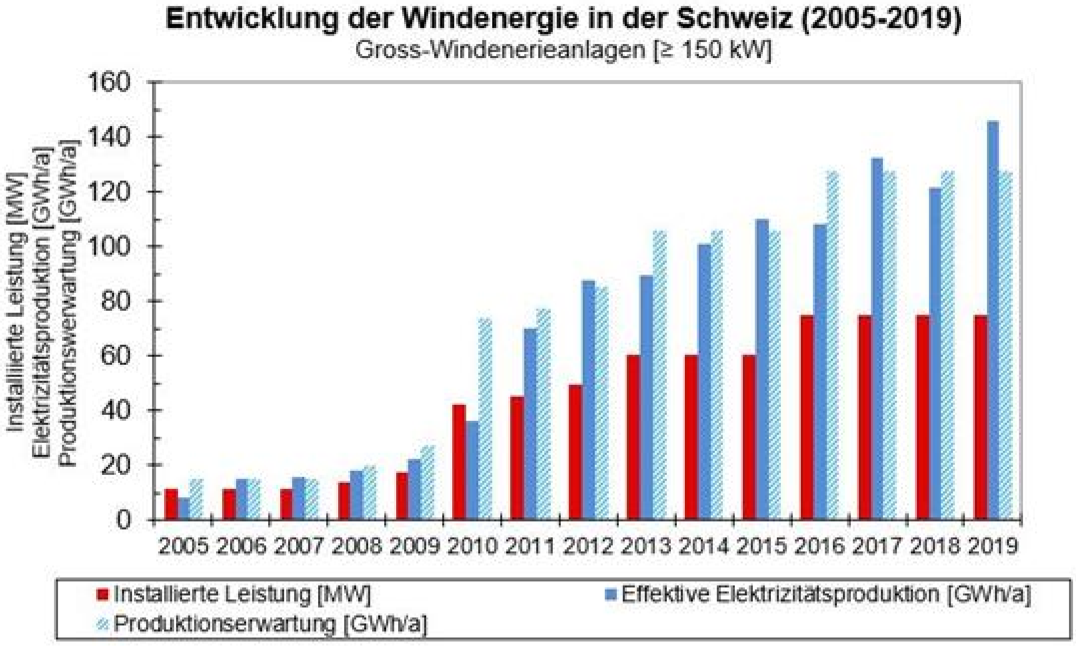



*Figure 5-9: The development of the installed capacity (red), electricity production (dark blue) and expected production (light blue) since 2005.*

## Wind Energy Potential in Switzerland

According to the Energy Strategy 2050, Switzerland aims to produce 4.3 TWh of electricity from wind energy by 2050, corresponding to approximately 800 new wind turbines with a total new installed capacity of 2.8 GW assuming an average installed capacity of 3.5 MW and 1'500 full load hours (Cattin et al. 2012). However, more recent studies suggest that the potential would be on the order to 9 TWh. On the other hand, problems with permitting due to acceptance issues have slowed down this process, and not a single wind turbine was installed in 2018.

## Wind Energy Production by 2030

Assuming a linear increase of installed capacity between 2020 and 2050 to reach the Energy Strategy goal by 2050 results in an estimated installed capacity of 267 wind turbines with 933 MW by 2030, and an electricity production of about 1.5 TWh. Through rapid implementation of ambitious measures (e.g. cantonal electricity quotas, simplified permitting process) this number could certainly still be raised.

# Efficiency

The main drivers of electricity consumption are electrification for building heating and mobility. Efficiency and sufficiency measures in these areas are covered in the corresponding chapters (see Chapter 2: Mobility and Chapter 4: Buildings).
Additional reduction of energy consumption is possible in other areas. In addition to sufficiency, the savings potential purely through technical progress, such as optimized heating circulation pumps, energy-efficient refrigerators and freezers or LED lighting, is around 26 TWh (Schweizerische Agentur für Energieeffizienz 2011).

*Table 5-4: Electricity efficiency potential for Switzerland. Scenario TECHNIK describes the demand with growth factors (population growth, jobs, replacement of fossil fuels, etc.) and the exploitation of the technical potentials. (Source: Schweizerische Agentur für Energieeffizienz S.A.F.E., 2011)*

| Endverbrauch Elektriziträt Schweiz (TWh/a) | 2010 | 2035 | Sparpotenzial (bezogen auf Trend 2035) | | 2035 | 2050 |
|---|---|---|---|---|---|---|
| | IST | TREND | Prozent | TWh/a | TECHNIK | TECHNIK |
| Beleuchtung Haushalte | 2.4 | 2.7 | 60% | 1.6 | 1.1 | 0.8 |
| Beleuchtung Dienstleistung, Gewerbe, Industrie, öffentliche B. | 5.9 | 6.5 | 40% | 2.6 | 3.9 | 3.4 |
| Haushaltgeräte Küche inkl. Spezialgeräte wie Kaffeemaschinen etc. | 4.2 | 4.8 | 35% | 1.7 | 3.1 | 2.8 |
| Haushaltgeräte Waschen + Trocknen | 1.7 | 2.0 | 40% | 0.8 | 1.2 | 1.0 |
| Haushalt: diverse und Kleingeräte | 1.4 | 1.6 | 30% | 0.5 | 1.1 | 1.0 |
| Unterhaltungselektronik | 1.3 | 1.6 | 50% | 0.8 | 0.8 | 0.6 |
| Bürogeräte, Informations-/Kommunikationstechnik, Heimbüro | 4.3 | 5.3 | 40% | 2.1 | 3.2 | 2.9 |
| Haustechnik: Umwälzpumpen | 1.8 | 2.1 | 60% | 1.3 | 0.8 | 0.6 |
| Haustechnik: Lüftung, Klima etc., ohne Elektrowärme | 2.8 | 3.2 | 40% | 1.3 | 1.9 | 1.6 |
| Industrielle + Gewerbliche Anwendungen (75% Motoren) | 23.5 | 25.9 | 30% | 7.8 | 18.1 | 15.5 |
| Bahnen, Trams, Seilbahnen etc. | 3.4 | 4.6 | 10% | 0.5 | 4.2 | 3.8 |
| **Zwischentotal ohne Elektrowärme und -Mobilität** | **52.6** | **60.3** | *35%* | **20.9** | **39.4** | **34.1** |
| Elektroheizung Widerstand | 3.7 | 1.9 | *50%* | 1.2 | 0.7 | 0.4 |
| Elektr. Warmwasser (inkl. Anteile WP) | 2.4 | 1.2 | *50%* | 0.8 | 0.4 | 0.3 |
| Elektro-Wärmepumpen | 1.2 | 7.4 | *40%* | 3.0 | 4.4 | 4.0 |
| Elektro-Mobilität individuell (Autos, Motos, Velos) | 0.0 | 1.1 | * | * | 1.1 | 2.1 |
| **Total** | **59.9** | **71.8** | | **25.8** | **46.0** | **40.9** |

Whenever devices are replaced before the end of their service life, the grey energy must be considered - so it may make sense to operate a less efficient appliance for longer, depending on the purpose. This also applies to a certain extent to fossil appliances (cars, heaters), although here replacement with electrical alternatives makes sense as soon as electricity from renewable sources is available.

# Power Grid

*Source of texts and figures for this section: BFE 2015, Entwicklung der Netzkosten in der Schweiz vor dem Hintergrund des derzeitigen Bedarfs, der ES2050 und der Strategie Stromnetze.*

Power grids must be continuously maintained and renewed. These measures alone generate costs, the amount of which is relatively easy to estimate, as they can be derived with a good approximation from today's - well known - installed assets. In addition, the Message on the first package of measures of the Energy Strategy 2050 from autumn 2013 and the Explanatory report on the electricity grids strategy from 2014 describe the changes that are being targeted in the areas of electricity generation, electricity consumption and power grids. These changes will in some cases have a significant impact on the future design and thus the costs of power grids - beyond the costs of maintaining existing grids.

Based on the study (Prognos 2012), this section describes the assumptions of the Energy Strategy 2050 (ES 2050) and the resulting estimates of future grid investment costs. These values can be taken as a rough estimation for the grid costs until 2030 if the net 0 $CO_2$ goal has to be reached until 2030.

## Assumptions of the Energy Strategy 2050

The current public and political debate on the future energy supply in Switzerland requires a comprehensive basis for decision-making. In the area of electricity supply, there is a need for a well-founded estimate of the costs of the power grids, which play a key role as the link between producer and consumer, in the coming decades.
In the past, various studies have been carried out to estimate future grid costs in Switzerland (Ladermann et al. 2010; Consentec 2012). However, some of these studies were based on assumptions that deviate from the current boundary conditions set out in the ES 2050 and the Electricity Grid Strategy. Furthermore, the previous studies did not yet take into account the extensive cabling of the distribution grids planned in the Electricity Grid Strategy (Consentec 2013). A possible expansion of grid level 3 was also left out in the past. Furthermore, the time horizons of consideration as well as the

presentation and differentiation of the results in the various studies are not uniform. Given this background, the future grid costs will be quantified again.
The ES 2050 describes, among other things, the targets for electricity generation and consumption in Switzerland for the next 35 years and outlines the measures planned to achieve them. On the basis of these descriptions, Prognos was mandated by the SFOE to derive various forecasts for electricity generation (supply variants) and for electricity consumption (demand scenarios). In the actual report (Prognos 2012), the supply variants E / C + E / C+ D + E and the demand scenarios wwb / POM / nEP / are considered.

**Demand scenario wwb:**
The reference scenario “continue as before” (dt. “weiter wie bisher” / wwb) shows the situation if all energy policy instruments currently in effect are not changed. The scenario results in an increase in electricity demand from currently around 59 TWh/a to 69 TWh/a in 2050 and thus in a higher load on the grids in consumption-dominated areas.
**Demand scenario POM:**
The scenario " Political measures" (POM) shows how the measures of the first package of the ES 2050 will affect energy demand. In this scenario, electricity demand is expected to increase slightly to 61 TWh/a in 2050.
**Demand scenario nEP:**
In the scenario "new energy policy" (nEP) a development of energy consumption is presented, which makes it possible to reduce CO2 emissions until the year 2050. This scenario leads to a slight decrease in electricity demand to 53 TWh/a in 2050 and thus to a slight relief of the grids in consumption-dominated areas.
**Supply variant E (renewable energies):**
In this variant, no additional central large-scale power plants are built. Instead, an ambitious expansion path for renewable production facilities is assumed, based on a corresponding political support regime. In the referred study, the expansion of decentralized combined heat and power (CHP) plants is based on the current support regime. The installed renewable energy capacity is approximately 2 GW in wind systems and approximately 10 GW in photovoltaic systems in 2050. The installed capacity of decentralized CHP systems is approximately 4 GW. Depending on the demand scenario, generation from decentralized generation plants and large hydroelectric power plants in Switzerland will not be sufficient to fully meet Swiss electricity demand. In this supply variant, the remaining shortfall is filled by imports.
**Supply variant C + E:**
In this variant, the same ambitious expansion path for renewable energies is assumed as in variant E. The remaining coverage gap is not closed by imports, but by central gas and steam turbine plants in Switzerland. Here, depending on the demand scenario, 4 to 7 gas and steam turbines with an installed capacity of approx. 550 MW each are assumed. For decentralized CHP plants, as in variant E, current support mechanisms are assumed. Compared to variant E, the changes in the generation structure primarily affect grid level 1 (transmission grid). The feed-in-related load on the distribution grids is identical in variants E and C+E.
**Supply variant C + D + E:**
In this variant, the same ambitious renewable energy expansion path is assumed as in variant E and C+E. However, here the electricity gap is covered by a combination of additional decentralized CHP plants and central combined cycle power plants. To realize this, it is assumed that the support conditions for CHP plants will change accordingly. Depending on the demand scenario, between approx. 6 GW (scenario nEP) and approx. 7 GW (scenarios wwb and POM) will be generated in CHP plants in 2035 and between approx. 4 GW (scenario nEP) and approx. 8 GW (scenarios wwb and POM) in 2050. The number of CCGT plants is reduced here to 3 (scenarios POM and nEP) to 5 (scenario wwb). From the point of view of the distribution grids, this variant is expected to have the greatest load from feed-in. From the point of view of the transmission grid, a similar feed-in-related load is to be expected here as in the C + E variant.

## Future Investment Costs

Below the expected need for investments in the Swiss grids for the period from today until 2035 and until 2050 is given. The demand includes investments in all grid levels, which result both from the forecast changes in supply and demand and from the replacement of the current grid infrastructure due to ageing. It is generally assumed that smart technologies in the form of adjustable local grid transformers will also be used.
Furthermore, the cost calculations for grid level 1 also take into account the multi-year planning of the national grid company Swissgrid (as of 2010). In the meantime - during the term of this study - Swissgrid has updated this multi-year planning and published a "Report on the Strategic Grid 2025". Due to time constraints, this new report could no longer be included in the calculations.

The results presented below also include investments for smart metering and the innovation budgets for intelligent grid solutions.
The presented results of the study (Consentec 2015) estimated grid costs until 2035 and 2050. These values can be taken as a rough estimation for the grid costs until 2030 if the net 0 CO2 goal has to be reached until 2030. More precisely, the grid costs for stock renewal until 2035 (which is needed anyway) and the grid costs for expansion until 2050 are used as benchmark in this report.

**Investment costs with the Energy Strategy 2050**
The need for expansion resulting from the measures according to the ES 2050 is illustrated below using the C+D+E supply variant. This supply variant can be regarded as a "worst case" variant. The results are differentiated according to the three demand scenarios wwb, POM and nEP. In the base case, it is assumed that controllable local grid transformers are used where they can reduce the need for grid expansion due to violations of the voltage range. Other smart expansion variants are not considered.
Table 5-5 shows the calculated investment costs in the Swiss transmission and distribution grids until 2035 for the supply variant C+D+E and for the demand scenarios wwb, POM and nEP compared to the investment requirements without ES 2050. Independent of the supply variant and demand scenario, investment costs for the installation of smart metering components of approximately CHF 0.9 billion and innovation budgets of approximately CHF 235 million to CHF 255 million should be taken into account.

*Table 5-5 Investment costs [Billion CHF] until 2035. The smart meter costs do not include costs for ripple control systems (German: Rundsteuerung). If these costs were taken into account, the above costs would be about 10 % higher. (Consentec 2015)*

| **Verbrauch** | ohne ES2050 (wwb) | wwb | POM | nEP |
|---|---|---|---|---|
| **Produktion / Zubau** | | **C+D+E** | | |
| Übertragungsnetz | | | | |
| Bestandserneuerung | 1,7 | 1,7 | 1,7 | 1,7 |
| Ausbau inkl. Mehrjahresplanung Swissgrid (Stand 2010) | 2,6 | 2,6 | 2,5 | 2,4 |
| Verteilnetz | | | | |
| Bestandserneuerung | 22,4 | 22,4 | 22,2 | 21,5 |
| Einfluss Lastzuwachs | 2,0 | 2,0 | 0,0 | 0,0 |
| Einfluss dez. Erz. | 0,0 | 8,1 | 8,0 | 6,6 |
| Einfluss MKF | 0,0 | 5,2 | 4,9 | 4,7 |
| Smart Meter (Mehrkosten)[9] | 0,0 | 0,9 | 0,9 | 0,9 |
| Innovationsbudgets | 0,0 | 0,2 | 0,2 | 0,2 |
| **Summe** | *28,7* | *43,1* | *40,4* | *38,0* |
| **Mehrkosten ggü. ohne ES2050** | - | *14,4* | *11,7* | *9,3* |
| Zusatzkosten bei non smartem Netzausbau (ohne rONT) | | | | |
| C+D+E (Produktion / Zubau) | - | 1,5 | 1,4 | 1,0 |

The investment costs for the supply variant C+D+E are shown graphically in Figure 5-10. In this supply variant, the additional costs compared to the case without ES 2050 are around CHF 14.4 billion in the demand scenario wwb, CHF 11.7 billion in the POM scenario and around CHF 9.3 billion in the nEP scenario. The higher investment costs compared to the C+E variant are mainly due to the higher expansion of decentralized thermal generation (CHP). Due to the higher expansion of distributed generation, the costs for cabling caused by the additional cost factor are consequently also higher. The additional costs caused by this are, however, rather low compared to the costs for cabling, which are needed anyway, and which are to a large extent determined by the replacement of the current grid infrastructure. In the wwb scenario, for example, they rise from CHF 4.7 to 5.2 billion. In contrast, the investment requirement for the cabling, which is caused by the load-related expansion and the renewal of existing infrastructure, is just as high as in the C+E scenario. If the grid is expanded purely conventionally (non smart), the investment requirement is CHF 1.5 billion higher in the wwb scenario, CHF 1.4 billion higher in the POM scenario and CHF 1.0 billion higher in the nEP scenario. Overall, therefore, by 2035 in the POM scenario and the C+D+E supply variant in the worst-case scenario, additional costs of CHF 13.1 billion will be required as part of the ES 2050 if only conventional expansion is implemented and smart metering systems and innovation budgets are included. However, an expansion that also makes use of controllable local grid substations is more likely (smart variant). In this case, CHF 11.7 billion can be expected by 2035.

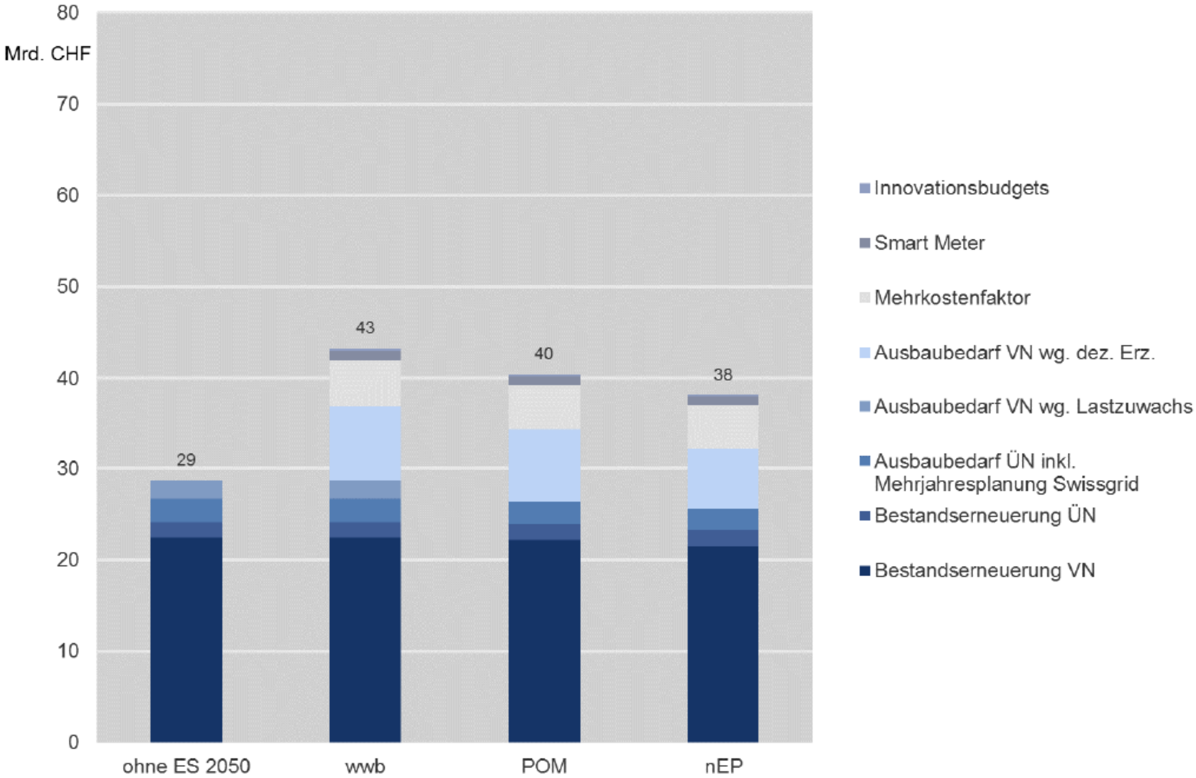



*Figure 5-10: Investment costs of the demand scenarios until 2035, supply variant C+D+E (Consentec 2015)*

Table 5-6 shows the investment requirements in the Swiss transmission and distribution grids up to 2050 for the supply variant C+D+E and the demand scenarios wwb, POM and nEP compared to the investment requirements without ES 2050.

The cost base for smart metering components and innovation budgets, independent of supply and demand scenarios, will increase until 2050. For smart meters, this will be CHF 1.3 billion and CHF 410 to 445 million for innovation budgets.

*Table 5-6: Investment costs [Billion CHF] until 2050 . The smart meter costs do not include costs for ripple control systems (German: Rundsteuerung). If these costs were taken into account, the above costs would be about 10 % higher. (Consentec 2015)*

| **Verbrauch** | ohne ES2050 (wwb) | wwb | POM | nEP |
|---|---|---|---|---|
| **Produktion / Zubau** | | **C+D+E** | | |
| ***Übertragungsnetz*** | | | | |
| Bestandserneuerung | 2,9 | 2,9 | 2,9 | 2,9 |
| Ausbau inkl. Mehrjahresplanung Swissgrid (Stand 2010) | 2,8 | 2,8 | 2,7 | 2,6 |
| ***Verteilnetz*** | | | | |
| Bestandserneuerung | 39,2 | 39,2 | 39,2 | 36,5 |
| Einfluss Lastzuwachs | 3,7 | 3,7 | 0,3 | 0 |
| Einfluss dezentrale Erzeugung | 0 | 12,2 | 12,7 | 9,1 |
| Einfluss MKF | 0 | 7,5 | 7,2 | 6,4 |
| Smart Meter (Mehrkosten)[13] | 0,0 | 1,3 | 1,3 | 1,3 |
| Innovationsbudgets | 0,0 | 0,4 | 0,4 | 0,4 |
| **Summe** | *48,6* | *70,0* | *66,7* | *59,2* |
| **Mehrkosten ggü. ohne ES2050** | - | *21,4* | 18,1 | *10,6* |
| **Zusatzkosten bei non smartem Netzausbau (ohne rONT)** | | | | |
| C+D+E (Produktion / Zubau) | - | 2,4 | 2,2 | 1,5 |

The investment costs up to 2050 for the three demand scenarios in the C+D+E supply variant compared to the case without ES 2050 are shown in Figure 5-11. In scenario wwb, the investment costs are CHF 21.5 billion higher than in the case without ES 2050. In the POM scenario these additional costs are CHF 18.2 billion. In the nEP scenario, the additional costs compared with the case without ES 2050 add up to CHF 10.7 billions and are thus only about CHF 0.8 billions higher than in the C+E variant. What is interesting in the C+D+E variant is that the cost difference between the nEP and POM scenarios is much greater than in the C+E variant. Scenario POM in variant C+D+E is about 12 % more expensive than scenario nEP, while this difference is only about 7 % in variant C+E. This can be explained by the different expansion requirements resulting from the increase in decentralized generation plants. In the supply variant C+D+E, the expansion requirement increases by approx. 51% in the scenario wwb compared to 2035 and by approx. 59 % in the scenario POM. In the nEP scenario, however, the increase in costs is only approx. 39 %. In supply variant C+E, the expansion requirement in this period increases by approx. 33 % in scenario wwb, by approx. 41 % in scenario POM, and by approx. 52 % in scenario nEP due to the addition of distributed generation plants. This means that in supply variant C+D+E, the increase in expansion demand from 2035 to 2050 due to the addition of distributed generation plants is higher in scenarios wwb and POM than in supply variant C+E, whereas in scenario nEP this increase is lower in supply variant C+D+E than in supply variant C+E. This in turn can be explained by the different expansion paths for decentralized CHP plants in supply variant C+D+E. While until 2035 in all three demand scenarios CHP generation plants are built up to a similar extent, and this increase is continued in the demand scenarios wwb and POM until 2050, the decentralized CHP plants are reduced in the scenario nEP until 2050. This decommissioning in turn is caused by the decline in load and consumption predicted in the demand scenario nEP from today until 2050. The total expansion requirement for distributed generation plants is thus essentially determined by the expansion of distributed renewable generation plants. If the grid expansion were to be conventional (non smart), additional costs of approx. CHF 2.4 billion would be required by 2050 in the wwb scenario, CHF 2.2 billion in the POM scenario and CHF 1.5 billion in the nEP scenario.

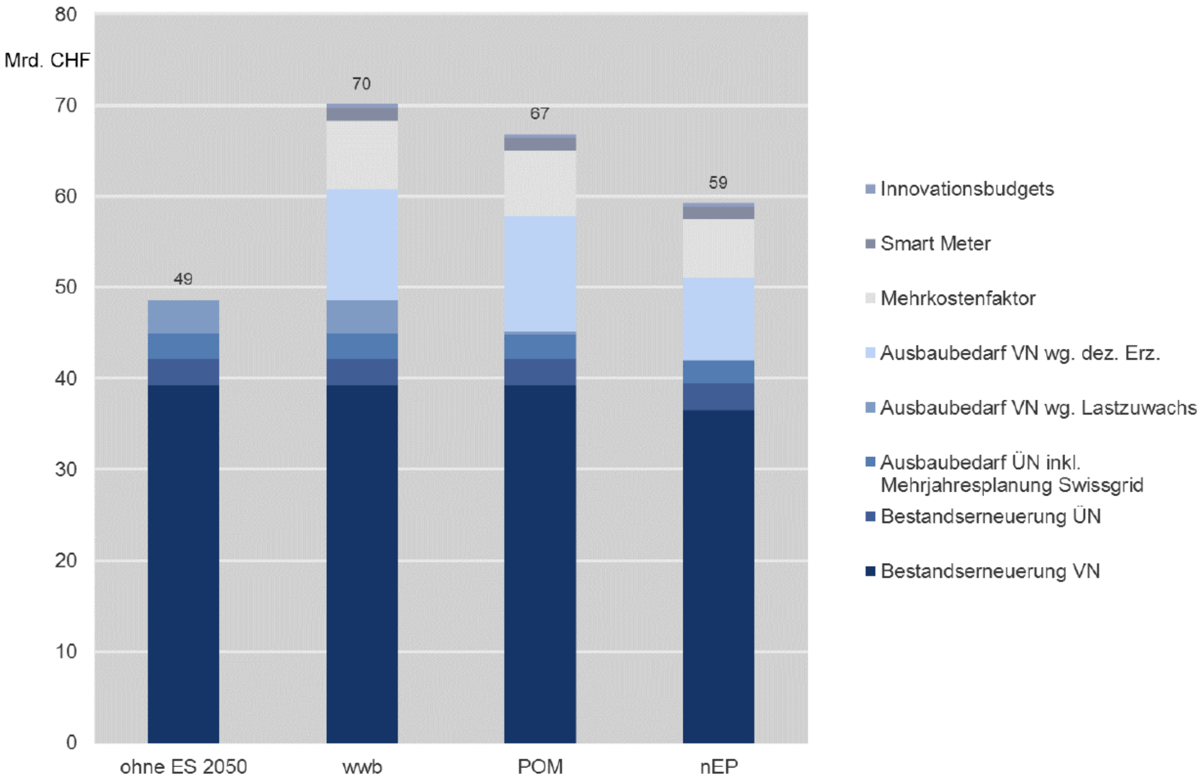


*Figure 5-11: Investment costs of the demand scenarios until 2050, supply variant C+D+E (Consentec 2015)*

# Storage

*Source of the texts and figures of this section: BFE 2013, Energiespeicher in der Schweiz, Bedarf, Wirtschaftlichkeit und Rahmenbedingungen im Kontext der Energiestrategie 2050.*

In September 2013 the Federal Council presented planned measures within the framework of the Energy Strategy 2050 in a message to the parliament. Energy storage plays an important role within the framework of the Energy Strategy 2050. Since generation from stochastic energy sources does not necessarily correspond to consumption in terms of time, there is an increased need for interim storage of (electrical) energy. Energy storage must be further developed, on the one hand, by promoting research and, on the other, by adapting the regulatory framework for the electricity market.

To describe the potential contribution of storage technologies to the transformation of the power supply, the study (Hewicker et al. 2013) estimated the demand for different storage technologies in the context of the Energy Strategy 2050.
The study showed that, in addition to traditional pumped storage, several other technologies are now available or are expected to become commercially available in the foreseeable future. Most technologies are limited to short-term applications (hours to max. several days), with the exception of power-to-gas technology and potentially seasonal heat storage. The use of these technologies is limited in most cases by high capital costs, whereby a considerable cost degression is expected especially for battery storage.

In this section, a technology overview is given, and potential applications are shown. The required decentralized storage capacity in the distribution grid is estimated. Further demand for storage at system level is analyzed.

## Technology Overview and Potential Applications

The storage of electricity is still dominated by pumped hydroelectric energy storage systems, which represent around 99 % of the installed capacity worldwide. This technology is well known and has been in use for decades, as is also the case in Switzerland. However, its expansion is linked to geographical conditions. In addition to pumped hydroelectric energy storage plants, compressed air storage systems, fly wheels and various battery technologies are now in commercial use worldwide. Other storage technologies are under development, some of them in an advanced phase, so that they will be commercially available in the near future. In the context of the study presented here, the following energy sources and technologies were considered: Chemical, kinetic, electrostatic, electromechanical, thermal.

In addition to the energy carriers used, the storage technologies differ in particular with regard to a number of technical properties. For the use in power supply the storage capacity (energy), the storage power, the efficiency as well as the reaction speed and the lifetime or aging are relevant. The storage capacity describes the maximum amount of energy that can be stored by the storage system, while the storage power describes the maximum charge/discharge power provided by the storage system.

In practice, a distinction is made between several power classes with regard to the size of a storage device, which refer to the maximum available discharge power. These range from micro-storage systems used in decentralized applications, through medium-sized storage systems at the medium and high voltage level, to large storage systems connected to the extra high voltage level. In the same way, various possible application areas for electricity storage systems can be identified. These range from ultra-short term storage in the range of a few seconds to minutes for voltage and frequency control, through classic daily storage for load leveling or balancing fluctuations in the feed-in of supply-dependent renewable energies, to seasonal storage.

As shown in Table 5-7, unconventional power storage systems, with the exception of power-to-gas technology, are only suitable for short-term applications. The majority of potential storage technologies are therefore not available for medium to long-term storage, e.g. for balancing fluctuating production from supply-dependent renewable energies. In contrast, batteries in particular are very well suited for providing system services.

*Table 5-7: Overview of potential applications of storage technologies by power class and storage duration (source: "Energiespeicher in der Schweiz", BFE 2013)*

| | Mikrospeicher | Kleintechnische Speicher | Mitteltechnische Speicher | Grosstechnische Speicher |
|---|---|---|---|---|
| | ≤ 100 kW | 1 - 10 MW | 10 – 100 MW | 100 - 1.000 MW |
| Monate | | | | Power-to-Gas |
| Tage / Wochen | | | Pumpspeicher | Pumpspeicher<br>Power-to-Gas |
| Stunden / Tage | Batterien | Batterien | Pumpspeicher<br>Druckluftspeicher<br>Elektrothermische Speicher<br>Batterien | Pumpspeicher<br>Druckluftspeicher<br>Elektrothermische Speicher |
| Minuten / Stunden | Batterien | Batterien | Elektrothermische Speicher<br>Batterien | Pumpspeicher<br>Druckluftspeicher<br>Elektrothermische Speicher |
| Sekunden / Minuten | Superkondensatoren, Spulen | Schwungräder<br>Batterien | Batterien<br>(Pumpspeicher)<br>(Druckluftspeicher) | (Pumpspeicher)<br>(Druckluftspeicher) |

## Decentralized Storage Systems

Especially for rural grids, a technically required storage requirement to avoid unacceptable grid overloads can be expected. This is particularly true in the case of a high level of additional decentralized, supply-dependent generation technologies, which will cause local overloading of the distribution grids with a comparatively high demand for decentralized storage solutions.

For distribution grids with a high load density, i.e. mainly in urban areas, on the other hand, no technical storage requirements could be identified. Due to generation close to consumption and a grid design for high loads, the urban grids considered in the modelling do not reach the limits of their capacity on the grid levels 6 and 7 or 4 and 5. Even the installation of electric vehicles does not lead to grid overloading given the assumed number of vehicles and charging strategies (an area-wide expansion of fast charging stations, which was considered in a sensitivity analysis, leads to overloads from about six fast charging stations per urban grid area and thus to theoretical storage requirements. However, in the case of grid overloads caused by electric vehicles, it is possible to use the storage integrated in the vehicle as mobile storage by means of intelligent controlled charging). Although in individual cases additional measures, e.g. to maintain voltage stability, may still be necessary, the expected storage requirement in distribution grids with a high load density can be estimated as low.

The highest storage demand was identified for the combinations NEP/E (and NEP/CE), as Table 5-8 indicates. The combination of low load, caused by the expected effects of the efficiency measures in the demand variant NEP, combined with the high increase in renewable production capacity in the supply scenario E leads to a necessary storage power of up to about 1600 MW with a storage capacity (energy) of about 6600 MWh. The majority of the storage demand arises at the low voltage level. There, due to the grid design and the expected increase in decentralized production capacity, storage demand is mainly found in rural areas. If the power flow from the low voltage level to the medium voltage level is reduced at the low voltage level through the installation of storages, the result is only a small storage demand at the grid levels 4 and 5. This shows the different effects of the installation of storage systems compared to grid expansion. The grid expansion could enable higher power flows from the low voltage level to the upper voltage levels and thus the loading would be passed to upper grid levels. On the other hand, a storage system can reduce the loading close to the source.

*Table 5-8: Storage demand in the distribution grid according to scenario NEP/E (Energiespeicher in der Schweiz, BFE 2013)*

| | Storage power [MW] | Storage energy [MWh] |
|---|---|---|
| Grid levels 6 and 7<br>Urban grids<br>Suburban grids<br>Grids in the mountains<br>Rural grids | <br>0<br>200<br>310<br>925 | <br>0<br>560<br>1310<br>4330 |
| Total | 1435 | 6200 |
| Grid levels 4 and 5<br>Urban grids<br>Rural grids | <br>0<br>180 | <br>0<br>400 |
| Total | 180 | 400 |
| Total needed storage in the distribution grids | 1620 | 6600 |

The values in Table 5-8 are based on an estimate of a benchmark for the design of storage systems that are not designed to store all surplus energy, but can store about 2/3 of the surplus energy over the entire year. Furthermore, the stated storage capacities are to be understood as net values in the sense of a completely usable storage capacity. A reduction in the depth of discharge would therefore require a corresponding increase in overall capacity. With a depth of discharge of 80 %, an increase in the number of cycles of the storage systems could be achieved, and the storage capacity would increase by about 25 %.

Due to the number of cycles as well as the need for storage power and storage capacity (energy), battery storage is a suitable storage technology in the low voltage grid. In addition, the relatively small space requirement and scalability are advantages of a battery system. Battery storage systems have not yet been used in large numbers in low-voltage grids, but there has been an increase in the number of suppliers of storage systems for self-generated PV electricity as a result of developments in Germany.

## Storage on System Level

In addition to the storage demand for the integration of the decentralized production technologies into the Swiss distribution grids, the further demand for storage was analyzed at system level. Under the assumption that the regulation of decentralized production due to an overfeed of the entire system should be avoided and all surpluses in Switzerland should be stored, a storage requirement at system level results. With the help of these storage facilities, surpluses can be absorbed, and it can be prevented that decentralized, renewable plants are curtailed due to an energy surplus. The excess energy is in particular due to the feed-in from wind and photovoltaic energy. In combination with the production of run-of-the-river hydroelectric plants, production can significantly exceed Swiss consumption.

If the energy surpluses of the Swiss energy supply system have to be absorbed by storage systems without international exchange, an appropriate storage design is necessary. The theoretical storage power and capacity (energy) required in addition to storage at distribution grid level is shown in Table 5-9. In this context, a purely national approach would result in a massive storage requirement at system level in 2050 for the C&E and E supply variants under consideration. Storage facilities with a storage capacity of up to 680 GWh and a storage power of about 8000 MW would be required to cover all surpluses in Switzerland. The very high values of the isolated consideration of Switzerland are particularly due to the above-mentioned energy surpluses in the low load periods of summer.

An extension of the analysis to include transmission capacities to adjacent electricity supply systems offers potential for reducing the storage requirements of the Swiss system. For this purpose, Table 5-9 lists the storage parameters of the storage systems at system level, in order to be able to store surpluses that would have to be curtailed due to a lack of national and international demand. A considerable reduction in storage requirements at system level can be observed by including exchange capacities with neighboring countries. Simultaneously high production from wind and PV and the minimum production volumes of, for example, geothermal energy and run-of-the-river hydroelectric power plants can cause long periods of surplus within Switzerland. The duration and quantity of surplus energy can be reduced by using export capacities, since neighboring electricity supply systems are available for the exchange of supply-dependent production quantities due to different production structures and weather conditions. This results in a required storage power in the range of almost 7000 MW for the E supply variants, while the storage capacity would have to be 62 GWh to absorb all Swiss surpluses.

*Table 5-9: Theoretical storage requirements at system level without and with cross-border exchange (Energiespeicher in der Schweiz, BFE 2013)*

| | national only | | with exchange | | reduction by exchange | |
|---|---|---|---|---|---|---|
| | Power [MW] | Capacity [GWh] | Power [MW] | Capacity [GWh] | Power [%] | Capacity [%] |
| Scenario NEP-E | 8025 | 680 | 6850 | 62 | 15 | 90 |

However, the question of the dimensioning of the storage parameters arises, if not the entire surplus has to be stored. Due to the diversity of surplus events at system level, the premises used for the distribution grid level are no longer valid here. Storage of all surpluses still does not seem reasonable. An analysis of the storage capacity that makes sense from an economic point of view cannot be made plausible without model-based optimising at system level. Therefore, we refer at this point to the results on the profitability of the storage power plants, which are further examined in Module C of the presented study (Hewicker et al. 2013).

Large-scale storage systems are suitable for storing energy surpluses of the overall system. However, to store the system surpluses in the NEP/C&E and POM/C&E scenarios, additional storage capacities are required that exceed the sum of the currently installed and planned pumped storage capacities. The obvious approach here is to include the storage capacities of the large storage reservoirs of seasonal storage. The currently installed and planned Swiss pumped storage plants have a typical storage capacity that allows a discharge duration in the range of 12 hours. Storage of longer-term surpluses requires a much higher storage capacity. In principle, the storage reservoirs could meet this requirement. However, in order for surpluses to be stored, firstly, the usability of the storage reservoirs would have to be verified on the basis of an analysis of the annual development of the filling levels and the surpluses that occur, and secondly, the power plants of the reservoirs would have to be equipped with a pumping system and existing reservoirs would have to be extended or new reservoirs built at great expense.

Power-to-gas is the only technology presented here that offers the prospect of a seasonal large-scale storage facility. However, short-term storage is also possible (e.g. in the weekly range). In terms of storage capacity, significantly larger classes are feasible than for pumped storage or compressed air storage, as gas storage facilities already in use today can be used.

# 6 Agriculture and Food System

# Vision

Our vision for the food system is to supply all people living in Switzerland with healthy food meeting their demands for nutrients and well-being in a sustainable way. The latter must allow the following generations to produce enough food for them with the same intensity. It is a food system in which producers get recognition for their important work, have a fulfilling job with a good income. Consumers have access to food but also education about nutrition, the way food is produced and processed and best also about how it is handled and experienced in a cultural context.

A sustainable and healthy diet is the focus of all policy measures proposed.
These changes are part of a policy framework which supports climate friendly production practices, shifts subsidies in the direction of a plant-based diet and allows us to get away from the dependence on highly polluting methods. Its aim is to enable a sustainable food production considering the evident complexity of the issue and the relations and interactions between agriculture, the environment, society and the economy. It is essential that the issues are addressed in all the proposed fields at the same time. If we omit one of these points, or concentrate only on certain, we run the risk that it can negatively compensate all the efforts in the other fields.

A sustainable diet consists of a much larger share of plant-based products, compared to today's consumption patterns. Animal products in the diet will be reduced to one third compared to the present situation. Luxury and unhealthy food items like alcohol, sweets, chocolate, cocoa will have a much lower share in our diet and thus reduce fatalities due to illness caused by malnutrition.

Switzerland will further use grasslands for animal production. Ruminant production in Switzerland will be regulated by the amount of grassland available and fodder imports or domestic fodder production will be cut to zero. Greenhouses in Switzerland are only heated by waste energy from industrial processes or if really needed by renewable local energy.

Agricultural practice will follow guidelines for an optimized production from an environmental point of view while considering global food security and social justice and not to optimize profit rates.
The ecosystem boundaries shall be at the basis of decision-making with technical, social and economic aspects adjusted accordingly. The integration and common long-term vision of a sustainable food system must be shared by all stakeholders namely farmers, the processing industry, retailers, consumers and politicians. Future development shall be characterized by a common understanding and a common will for sustainable solutions.

# Current Situation

## Greenhouse Gas Inventory of Swiss Agriculture

According to the national greenhouse gas (GHG) inventory, agriculture causes approximately 15 % of all Swiss GHG emissions. In the year 2017, the agriculture sector as defined by the 2006 IPCC Guidelines for national GHG inventories encompasses an amount of 6.08 Mt CO2 eq. (FOEN 2019). Major emission sources are methane emissions (CH4) from enteric fermentation (3.29 Mt CO2 eq.) and emissions of nitrous oxide (N2O) from agricultural soils (1.58 Mt CO2 eq.). Both these gases are also released during storage of livestock manure (0.75 and 0.41 Mt CO2 eq. respectively). Less important are emissions of CO2 from application of lime and urea (0.05 Mt CO2 eq). In addition to these sources, other emissions are related to agricultural production that are assigned to other sectors in the greenhouse gas inventory. CO2 emissions from the combustion of fossil fuels in agricultural machinery and buildings amount to 0.63 Mt CO2 eq. Furthermore, carbon stock changes of agricultural soils which are reported in the “Land Use, Land-Use Change and Forestry” (LULUCF) sector are also relevant. Whereas organic soils are a major source of CO2 (0.59 Mt CO2 eq.) It is assumed that carbon stocks in mineral soils are more or less balanced (see chapter Negative Emissions). Finally, a small amount of GHGs is also emitted during incineration of agricultural waste, from losses in agricultural biogas plants and during field composting (0.04 Mt CO2 eq.).
Furthermore, emissions of around 0.81 Mt CO2 eq. are incurred during the production of agricultural inputs abroad, in particular mineral fertilizers and animal feed. These emissions are not accounted for in the Swiss GHG inventory but allocated to the countries of origin in accordance with the international guidelines in climate reporting (territorial principle).

This sectoral perspective of emission inventories is limited and must be extended when assessing GHG emissions of the whole food sector in an integral way. Adopting a consumption perspective all emissions related to food processing and transport as well as emissions related to food imports and export must be considered. Under this perspective, it is apparent that more than half of all GHG emissions related to food consumption in Switzerland are originating from abroad (Bretscher et al. 2014). Nutrition turns out to be one of the most relevant consumption categories ranking third after “mobility” and “housing and energy” (Jungbluth et al. 2011; BFS 2018).

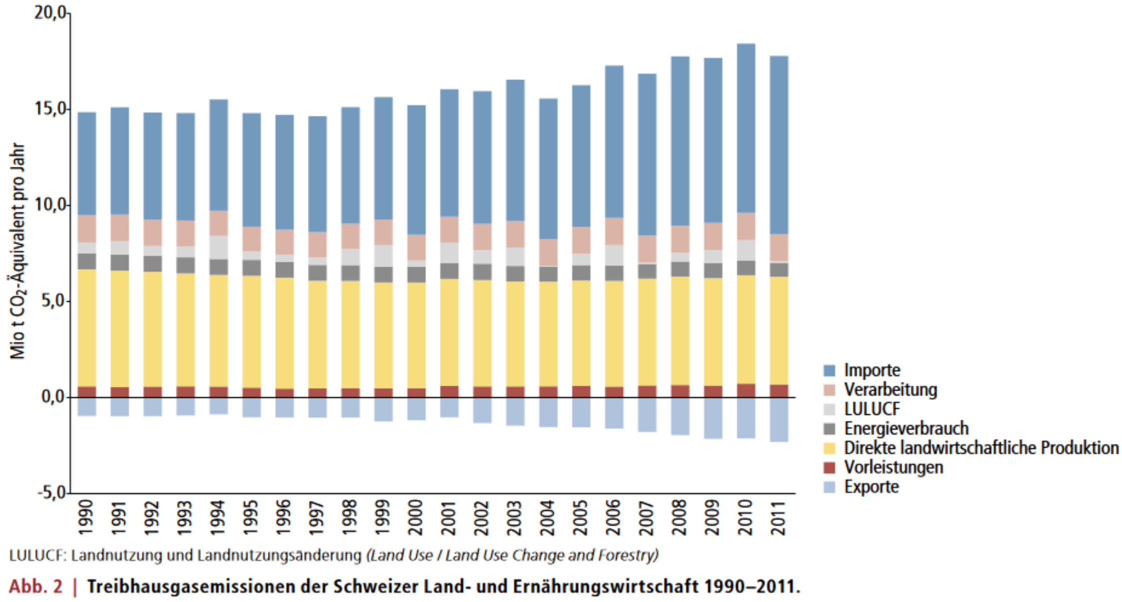


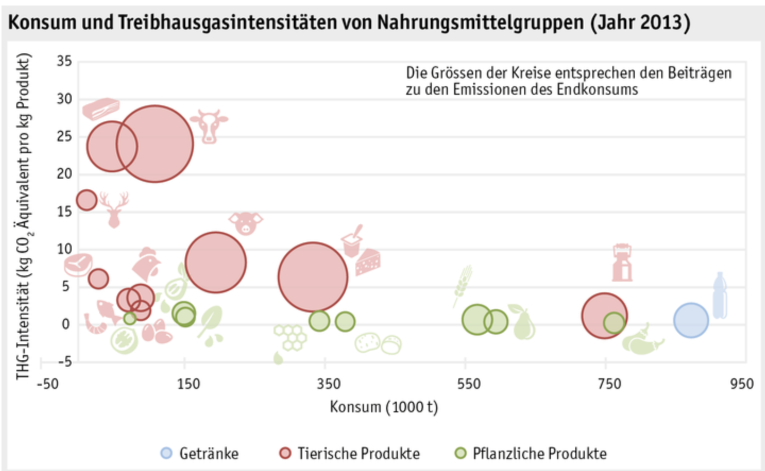

*Figure 6-1 Greenhouse gas emissions of the Swiss agricultural and food industry 1990-2011*

## Import

According to pilot estimates by the Swiss Federal Office for Statistics, 65 % of the GHG-footprint of Switzerland is generated by imports (including Food & Non-Food). The emissions of imported food products (including non-alcoholic and alcoholic beverages and tobacco) amounts to about 12 million tons of CO2 equivalents (FSO 2020a). In addition to production-related emissions, imported food has significantly higher emissions if transported by plane or if associated with deforestation. About 80% of deforestation it is caused by agriculture, for example to produce palm oil, meat and soy (animal feed for meat and milk production) (Kissinger, Herold, and De Sy 2012). Three products which are also of large importance in the Swiss food system.

## GHG Emissions According to Different Diets

From a food system point of view, the GHG emissions coming from the diet are substantial. Especially over consumption of certain foods are increasing GHG emissions significantly. Mostly meat products, first and foremost meat from ruminants, are contributing very much to the overall GHG emissions (see Figure 6-2).




Quelle: Agroscope

*Figure 6-2 Consumption and greenhouse gas intensities of food groups*

Bretscher et al. (2018) estimate that animal husbandry is responsible for approximately 85% of all agricultural greenhouse gas emissions in Switzerland, 75% alone by cattle livestock. CH4 emissions from enteric fermentation of ruminants is by far the most important single emission source followed by emissions from feed production (mainly N2O emissions from manure fertilizers). The outstanding relevance of livestock is also apparent when assessing the GHG footprint of food consumption in Switzerland. More than 80% of the emissions related to food consumption in Switzerland are due to the production of livestock-based food items (D. Bretscher, Lansche, and Felder 2015).

# Food Waste

According to Beretta and Hellweg (2019), in Switzerland, each year about 2.8 million tonnes of avoidable food loss (food intentionally produced for human consumption which never gets consumed) is occurring across all stages of the Swiss food chain. This equals about 330 kg of avoidable food waste per person and year and about 37% of all agricultural goods produced for consumption in Switzerland (inland and abroad). The climate impact of avoidable food waste equals about 24% of the GHG emissions produced by the entire Swiss food system. Dividing the climatic impact into the main stages of the food chain, about 11% can be attributed to losses occurring at the stage of agricultural production, 30% to industrial food processing, 7% to food retailers, 12% to gastronomy and 40% to the stage of private households. The largest climate impact is caused due to losses of bread and bakery products, cheese, beef and fresh vegetables.

# International Agricultural Trade

Considering not only the Swiss GHG emissions within Switzerland but also worldwide, global agricultural businesses with their headquarters in Switzerland can be crucial.

Switzerland is a hub for international commodity trade. Every year billions of tons of both agricultural and non-agricultural commodities are traded through Switzerland without ever crossing the Swiss border. Recent estimates indicate that Swiss-based companies buy and sell roughly 50% of globally traded grain, 40% of sugar, 30% of cocoa, at least 30% of coffee and at least 25% of cotton (Braunschweig, Kohli, and Lan 2019). Many of these companies have moved beyond the mere trading of agricultural commodities though and tend to exert increasing influence on many stages of the agricultural value chain nowadays. This increasingly includes, but is not limited to, direct involvement of Swiss agricultural traders in the production of agricultural commodities outside Switzerland. Mergers and acquisition have allowed few giant multinational trading companies, among which many are Swiss-based, to rapidly expand their activities and consolidate their power at the expense of farmers and agricultural workers in commodity-producing countries (Braunschweig, Kohli, and Lan 2019).

The recent surge in commodity trading has generated high tax revenues for the Swiss state. The environmental impacts of the extraction, production and transport of all commodities traded by Swiss companies, on the other hand, have been found to be 19 times larger than the ones caused by total Swiss consumption (Jungbluth and Meili 2018). (The study by Jungbluth and Meili (2018) only partly covers the emissions caused by the transport and storage processes that are associated with trade.) Similarly, the agricultural trading sector in Switzerland remains extremely opaque. The lack of transparency is the corollary of the ongoing efforts by the Swiss government to grant trading companies a very discrete and business-friendly environment. Under these lax transparency regulations, the latter have no pressure to disclose concise data on their trading activities and the potential social and environmental repercussions they entail.

The implications of Switzerland´s dominant position in the global agricultural commodity market are two-fold. Firstly, Swiss trading companies´ decisions about which products they buy and sell can make a considerable contribution to the goal of cutting down emissions produced by the global agricultural sector. Secondly, and closely related to the first aspect, Swiss trading companies have both the opportunity and thus the responsibility to shape international commodity trade sustainably. Swiss companies need to acknowledge their responsibility for the negative side effects of their trading activities and try to mitigate these accordingly.

# Global Food Security and Climate Change

According to the FAO (2003), food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. The global food system and thereby food security is under pressure from non-climate stressors (e.g., population and income growth, demand for animal-sourced products) and from climate change. These stressors impact all aspects of food security, namely food availability, access, utilisation and stability (Mbow et al. 2019b). Climate change already affects global food security through increased temperatures, changing precipitation patterns as well as the occurrence of extreme climatic events (e.g., droughts and heat events). Food security will be increasingly affected by the projected changes in climate. Until the year 2050, a 1-29% increase in the global cereal price is expected, severely increasing the risk of hunger for low-income consumers (Mbow et al. 2019a). Agricultural production and thereby food availability will further be affected by altered distribution of pests and diseases and the negative impacts of more frequent and severe extreme climate events (Mbow et al. 2019a).

# Agrofuels

Fossil fuels are infamous for their considerable contribution to global warming. This is mainly due to the emissions that are caused when extracting, transporting and consuming (=combusting) oil, natural gas and coal. In light of these negative environmental impacts of fossil fuels, as well as the oil price spikes in 2008 and 2011, agrofuels have been praised as a green, affordable alternative that help mitigate climate change. Agrofuels refer to the production of ethanol, methanol, hydrogen and diesel from vegetable biomass (but excluding biogas or energy produced e.g. with crop residues or compost on smaller scales). Over the past years, different methods of agrofuel generation have been employed: The first generation of agrofuels describes agrofuel that is generated from feedstocks. i.e. annual and perennial edible crops that are cultivated to generate diesel and ethanol. Agrofuel feedstocks encompass a variety of common crops, including maize (corn), sweet potato, sugar cane, palm oil and oil seeds. The second and third generation use lignocellulosic biomass and microalgae to produce agrofuel. The overwhelming majority of agrofuels used today is still generated from the cultivation and processing of edible crops though (Correa et al. 2017).
A strict set of import rules have prevented agrofuels to obtain a noteworthy market share in Switzerland for a long time. For example, the revised 2016 version of the Mineral Oil Tax Law Imports states that only those imported agrofuels may be exempted from the mineral oil tax that meet stringent ecological and social criteria. Imports of agrofuels have increased notably during the past decade though. This upsurge has been largely driven by legal amendments in 2014 which allow importers of fossil fuels to use agrofuels to compensate partly for emissions generated by the combustion of fossil fuels in Switzerland´s domestic traffic. Current figures by the Federal Customs Administration indicate that roughly one quarter of fuels sold in Switzerland contain biocomponents. While agrofuels play an ever-more important role in Switzerland, there is extremely scarce knowledge about the specific agricultural raw commodities from which the agrofuels used in Switzerland are made, under which conditions these raw commodities are produced and which Swiss-based companies participate in the trade of agrofuels. The same is true for the production of biocomponents which are mixed with conventional fuel before being sold on Swiss markets. This blatant lack of transparency prevents a thorough assessment of Swiss-consumed agrofuels´ environmental and social sustainability.

In spite of widespread initial euphoria concerning the alleged superiority of agrofuels vis-à-vis fossil fuels scholars and other experts have voiced skepticism as with regard to agrofuels´ "renewability and cleanliness" for different reasons (Ji and Long 2016):
Firstly, as indicated above, the huge amounts of crops cultivated to produce agrofuel could equally be used for human consumption. The upsurge in the international demand for agrofuel production has entailed violent incidents of land grabbing in Africa, Latin America, Eastern Europe and Asia (GRAIN 2015), squeezed the area that contributes to human food supply and obviously entailed an increase in prices for different food crops, including oilseeds (Correa et al. 2017; Rosegrant et al. 2008; Ji and Long 2016). Ultimately, agrofuels thus have strong potential to deplete the income of millions of households due to land grabbing and destroy large areas of tropical forests, pastures and meadows. Secondly, depending on the circumstances such as climate, soil fertility and the type of agrofuel feedstock cultivated, the amount non-renewable energy that is needed in the agrofuel production and transport process surpasses the quantity of energy agrofuel provides (Ji and Long 2016). Thirdly, the widely spread first generation agrofuels need large quantities of pesticides and fertilizers which all pose an immediate threat to vertebrates populations, species richness and biodiversity as a whole (Correa et al. 2017; Sreevani 2019). This threat is exacerbated by the fact that many agrofuel feedstock plantations are monoculture plantations. Fourthly, agrofuel feedstocks require huge amounts of water (FAO 2008; Jewitt and Kunz 2011; Ji and Long 2016). Finally, there is evidence that the increased competition between agrofuels and fossil fuels decreases the prices for the latter (=positive rebound effect) (Allaire and Brown 2015; Ji and Long 2016). Low fossil fuel prices, however, spur economic activity which in turn increases pollution levels.
The detrimental environmental and social consequences of agrofuel production sketched above threaten to be amplified by the plans to use agrofuels in aviation. Aviation is responsible for roughly 2% of the planet´s annual CO2 emissions. This figure is likely to increase in the future as experts anticipate annual passenger figures to soar until 2050 (Terrenoire et al. 2019). The excessive operation of airplanes thus represents a major obstacle to climate change mitigation. Comparable to the situation in the automobile sector, agrofuels have been identified as an viable alternative for conventional fossil fuels in terms of their environmental sustainability (Hari, Yaakob, and Binitha 2015). Many governments around the world share this positive view and provide considerable financial means to research and testing programs that shall help agrofuels achieve aviation market maturity (Cremonez et al. 2015; O'Connell, Kousoulidou, and Lonza 2019). The Swiss government has equally embraced sustainably produced agrofuels in aviation as a potential element of a coherent climate change mitigation strategy. At the same time, it has not outlined the extent to which it will actively promote agrofuels in the aviation sector in the future. Any decision in this regard will arguably depend on the content of Switzerland´s revised CO2 Act (UVEK 2019). In the meantime, the managers of Zurich-international airport have celebrated the first airplane ever having been filled up with a blend of conventional fuel and agrofuel in Zurich in January this year (Zürich 2020). This clearly indicates that the operation of airplanes on agrofuels starts becoming reality in Switzerland.
The proponents of agrofuels in the aviation industry tend to ignore or talk down the detrimental environmental and social consequences the conversion to agrofuels in the aviation sector would entail in the countries of production. The aviation industry would require incredible amounts of agrofuels every day to refuel only a small proportion of the thousands airplanes which are used for transport of goods and people nowadays. Large-scale production of agrofuels that satisfy this huge demand would accelerate deforestation, biodiversity loss, water depletion and pollution and land grabbing, and undermine food security in producing countries (Hari, Yaakob, and Binitha 2015). Along these lines, a significant and permanent reduction in the number of flight movements is the only viable way to ensure that the aviation industry attains the Paris Agreement´s objectives. (For more information on aviation, see chapter Mobility.)
Overall, the production of agrofuels undermines global food security and accelerates deforestation and biodiversity loss only to fill tanks. We acknowledge though that microalgae-based agrofuels seem to be superior to traditional agrofuels. The former seems to require less direct and indirect land use

change, works well on non-arable land and without pesticides, does not compete with the cultivation of food crops and saves water (Correa et al. 2017; 2019; Klinthong et al. 2015; Voloshin et al. 2016). Some contributions, on the other hand, highlight prevalent weaknesses in the current microalgae agrofuels production process including the large quantity of energy required (Dasan et al. 2019).

# Speculation with Agricultural Commodities and Food

The global food market has seen major price swings in agricultural commodity prices over the past two decades, with food prices hitting a high point in 2008 and 2011, respectively. These price spikes have pushed millions of people in Sub-Saharan Africa and the Middle East below the poverty threshold and incited food riots in poverty-stricken regions (Cochrane, Adams, and Kunhibava 2015). Both the price swings on the global agricultural commodity market and the food price spikes have coincided with a doubling of financial flows into the food commodity markets between 2006 and 2011. A considerable share of these new financial inflows can be attributed to speculators who bet on price developments in the global food market to benefit from the volatility in food prices. It is the co-occurrence of these developments that nurtures concerns among experts and students with regard to the distortive impact of unregulated speculation on food commodity prices.

In the beginning, contracts on future deliveries of agricultural products at a spot price that is fixed before the actual crop is harvested have proven to be an effective tool for farmers to hedge against adverse future price changes. Things have considerably changed though with the massive deregulation of commodity trading in the 2000s, first and foremost in the US. Under these relaxed rules new speculators with very distinct economic interests have rapidly increased their level of activity on the future markets in the field of agricultural commodities. Banks, hedge funds and pensions have no interest in actually possessing the agricultural crops but merely hope that food prices will increase or decrease in the time between they draw a future contract and the expiry of that contract.

Different empirical studies indicate that food speculation can dramatically amplify the detrimental effects of factors such as weather extremes or surging world market prices for fossil fuels that often precede food price spikes (Lagi et al. 2011; 2015; Herman, Kelly, and Nash 2011; Tadesse et al. 2013; UNECTAD 2009). In a nutshell, due to investors' activity, the pronounced volatility in agricultural commodity prices does not mirror demand and supply, but speculators' expectations about how the price will develop. The resulting jumps in food prices are a major concern for producers and consumers who need stable food prices to plan ahead. Moreover, speculators' attempts to fill their own coffers, result in artificial price spikes that breed poverty and malnutrition in many developing countries where millions of people spend the lion's share of their income on food.

# Swiss Agricultural Policies

Three different aspects of Swiss agricultural policies and laws were detected to have a direct impact on the $CO_2$ emissions produced in Swiss agriculture.

First of all, the Direct Payments (Table 6-1) regulated within the Agriculture Act are a big part of Swiss farmers' income and therefore have a huge impact on the way agricultural goods are being produced. Within this legislation frameworks for agricultural production, standards that have to be met to get financial basic support are defined (Proof of Ecological Performance – ÖLN/PER). Furthermore, payments are possible if other, higher standards are met. However, the ecological requirements (ÖLN/PER) the farmers have to fulfill to receive these payments are in most cases based on self-declaration of data that are difficult to quantify. Monitoring and enforcement of the proof of ecological performance is thus difficult and offers many loopholes. In addition, those requirements are mostly not higher than what the legal basis is demanding anyhow. Some of the requirements do not even meet the existing environmental law. Key Elements of the Proof of Ecological Performance are a balanced fertilizer regime (Suisse-Bilanz) and a minimal ecological compensation area of 7%. (FOAG 2018)

*6-1 Payment framework for direct payments in agricultural policy 18-21* (Schweizerische Eidgenossenschaft 2016)

| (in Mio. CHF, mit Rundungsdifferenzen) | B 2016 | 2018 | 2019 | 2020 | 2021 | Total |
|---|---|---|---|---|---|---|
| Versorgungssicherheitsbeiträge | 1095,0 | 1055,7 | 1055,7 | 1055,7 | 1055,7 | 4222,8 |
| Kulturlandschaftsbeiträge | 505,0 | 530,0 | 530,0 | 530,0 | 530,0 | 2120,0 |
| Biodiversitätsbeiträge | 400,0 | 400,0 | 400,0 | 400,0 | 400,0 | 1600,0 |
| Landschaftsqualitätsbeiträge | 130,0 | 150,0 | 150,0 | 150,0 | 150,0 | 600,0 |
| Produktionssystembeiträge | 455,0 | 467,0 | 472,0 | 477,0 | 480,0 | 1896,0 |
| Ressourceneffizienzbeiträge | 45,0 | 72,0 | 77,0 | 82,0 | 87,0 | 318,0 |
| Übergangsbeiträge | 179,0 | 78,1 | 59,3 | 49,3 | 41,3 | 228,0 |
| Total | 2809,0 | 2752,8 | 2744,0 | 2744,0 | 2744,0 | **10 985** |

A third of all the direct payments paid in Switzerland indirectly supports costly, not necessarily sustainable farming practices that would otherwise be too expensive. For instance, livestock husbandry, currently causing the major part of GHG emissions, is heavily subsidized within the Direct Payments. Contributions for the assurance of food supply (Versorgungssicherheitsbeiträge/ Contributions à la sécurité de l'approvisionnement/ Contributi per la sicurezza dell'approvvigionamento) ask for a minimal number of livestock grazing on permanent grasslands. Various subsidies, originally thought to promote animal welfare and sustainable livestock husbandry, are coupled to livestock numbers and thus indirectly lead to higher population numbers and a consolidation of an unsustainable extent of livestock.
In article 12, the Agriculture Act also states support of sales promotion measures (2) of Swiss farming products. Even though the amount of money spent on sales promotion for livestock products (12 Mio CHF for ProViande in 2018) is very little compared to the amounts spent within the Direct Payments (approx. CHF 3 bn / year) the advertisement can have a big impact on the public perception of meat & dairy products (Schweizerische Eidgenossenschaft 2020b).

Lastly, Swiss farmers profit from a reduced value-added tax for pesticides, fertilizers, animal feed and fossil fuels. These indirect subsidies lead to an economically and environmentally unsustainable use of the discounted products.

# Situation of Farmer and Food Production

Climate protection in agriculture is challenging and complex. Many other aspects such as food security, land use and other aspects of sustainability as well as other actors in the food system and their dependencies must be taken into account. Achieving a sustainable food system that can cope with the climate crisis, the increasing demand for food and the shortage of fresh water is a major challenge. In order to meet this challenge, additional sectors and the population must cooperate.

To achieve the needed transition and reorientation, a lot is expected from the farmers in particular, who make up the agricultural sector. The farming profession is already a demanding profession and many standards and expectations must be met in Switzerland. The subsidies and the orientation of agriculture is already a discussed topic.

For these reasons it is important to have a look at the situation of farmers and the food system in Switzerland. Here, we will try to give a brief overview, which of course does not deal with the subject in an exhaustive manner.
Work in agriculture is demanding. In Switzerland, a farmer works an average of 60 working hours per week (BfS 2016) and seasonal harvest workers sometimes even more. Working in nature is also physically demanding and requires passion and commitment. It often means taking over a farm and a lot of responsibility and in most cases, it means a long term and far reaching decision on how to live.

Despite subsidies, farmers' economic scope is becoming increasingly limited. For many farmers and their families, it is difficult to earn sufficient income from agricultural products, or even to cover their costs at all. The number of farms has halved since 1990 and continues to decrease steadily while the average size of farms is increasing (BfS 2020). Dairy farming, which in Switzerland has long been a secure route to stable income, also through political support, can increasingly only be economically viable for large farms.
Agricultural production is at the beginning of a long value chain in which all the subsequent players must earn the greatest possible profits and put pressure on prices. At the end of this chain, there is often not much left for farmers to gain.
One criticism is that subsidies to agriculture ultimately do not help the farmers in the first place, but rather the purchasers, who can buy at lower prices. Especially monopoly customers, such as Migros, Coop or Red Bull (for sugar), can allow themselves to reduce prices extremely. But also, the sellers of machines, fertilizer, animal feed and other inputs can often profit from the subsidies.

Many farmers complain that it is no longer really possible to earn money with food production. In order to find new solutions which are financially viable, those in which the production of food is no longer the main focus often need to be chosen such as gastronomy, energy production, class tours etc. Even when new profitable techniques or methods come onto the market, the farmers are usually not the ones who benefit from the business. Nevertheless, they are often the ones who have to take responsibility for the environmental damage caused and for the practices.

For it is not only the subsidies that are politically charged, there seems to be a lot going on in Swiss agriculture in general, and there are various initiatives with different backgrounds and interests. A great deal of research has also been conducted, established and debated in Swiss agriculture on sustainability.
This high level of activity and the many changes in agriculture are also related to the profound structural changes that have taken place in global agriculture in the last decades. Due to the industrial and green revolutions, agricultural productivity exploded within a few decades. Farms could suddenly feed many more people with less labor and farm much larger areas of land. In addition, farms were increasingly managed towards a gradually profit-oriented and growth-oriented manner. Food prices of many small farms were displaced by larger and financially more efficient ones. This restructuring has an ongoing impact on agriculture around the world which was and still is traditionally very small scaled in big parts of the world. It has not reached the same extent in every region and in different countries it changed agriculture in a different way or only some aspects were adopted while others were not. In many countries, this has already taken on a much more extreme dimension than in Switzerland, where it is due to geographical, political and cultural conditions.

Although restructuring brings an increase in productivity, in many cases it also requires a lot of seasonal work such as harvesting legumes. In Switzerland this work is carried out by migrant seasonal workers. In order to pay Swiss people appropriately for their hard and arduous work, there seems to be a lack of money in agriculture. The workload is therefore generally concentrated on just a few people who work much. The number of full-time employees has been cut in half since 1990 (BfS 2020).
The migrant workers are often invisible and are not part of our image of agriculture. In fact, they are an evident part of Swiss agriculture, as well as of the European one.

# Policy Measures Concerning the International Impact

The volume of internationally traded processed and unprocessed agricultural products has skyrocketed over the past years, from 443.2 billion USD in 2000 to 1310.8 billion USD in 2016, and is expected to continue doing so in the future (Tuninetti, Ridolfi, and Laio 2020; Balogh and Jambor 2020). Switzerland is no exception to this trend and its import and export figures of agricultural products hit a new high point in 2018 (Eidgenössische Zollverwaltung 2020). While it strictly protects its domestic markets from the entrance of some agricultural products, the country strongly relies on agricultural imports, including soybeans, palm oil and animal feedstuff (Rossi 2019). Recent developments suggest that Switzerland will not reduce its activities in international agricultural trade any time soon. On the contrary, the conclusion of the trade deal with first Indonesia and then the MERCOSUR states in summer 2019 indicates that the Swiss government is willing to sacrifice environmental interest for economic prospects.

## Policy 6.1: Free Trade Agreements

Roughly two-thirds of the CO2 emissions that result from today's consumption in Switzerland are produced outside of the country (FSO 2020a). Under the principle of territoriality, however, Switzerland and other industrial nations have assumed very little responsibility for the emissions it produces abroad in the past. In order to obtain an accurate picture of Switzerland's carbon footprint and initiate mitigating measures it is time to acknowledge the detrimental environmental consequences of Swiss consumption, irrespective of where exactly they are produced. This also implies that Switzerland must necessarily be held accountable for any negative side effects its consumption patterns entail in the realm of human rights and labor standards abroad.

The Swiss government must revise both planned and existing trade agreements that cover agricultural products so that they adhere to strict and enforceable environmental and social standards. New trade agreements for agricultural products should be reduced to a minimum and may only be concluded if they contain an environmental and human rights compatibility statement. Any such compatibility statement must necessarily include the following provisions:

- The trade agreement merely allows for the import of crops that are cultivated on already existing cropland.
- Trade agreements are only possible if the production of the goods in the other country fulfills location-appropriate ecological standards and if the relevant government takes serious action to achieve and support a sustainable food production.
- The Swiss government must commit itself to provide financial support to agricultural extension programs in order to boost local knowledge on how to grow the traded crops in a sustainable and climate-friendly manner.
- Trade agreements must contain provisions on how to mitigate the socio-economic and human rights implications of the agreement.

For trade agreements that have already been implemented such statements must be added where necessary. These compatibility statements must be complemented by an environmental and human rights impact analysis that helps assessing whether the products covered by the respective free trade agreement comply with strict environmental and human rights standards. In addition, new and already existing trade agreements to which Switzerland is a signatory party must encompass concrete

provisions on how the exporting country continuously and efficiently monitors the production process' compliance with these standards.
Based on the overarching goal to render Swiss consumption environmentally and socially sustainable, Switzerland must ban all import products that fail to meet these standards. The Swiss government must equally assure that Switzerland has the right to terminate trade agreements should other signatory parties to a trade agreement be convicted of fooling their trade partners regarding the environmental and social impact of the traded products. This ensures that Switzerland neither fosters the production of environmentally harmful products nor neglects human rights and labor standards abroad.
At the same time, it is crucial to acknowledge that a shift in Swiss diets towards dramatically reduced animal product consumption is key to mitigate the negative side effects associated with agricultural trade (Eggenberger, Jungbluth, and Keller 2016; Balogh and Jambor 2020; Jungbluth, Itten, and Schori 2012). The Policy Measures Concerning Swiss Food Consumption below fleshes out several measures that shall help achieve this: The Swiss government must encourage different Federal Offices (e.g. BLW, BAG, BLV and BAFU) to map out a cross-sectoral nutrition strategy plan that promotes a healthy and climate-friendly diet in Switzerland; Renders the production of plant products financially attractive and ensures that producers have access to technical support where necessary; Raises the Swiss population's awareness of alternative diets; Stops subsidizing animal sourced food publicity and continuously increases taxes on animal sourced food. To multiply the impact of these policy measures, Switzerland should nevertheless promote to limit export of agricultural products, first and foremost meat and dairy products, in international negotiation. If traded meat volumes remain high and Swiss consumers resist to change their diets, the Swiss government must consider the outright ban of meat imports.

The advanced trade liberalization also forces Swiss policy makers to take continuous care of the Swiss agricultural sector. It is mainly the giant industrial agri-businesses that benefit from eroding barriers in agricultural trade. The growing dominance of these large industrial players poses a severe threat to local producers who are unable to compete with the masses of cheap imported agricultural products under an increasingly liberal trade regime. It follows that there is a strong need to ensure that all trade agreements signed do not undermine the survival of the Swiss agricultural sector that adheres to comparatively high environmental standards. Accordingly, no trade agreements may grant agricultural products access into the Swiss market whose production and transportation emits large quantities of carbon dioxide and methane, pollutes and depletes water resources or soil in the country of production and clears primary forests. Crucially, Switzerland must maintain the right to prevent environmentally harmful agricultural products from entering the country. Along these lines, the Swiss government may not join trade agreements that allocate legal arbitration power to non-transparent arbitral tribunals. Rather, the process of drafting, implementing and monitoring of those new free trade agreements deemed necessary must include Swiss politicians, civic community representatives and scientists and their counterparts in the respective countries.
Two final issues related with the endeavors to curb agricultural trade liberalization deserve attention as well. Firstly, we acknowledge the potential of agricultural free trade agreements to address imbalances of global food supplies by transferring foods from surplus regions to regions that grapple with diminishing yields due to climate change driven weather extremes (H. Huang, von Lampe, and Tongeren 2011; Ludi et al. 2007). If Switzerland can contribute to a steady supply of food products to poverty-stricken regions that are hit by the repercussions of climate change via free trade agreements, the Swiss government should engage in such "supportive free trade agreements". Those agreements must nevertheless adhere to the general guideline of mitigating $CO_2$ emissions and producing sustainably within Switzerland.
Secondly, we recognize the risk that discrimination of certain products based on environmental concerns might be in tension with WTO rules to which Switzerland is a signatory party. Legal experts stipulate that existing multilateral trade rules do not preclude the preferential treatment of sustainable products vis-à-vis their respective conventional counterparts at the border per se (Buergi Bonanomi 2016; Häberli 2018). Yet, arbitration in previous years and legal experts´ interpretation of the WTO

rules indicate that the WTO is probably willing to accept state-induced Sustainability Ordinances that concern agricultural imports only if they do not distort full-fledged free trade (Buergi Bonanomi 2016). It is, however, essential that the WTO at least commits to the goals of the Paris Agreement and undertakes serious endeavors to mitigate trade´s carbon footprint accordingly. Modifications of the multilateral trading rules are always possible, and Switzerland should lobby at the international stage for the acceptance of trade barriers that demonstrably discriminate against products with high carbon footprint only. These lobbying attempts will only succeed though if the Swiss government grants radical preferential treatment to domestic environmentally and socially sustainably produced agricultural products, too.
For this topic, see Policy 10.3 of the International Collaboration and Climate Finance chapter.

# Policy 6.2: Ban for Growing, Using and Trading Agrofuels by 2023.

Background information for this policy can be found in the section about Agrofuels.
It is important to state that agrofuels are not a panacea to the global climate crisis and risk diverting attention from the ultimate need to leave oil in the soil. Therefore, the Swiss government must thus ban the production, usage and speculation of agrofuels altogether from 2023 onwards. This ban must necessarily apply to both the automobile and the aviation sector. However, based on the ample evidence gathered on the microalgae system's potential to become a truly sustainable alternative to fossil fuels they should be explicitly exempted from the ban for the time being. This exemption must be both continually reviewed and immediately revoked if more evidence about the negative environmental side effects of microalgae agrofuel production appears. Until the ban enters into force, tight transparency rules must be enforced to make traders and retailers of agrofuels disclose full information on the origin, composition and production processes of agrofuels that are currently used in Switzerland. This will foster a better understanding of the features of agrofuels used in Switzerland and help draft the envisaged ban of agrofuels.

# Policy 6.3: International agricultural corporations in Switzerland

Switzerland is home to many international agricultural corporations (headquarters or branch offices in Switzerland) that provide inputs for agricultural production or produce and process agricultural output themselves mainly outside of Switzerland. These Swiss-based players must change fundamentally to render global agricultural production more sustainable. To this end, the Swiss government must democratically establish enforceable and binding frameworks and rules on climate mitigation by the end of 2021 for these companies. Based on these binding frameworks, each corporation must democratically elaborate plans to outline how it intends to cut down its emissions. These plans must necessarily encompass the following aspects:

- A calculation of the amount of GHG that the respective corporation and its subsidiaries currently emit, as well as other environmental impacts e.g. on biodiversity.
- Detailed and consecutive GHG reduction plans of the corporation and its subsidiaries that can be assessed quantitatively and align with the ambition of the Paris Agreement to limit the increase of global warming to below 1.5 °C.
- The corporation and its subsidiaries must fully and transparently cooperate with the state to evaluate their compliance with both their reduction targets and human rights on a rolling basis. If they fail to follow the rules given by the government, there must be effective sanctions.

All corporations and its subsidiaries must necessarily commit themselves to only use already cultivated agricultural land for production on which no one has any claims and to exclude all products from their activities that were grown on land that was cleared to expand agricultural production.
The corporations should elaborate their plans on how to ensure their environmental and social sustainability democratically. This implies that both people who are employed at the corporations and actors that are affected by the corporations' activities participate equally in the drafting process of the respective corporation´s climate strategy and have no lesser rights than the company shareholders or management. It is the state that controls this process. This inclusive drafting process ensures that the corporations, as well as the affected people and employees, remain in the driving seat. While the transition towards more sustainable and labor-friendly agricultural production will involve considerable costs in many cases, the corporations are demanded to exploit their huge financial clout in order to implement their sustainability plans.
Should the corporations fail to present their mitigation strategies by the end of 2021 or act against the targets defined by the state in the future, the Swiss government must elaborate sanctions that target the non-compliers.

# Policy 6.4: International Trade with Food in Switzerland

Background information for this policy can be found in the section about the International Agricultural Trade.
The trade with agricultural products in Switzerland must adhere to strict environmental standards which align with the ambitions of the Paris Agreement. Swiss trading companies must legally commit to only buy and sell agricultural products whose production and distribution inflicts minimal possible damage upon the environment. To this end, agricultural products must be classified according to their environmental and social impacts. This classification should then be promoted by the Swiss government to create a level playing field in international trading relationships. Again, trading agricultural products that were grown in previous forest areas, meadows and pastures shall be strictly prohibited. Additionally, trade must also guarantee living wages/prices and decent work conditions in the food systems of the exporting countries. Merely relying on Corporate Social Responsibility like the Swiss government mostly does in the realm of agricultural commodity trading these days will not do the job. Rather, the Swiss government must start regulating agricultural commodity traders and ensure that each trading company provides precise and coherent information about both the quantities of agricultural commodities it trades and where and under what labor conditions these commodities are produced on a regular basis. This high degree of transparency has ample positive effects. Firstly, it is key to address the numerous human rights violations and incidents of forced and child labor reported in countries that cultivate and harvest agricultural commodities for export in a targeted manner (Braunschweig, Kohli, and Lan 2019). Secondly, high transparency will help counteract rampant corruption and tax evasion along global agricultural value chains and thereby help exporting countries build up the necessary financial clout to enforce and monitor the compliance with human rights in their agricultural sector and even more generally. Ultimately, state-decreed compliance of agricultural traders with strict transparency rules will increase the leverage of small-scale farmers and agricultural workers in exporting countries over the powerful agricultural trading companies. If Swiss-based agricultural traders should then stand convicted of violating the compulsory human rights and environmental standards abroad the victims of this misconduct must be granted the possibility to sue them in Swiss courts. This will help restore the balance of power along agricultural global value chains.

Those products which are not classified as environmentally and socially sustainable by 2025 must be blacklisted and may no longer be traded by Swiss-based companies from then onwards. Irrespective of this measure, the Swiss government must ensure that all Swiss-based agricultural traders respect, adhere to and help strengthen human rights everywhere.

# Policy 6.5: Ban for Speculation with Agricultural Commodities and Food

Background information for this policy can be found above in the section about the Speculation with Agricultural Commodities and Food.
To strengthen global food security, it is crucial that agricultural commodity prices are both stable and determined by actual global supply of and demand for food crops. Speculators in the food market that prefer food prices to jump continuously in order to financially exploit these variations are an obstacle to this goal. Along these lines, speculative trading in foodstuff must adhere to different rules and principles than speculation in other commodities. By the end of 2021 the Swiss government must ban all institutional investors and investment funds from the agricultural commodity market. Banks, pension funds and hedge funds may no longer retail financial products based on food commodities accordingly. A major exemption from these stricter regulations concerns the use of future contracts to do price hedging: Food producers, traders and on-traditional speculators in the agricultural commodity market may still use these contracts to hedge against plummeting food prices. However, to close potential loopholes in the food speculation regulations, the government should implement strict limits on the amount of food commodities an individual trader can buy and sell.

# Policy Measures Concerning Swiss Food Consumption

## Policy 6.6: Cross-Sectoral Nutrition Strategy

### Description

The federal departments BAG, BLW, BLV and BAFU should work on a cross-sectoral plan. This national nutrition strategy should guarantee both a healthy and an environmental- and climate friendly diet. This strategy needs to be elaborated together with people working in these sectors (agriculture, proceeding, sales, gastronomy). Their participation is guaranteed in the strategy.

### Background

As Swiss consumers we eat three times more meat than it is recommended by the "Federal Food Safety and Veterinary Office" (FSVO 2017). This overconsumption affects our well-being in two ways: it is unhealthy, and we produce greenhouse gases that could be easily reduced (Daniel Bretscher et al. 2018). In the meantime, one third of globally produced food for humans is lost or wasted (Schanes, Dobernig, and Gözet 2018). This estimated 1.3 billion of food wasted per year could feed the people that are still suffering from hunger today (Priefer, Jörissen, and Braeutigam 2016). According to Müller et al. (2017), the reduction of food waste in combination with less meat and animal sourced products consumption would allow an agricultural model without any need to increase productivity while still guaranteeing food security.
From a food-system perspective, a shift in our diet is crucial (see Current Situation). As consumers, our food habits and culture or even individual decisions can directly trigger the supply of climate-friendly products. The condition for consumers to choose a climate friendly and healthy diet should be improved with our policies, so that our society backs up and supports a climate friendly way of food production and a sustainable and healthy food culture.
Especially wealthy consumers, that have a connection or knowledge about the production of their food can bear a great responsibility for the direct and indirect emission of their food.

Today, agricultural policy supports the production of meat, while other federal departments promote the reduction of meat consumption (FSVO 2017). It is not the only contradiction these two departments produce that slows down all efforts to achieve a sustainable nutrition in Switzerland or makes them less effective.
To solve this contradiction researchers, suggest cross-sectoral political actions, which consider the different players (Stolze 2019).
In concrete we would suggest that BAG, BLW, BLV and BAFU should work on a cross-sectoral plan. This national nutrition strategy should guarantee both a healthy and an environmental- and climate friendly diet. As for many issues in today's food system, solutions like reducing the meat and milk consumption are working for both, the environmental and the health aspect need to be elaborated together with the auteurs active in agriculture and be included in the future plans for Swiss agriculture.

### Financing, Implementation & Impact

The aim of this policy is to use the resources that are already used today in a more coherent and efficient way. Additionally, the amount of CHF 40 million that is spent to publicly finance sales promotion of meat and dairy products can be used to improve the elaboration and improvement process of the strategy. We can profit massively from the resources we already spend on these departments, if they focus on working together for a sustainable future nutrition- health- and agriculture-strategy or at least avoid breaking each other out. New decrees regulations and laws need to be in line with the strategy. Concerning the working strategy, it is evident that the people working in these sectors (agriculture, proceeding, sales, gastronomy) contribute to the elaboration and their participation is guaranteed in the strategy.
A central point therefore can be the support and development of alternative food products, but also income possibilities and models concerning businesses and actors. Therefore, the cultivation, proceeding, product development and connection between the different players within the food chain could be massively supported by educational programs, courses and training platforms for connection between the actors and specific efficient support as we suggested in Policies 6.8, 6.9 and 6.17.

A further supporting tool could be an annual published update magazine which is provided to all people working in the processing, distributing, delivery or selling industry and contains news and aspects about the current climate crisis and a sustainable food system as well as the latest common projects, progresses and new possibilities. This example - or further information tools - should not only be focused on greenwashing existing practices or glorifying tiny changes, but be delicately focused on achieving a net zero emission food system at the needed scale.
The nutrition strategy should be compatible with our needed emissions reduction path and needs to be controlled with accurate estimations. The work of the departments should enable Switzerland to adapt its nutrition to a sustainable, zero emission for both food produced in Switzerland and imported.

Policies in the following chapter can partly be suggested examples for measures of such a plan including a national food waste reduction plan in Policies 6.13, 6.14, 6.15 and 6.16. Even if ours would need to be improved and the list is far from complete.

# Policy 6.7: Awareness Rising and Sustainable Diet in Public Canteens

## Description

Each day one million people are eating outside: takeaway, in restaurants or in public canteens (BLV, 2016). Especially public canteens have a great potential to reduce the ecological footprints of their meals.
They can not only convey information about the environmental impact of food, but also show various delicious sustainable menus and offer them at a good price.
People get in touch with those menus, they may get used to them, start being interested in a sustainable diet or start seeing and knowing the different alternatives for animal sourced food (ASF) and the various possibilities for a sustainable and healthy diet.
Vegan and vegetarian sustainable and healthy menus should no longer be just chic or a luxury product they should become the everyday meal in people's lives.

Therefore, all public canteens (such as universities, hospitals etc.) should have:

- 60% of their meal vegetarian or vegan by 2025;
- 100% vegan and vegetarian meals by 2030;
- Furthermore, the food must be as seasonal and local as possible.

Possibilities for a direct supply of food from local farmers or local food waste should be preferred. To organize this supply in an intelligent way and to get the connection with local food producers the canteen manager and worker should be supported by the work of the federal departments for example with platforms for connection and organization but also with help for their specific issues.

As described in policy 6.8, obligatory training for professional chefs and canteen workers on sustainable diet and how to work and prepare these foods will be organized.

Furthermore, materials for information about the food, its production, the environmental impact and needed contexts should be prepared and free to use for the canteens. The canteens are free to creatively create their pathway to sustainable diets by 2030 and the target for 2025. They can have different priorities and are free to use the prepared info material or to convey information about the meals in their own way.

Finally, we propose this measure to be also implemented in the compulsory military service in Switzerland. The time of military service can represent a shaping period in the lifetime of young people in Switzerland. Rising awareness of environmental issues related to food might have a long-term impact on the Swiss society.

## Financing

The canteens do not need to have higher costs. Money will just be spent on other food. For the transition the national strategy should provide the needed expertise. Education courses and information materials can be organized nationally so that the budget can stay very small.

## Social Compatibility

It is socially compatible as no prices will increase. Especially, large quantities food with none to very little animal sourced food can be prepared with the same amount or even less money. In combination with further measures, it can contribute to a cultural change towards new eating habits.

## Impact

The measurement should reduce the carbon footprint through sustainable diets in canteens. Based on interventions in 6 canteens in Zurich $CO_2$ emissions could be reduced by up to 42% and on average, by 18% given the right coaching on food and their impacts (Ellens et al. 2018). With our measures that go further than the interventions in the study, even more reduction can be expected.

Also, awareness should be raised with the aim to change long term behavior of participants to increased satisfaction and demand for sustainable food.

# Policy 6.8: Training Courses for Professional Chiefs

## Description

Training courses lasting several days should be mandatory for all Professional chiefs and gastronomy-managers.

The content of these courses is intended to provide an understanding of the current crisis, the consequences and impact on agriculture and the food system, the challenge of a sustainable and productive food system as well as various approaches to solve the problem.

It should then focus on sustainable nutrition and mainly serve as a practical skills training in composing and preparing a sustainable menu as well as organizing access and connections to suppliers for sustainable food.
These courses (as well as aspects in Policy 6.6 or 6.9) should also serve as a platform to connect with people working or studying in other sectors of the food system.

## Financing

As spending on this Policy will not be much, compared with the government's budget, we have not proposed a specific financing for these courses. There are several possibilities: For instance, it could be financed with a levy or tax on profits for major distributors and other actors in the food sector that made the most profits in recent years (and therefore profited the most from the unsustainable way food was produced and consumed and did not have to pay all the externalized costs - see Policy pricing). Otherwise, it could be financed with revenues from policies 6.11 and 6.12 or co-financed with the department's available budget for nutrition or already existing education projects in the sector, for example by integrating the project into existing Universities, colleges or other educational programs.

## Impact

The concrete Impact of such a measure is hard to quantify. Its aim is to create the necessary foundations and connection of people in the food sector to help create the possibilities for the necessary changes. It should educate people and enable them to work actively on solutions. In this sense it should also serve to make the other proposed measures realizable and to improve and guarantee their impact.

# Policy 6.9: Support Sustainable Alternatives in Proceeding Sector and Retailer

## Description

Cheaper and healthier alternatives to animal sourced food (ASF) should be available on the market. On the political level, not only research on processing of leguminous and other sustainable protein production should be fostered, but also the proceeding sector and the retailers, should be included.

Especially in the processing industry we have many businesses that have been depending on the processing of milk or meat like dairies, cheese dairies or butchers. For them the needed shift in the diet should not conclude in their ruin. Instead they should be supported in proceeding with more and more other foods with similar or different techniques and adapt the development of their products to sustainable food.
A processing culture that evolved by processing milk and meat can use its knowledge and capital also for the processing of other food. Especially those of alternative milk products or fat and protein rich foods. The production of yoghurt for example can, with a very similar procedure also be produced out of Swiss soy instead of Swiss milk.
In general, processes such as enrichment through bacterial processes can also be applied to various other foods and products, especially since we have much more knowledge and possibilities about microbiological and other enrichment processes today than when they were first developed. In order to fully exploit this potential, cooperation with universities and research in the field of nutritional sciences should take place there and be promoted.
Other qualities of the milk and meat processing industry, such as the good location and infrastructure access to the farmers, can also be used to process other fresh food or to find new products and opportunities to directly sell their products to consumers together with the farmers.

### Retailers

An independent political consulting institution for retailers should provide comprehensive information about climate friendly alternatives and inform grocers about the environmental impact of food. The aim of this consulting institution is to encourage grocers to change the food assortment towards a more sustainable diet. It is crucial that also retailers assume their responsibility against climate change. With this measure the state could be an assistance to promote corporate responsibility of grocers and consumers against climate change.
An example of a marketing idea could be that only sustainable products give points on customer cards and at the end of the year the customers can see how much GHG they saved compared to an average consumer.

## Policy 6.10: No Subsidies for Animal Sourced Food Publicity

### Description

Swiss government supports sale promotion for ASF with around CHF 40 mio (FOAG 2019). This public financing of sales promotion needs to stop immediately and is easy to stop. Instead, this budget should be invested in the elaboration and improvement process of the national nutrition strategy (Policy 6.6). These publicities about meat and dairy products shape consumer's perception, in a wrong way as we consume three times as much meat as is recommended and ASF products have a big responsibility on the climate crisis we are in. These spending increase the ASF consumption and work against brought efforts to achieve the opposite.
The “Milk Day” in public schools should be replaced by a day about sustainable diet, especially substitutes for milk products and how they are produced.

## Policy 6.11: Food Labelling and Pricing with Climate Impact Assessment

### Description

Food prices were assessed to be a major driver for consumer’s buying decision in Switzerland (Stolz et al. 2017). These prices however mostly only include the direct costs of production but do not account for the impacts on quantity and quality of natural capital (see Policy 1.2. in the Cross Sectoral chapter).

For the implementation of an effective and socially compatible labelling and pricing for food products there is a need for accurate and transparent assessment of the climate impact on food and mechanisms ensuring the ability for lower income households to afford a diverse and high-quality diet.
Regarding the assessment of climate impacts of food products there has already been a lot of research being done and there are extensive databases on the environmental impacts of several food products and categories (Poore and Nemecek 2018). Such a labelling should in a first step be implemented for all food products and could further serve as a basis for a pricing policy.

### Financing

Tax revenues can be earmarked for developing clean technologies. They could also be earmarked to compensate for incurred damages from climate change, or they could just be fused with the general tax revenue of the government. One approach would also be to use them in so-called "refunded emission payments". In those, only a small part of the tax revenue would be used for administration of the instrument, while the largest part for it would be redistributed to the payers, depending on their relative emission performance: Those that are better than the average get money back, those that are worse pay. Such a scheme has slightly lower emission reduction incentives (as part of the money flows back), but it can be more acceptable among the targeted industries or consumers.

## Impact

A pricing of food products according to their actual environmental impact would influence the buying decisions of consumers, with resource-intensive and environmentally harmful products being less demanded and likely less wasted once bought.

Pricing policies (True Cost Accounting) can be crucial for the transition towards sustainable food systems. The leading audit and advisory firm KPMG estimated the environmental costs of food production to reach 200 bn USD in 2012, making the food industry the most environmentally detrimental industry. In comparison, the global oil and gas industry was accountable for 150 billion USD of environmental costs according to the consultancy (Averchenkova et al. 2012). In 2014, the FAO estimated that environmental and social costs of global food waste – which amounts to roughly one third of global food production – cost society at least 700 and 900 billion USD, respectively (Scialabba et al. 2014). Although the calculation of these numbers show an increasing interest in the consideration of the food system as an entity, most existing numbers address only selected food system externalities. True Cost Accounting aims to include all these externalities and is promoted as a key methodology to inform the development of sustainable food system policies (Aspenson 2020). True Cost Accounting can be utilized to include considerations of other important externalities into food and agriculture policies. Only a holistic consideration of the food system and its impacts will lead to a truly sustainable food system.

## Social Compatibility

There is a need for mechanisms ensuring the ability for lower income households to afford a diverse and high-quality diet which is discussed in the cross-sectoral chapter on GHG pricing.

## Questions and Uncertainties

Are discussed in detail in the policy 2 on GHG pricing in the cross sectorial chapter.

# Policy 6.12: Taxes on Animal Sourced Food

## Description

We suggest higher tax rates on ASF to reflect the true cost on the environment and on the society.

As a first step for a tax system towards a sustainable diet we suggest a small change in the national tax system. ASF should be excluded from the reduced value-added tax (VAT). In Switzerland all food items are taxed at a reduced rate of 2.5%. The normal VAT rate for most other products is 7.7% (Die Schweizer Behörden online 2020). ASF should not be included in this reduced VAT, as their production causes environmental pollution, which triggers climate change (Bundesamt für Umwelt (BAFU / FOEN) 2019). Therefore, we suggest that products containing ASF are included in the normal VAT rate. All products containing more than 5% ASF should be taxed with a VAT rate of 7.7% irrespectively if they are produced in Switzerland or imported.

This first step is rather easy to implement and the administrative costs are low, as there exists already different VAT rates (Schweizerische Eidgenossenschaft 2004). The change should enter into force by the 1st 2022. The legal basis can be found in Art. 130 of the federal constitution, whereas the federation can change value added tax rates from a reduced to a normal tax rate on any objects.

With this political measure we want to achieve two effects: On one side, a higher governmental revenue through the increased tax rate. On the other hand, should the slightly higher prices for ASF products show the consumers that these products have higher environmental costs than other food items. The policy should be a first step towards a sustainable diet:

- The price increase of 5.2% for ASF is not enough to change the consumers purchase behavior. Therefore, we suggest a dynamic tax rate approach: The tax will be higher each year if a specific GHG aim is not reached.

- For the future we suggest taxing food concerning its average emission, which would be more accurate, but also would mean an additional administrative effort. A feasibility analysis on specific GHG emission tax for different food categories should be conducted until January, the 1st 2023.

- Another approach or a complementary measure would be to introduce certificates on meat. The federation auctioned off a few certificates, which empower to slaughter animals or import meat. This would allow direct control of the availability and therefore the consumption of meat can be easily reduced. The number of certificates available needs to be strictly linked to the emission goal of net zero by 2030.

## Financing

This measure will generate money that can be used for implementing other measures.

## Impact

Broeks et al. (2020) were the first to create a model study including and monetizing social costs and benefits of a 15% or 30% meat tax or a 10% fruit and vegetables subsidy in the Netherlands. The outcome shows that all three interventions could lead to a net benefit to society over a 30-year time frame.
To our knowledge no country has yet implemented taxes on ASF. Neither did anyone research about the impact of such a tax in the Swiss context. Therefore, we cannot say if a higher VAT rate of 7.7% would trigger the consumers to buy less ASF or if we can reduce GHG emissions at all with this policy. However, it is very clear that the meat consumption must be reduced as emissions from animal husbandry must be reduced.
An interesting side effect is that the overconsumption of meat is shown to be the cause of several illnesses (Richi et al. 2015). If we can reduce this overconsumption, we can also reduce health costs.

## Social Compatibility

**Farmers:** Animals, especially cows are part of the cultural heritage of Switzerland. They are the pride of most farmers. Tax revenue shall be used to financially support farmers wishing for a transition from ASF to more sustainable crops using the current administration for agricultural subsidies.
As the sales of ASF might decrease, farmers and retailers will have less revenue. Mechanisms which are described in the other policies should help farmers and retailers to get other income sources.
**Retailers:** Retailing is dominated by Coop, Migros and Fenaco. We cannot imagine that these three companies would be hardly affected by our policy, as these retailers sell a lot of other products, where

they can get revenue from. However, retailers, which only depend on selling ASF, will be affected. For them a supported reorganization is needed.

**Consumers:** Swiss people spend on average around 6% of their monthly budget on food (FSO 2017a). A tax of this kind will of course bring a strong financial pressure not to buy meat. However, we believe this is acceptable since meat is not the only type of food available. In fact, it will probably be cheaper to cook with less meat and should not be a problem if consumers are educated on how to cook with alternatives.

Authors of studies modeling such taxes affirm that the use of tax revenues is critical for acceptability considering its economic effects (Caillavet, Fadhuile, and Nichele 2019) hence the revenue shall be directed to satisfy as many stakeholders as possible.

# Food Waste

Food waste indicates a substantial inefficiency in our food system, from an ecological, ethical as well as an economic perspective. Ecologically, food waste stands for a waste of those natural resources which build the foundation of our food system. Reducing food waste thereby means avoiding the waste and depletion of soil and water resources, the waste of energy as well as agricultural inputs including pesticides and fertilizers. For Switzerland, zero food waste would indicate avoidance of 24% of the total GHG emissions from the entire food system (C. Beretta & S. Hellweg, 2019). From an economical point of view, only considering avoidable food waste in households, the costs of food waste in Switzerland amount to about CHF 600 per person per year, summing up to the potential of saving CHF 5 bn per year. Finally, considering the millions of people facing hunger worldwide, reducing food waste represents an ethical necessity.

However, as previously introduced, food waste is a complex problem concerning all stages of the food chain, including producers, distributors and consumers. Accordingly, to reduce food waste, a coherent framework with measures concerning all stages of the food chain is needed. Thereby, these measures primarily should seek to prevent food waste by limiting the generation of surplus food at each stage of the food supply chain (i.e. production, processing, distribution and consumption), and secondly, where food waste still arises, they should secure the most efficient use of the surplus food.

# Policy 6.13: Educate and Raise Awareness on Food Waste

Households are responsible for about one third of the total food waste in Switzerland (in terms of fresh matter). The extent of food waste heavily depends upon the societal value we give food. Food waste at the household level might be driven by a devaluation of food, meaning that we no longer value food as something essential for life, a lack of knowledge of how food is produced (e.g., resources and energy used, farmer’s commitment) as well as a loss of food cultures in the course of globalization. These things lead to a loss of social and emotional linkages to food.

We consider a lack of knowledge and awareness to be a major driver for this development and thus consider the targeting of food related topics in education as one of the most important measures to combat food waste. The production of food, its impacts on the environment as well as the meaning of seasonality and locality needs to be part of the educational schedule in the Swiss education system at all levels. We thereby consider practical experience in the form of field work on farms, excursions to farmers or any stakeholder in the food chain. Foremost there should also be practical skills training in conserving and storing food, in assessing what is still edible and what is not as well as healthy, sustainable and waste-free cooking classes.

A further possibility to increase the experienced value of food for consumers, is to increase their contact with producers. This should lead to less food waste and possibilities for direct selling from farms but also from the processing sector as they are already increasing today and should be supported further as described in Policy 6.9., 6.20 and 6.21. One possibility to concretely reduce food waste with that is to sell and buy non-tradable food in farm shops.

# Policy 6.14: New Labeling for Expiration Dates

Largest environmental impact of food waste can be attributed to the last stages of the food chain due to the resources needed for transporting, processing and storing of the respective goods (Beretta and Hellweg 2019). Food waste at the respective stages (especially at the retail, catering and household stage) might be considerably supported by misinterpretations and confusion on the food labelling concepts 'sell until', 'best before date' and 'expiration'. Expiration dates are of great importance regarding food safety and human health as they indicate the potential of contamination by microorganisms producing harmful toxins. However, these are only mandatory for products which need continuous cooling throughout the food chain and that can represent a health risk even if their smell and taste are normal. The 'best before date' indicates the date until a specific food product maintains 'original' quality regarding for example smell, consistency or color. This however does not mean that the respective product cannot be consumed thereafter and should not be interpreted as an expiration date. Finally, some products are currently still labelled with a 'sell until' label which does not indicate any quality or health aspect at all (FSVO 2014). To avoid misinterpretations with expiration dates, the food labels 'sell until' and 'best before' need to be communicated clearer to the consumer or even better be omitted completely.

# Policy 6.15: Adjust Industry Norms

From the total Swiss agricultural food production for human consumption about 225’000 tons of fresh matter is not used as food and ends up as food waste. From these 225’000 tons about 90% is considered potentially avoidable. Main sources for food waste at this production stage are the failure to comply with industry norms and unsuitable storage (Baier et al. 2017). Assuming an average price of CHF 3 per kg of fresh matter, this corresponds to a value of CHF 600 mio per year.

A reduction of food waste from the agricultural production can be achieved by adjusting the industry norms so that less of the products are rejected due to size, form, color or other appearance quality standards not influencing food quality. There are several ways how an adjustment of industry norms could be carried out. One way would be to carry out a mandatory consumer survey to set norms adjusted to consumer's needs. Another possibility would be to omit industry norms completely so that food processing companies must accept all products from a specific farmer. It then is in the competence of the companies to decide on which agricultural resources they can use for further processing and which not. This would additionally increase product innovation to enable the use of the entire quality spectrum of the products delivered by the farmers. In any case, fair sectoral agreements between farmers, industry and retailers are needed.

# Policy 6.16: Promotion of initiatives for food waste reduction

If food waste cannot be prevented by the depicted measures, still the most efficient use of the respective goods should be enabled. In several cities of Switzerland there is an increase in communities which try to establish concepts to ensure this. These 'food sharing' communities, for instance, make overproduced food or leftovers freely available in public fridges. However, considering the total mass of food waste across all stages of the food chain, these initiatives reduce food waste only to a very limited extent. Thus, the promotion and up-scaling of such activities at all stages of the food chain have a large potential to decrease food waste in Switzerland. Governmental actions in this context could include the adjustment of law and regulations to enable such activities on a legal basis, the creation of a fund specifically supporting start-ups which develop concepts and technologies to use food resources which were discarded at the industry, retail or gastronomy stages, the provision of consulting for such start-ups, the promotion of food sharing activities at the community level or the provision of energy-efficient infrastructure for such.

# Policy Measures Concerning Domestic Agricultural Production

## Policy 6.17: Updating the Vocational Education for Farmers

### Description

Aspiring farmers should be prepared for the challenges they face concerning food production in the 21st century and the current climate crisis, and be equipped with the necessary skills. Therefore, today's vocational education for farmers needs to be updated.

The education should contain an understanding of the climate crisis, its consequences and impacts on agriculture and the challenge of a sustainable and productive food system. Only methods and techniques that are sustainable and compatible with the following measures of the chapter should be learned. Accordingly, livestock farming should be less centrally located, and more focus should be placed on resource-conserving and productive food cultivation. Agro-ecological methods should be introduced and learnt, as well as skills in understanding the local impacts of the climate crisis and adaptation possibilities.
Within their education the future farmers should also have the possibility to get in touch with other people working in the food sector as well as students in the field. (See Policies 6.6, 6.8 and 6.9..) Project-weeks as well as theoretical and practical excursions to learn about aspects of the climate crisis and sustainable solutions together with others should be integral parts of vocational education.
Education should also be made more attractive and accessible for more people.

### Financing

This policy does not require additional funding as the vocational education for farmers could be financed in the same way it is financed today.

### Impact

The impact of this measure is hard to quantify. Its aim is to create the necessary foundations in the food sector to help create the possibilities for the necessary changes. It should educate people and enable them to work actively on solutions. In this sense it should also serve to make the other proposed measures realizable and to improve and guarantee their impact.

# Policy 6.18: Improving Farmers Rights and Working Conditions

To achieve the needed transition and reorientation in the agricultural sector, a lot is expected from the farmers. (See Current Situation.)
To make this possible, it is important that farmers can inform themselves, get involved and have an amount of operational scope in their work. This requires sufficient time and good working conditions, which should be ensured with the following three measures:

1. A core part of a strategy to render Switzerland's agricultural sector socially and environmentally more sustainable must protect the peasant land law (Bäuerliches Bodenrecht/ droit foncier rural/ diritto fondiario rurale). This law prevents the fragmentation of agricultural land, hedges against massive land price increases by prohibiting speculation on agricultural land and regulates the transfer of agricultural land. A relaxation of it could open the doors for climate-damaging, profit driven large-scale agriculture. Small-scaled agricultural production must remain possible in Switzerland as it is also the chance for many people to engage in this sector and not to further lower the number of people working in this sector. It should also protect the people’s right to define their agricultural and food policy and to prioritize local agricultural production in order to feed the people as well as to give access of peasants and landless people to land, water, seeds, and capital which are core principles of food sovereignty.

2. A farm provides a family with work, livelihood, housing and free time and is therefore the central element in the life of a farming family. Therefore, there is often a strong interdependence between business and private life. Marriage and divorce are closely linked to material claims and business obligations. Today, wives of farmers have no guaranteed right to have the work done on the farm credited for payments and pensions and in the event of divorce they are much more likely to waive claims or compensation. To reduce legal dependency on other people, this must be corrected, and insurance and compensation must be guaranteed for both married partners in future. In addition, further projects are to be intensified and promoted to make the sector more attractive and accessible for women, not only as wives.

3. To create a decent working environment for agricultural workers (also migrant workers), jobs in agriculture must be amenable to the Swiss labor law. This includes the conclusion of a collective bargaining agreement that defines maximum weekly working hours for agricultural workers and regulates their salary, accommodation and residence status. The government must establish legal contact points for both domestic and foreign agricultural workers and start proactively informing seasonal workers about their rights as well as monitoring the working conditions of Swiss farms on a regular basis. Since the income for many is already scarce in agriculture and many farms are heavily indebted, it is crucial that this must be accompanied by projects for more subsidized auxiliary workers (Policy 6.19) and good income opportunities to produce food. (Policy 6.9 and 6.28)

# Policy 6.19: More People Working in Agriculture

What is also needed to achieve the necessary transition and reorientation in the agricultural sector as described in the current status, is enough committed people working in agriculture. The sometimes-hard work and the many weekly working hours will be spread over more people as well as being accessible to more people. More people being engaged in the production of food could also have an impact on consumption patterns in society.

To this end, not only vocational education for farmers should be made accessible to more people but also the following three points should be implemented.

1. Swiss agricultural policy must facilitate the access to agricultural land for young educated farmers, who are often struggling to find that nowadays.
2. The opportunity to cultivate agricultural land in Switzerland should not be reserved foremost for members of peasant families. Rather, lateral entrants with agricultural education from non-peasant families must be granted simplified legal access to farmland state support.
3. Possibly created green job programs as well as other projects to support and pay auxiliary workers should be used to help and work on farms or other food-producing facilities. Existing projects like ZIVI/CIVI therefore could be extended and not only include male persons.

## Overview on Livestock Production in Switzerland

The extent of livestock husbandry can be understood to be mainly determined by two constraints: (A) Sufficient provision of nutrients for a healthy and balanced diet of a population and (B) Environmental impacts that must not surpass environmental limits of local and global ecosystems. Land use suitability (e.g. for cropland, grassland, forestland) can be seen as an additional framework condition. Three quarters of the agricultural land in Switzerland is grassland that cannot or should not be ploughed. Production of food on this grassland is only possible with ruminants. However, alternative uses of grass (e.g. for fiber, insulation, energy production) and grasslands (e.g. reforestation, promotion of biodiversity) should be considered as well.

For many industrialized countries including Switzerland consumption of animal-based food, particularly meat is above the recommendations of public health institutions (FSVO 2017). At the same time, overly large livestock populations lead to negative impacts beyond the environmental limits, particularly in respect to global climate change (Searchinger et al. 2019; Springmann et al. 2018; Willett et al. 2019). Buckwell and Nadeu (2018) conclude that in order to reach the 2050 climate goals (reduction of GHG-emissions by 80%) the EU28 must reduce its direct livestock emissions by 74%. This can hardly be realized by technical measures (see policy 6.33). In view of that, numerous studies conclude that a significant shift towards a more plant-based diet together with a respective reduction of livestock populations is an important - if not indispensable - step in order to reach necessary GHG emissions reduction goals (Bajzelj et al. 2014; Bryngelsson et al. 2016; Hedenus, Wirsenius, and Johansson 2014; Happer and Wellesley 2019).
Further industrial meat production creates an ideal environment for the spread, development and increased virulence of viruses.

Livestock usually converts only a small part of the nutrients and energy in the feed to human edible food (Shepon et al. 2016; McDonald et al. 2011). As far as possible, use of animal feed should thus be limited to feedstuff not edible for humans (M. Meier, Moakes, and Spörr 2018; Mottet et al. 2017; Schader et al. 2015). This namely includes grass grown on permanent [natural] grassland (i.e. land not suitable for crop production) and by-products from the food industry that cannot be transformed to human edible food. These animal feeds should be used efficiently, getting the right nutrient to the right animal at the right time (Andeweg and Reisinger 2015).

## Framework for Future Livestock Production in Switzerland

As an overarching goal for agricultural production in Switzerland, it is necessary to determine the extent of livestock populations that combine sustainable production and healthy diet. Several studies have been conducted in this direction (H. Kim et al. 2019; Stolze 2019; Zimmermann, Nemecek, and Waldvogel 2017). As a point of reference, we suggest here a diet and agricultural production according to the LMP/Kal scenario in Zimmermann et al. (2017) (Table 6-2). This would lead to a reduction of total GHG emission from food consumption in Switzerland by 56%. The reduction potential might even be higher if food waste were reduced as far as possible (see also chapter on food waste). GHG emissions from agricultural production within Switzerland decrease to a lesser degree. Based on the model of the Swiss national GHG inventory, Bretscher et al. (2018) calculated a respective reduction potential of approximately 30%.

Under the LMP/Kal scenario in Zimmermann et al. (2017) the total number of livestock units falls by 44%. Particularly meat production from cattle, swine and poultry is reduced. Production and consumption of milk and eggs is maintained or even increased in order to guarantee sufficient provision of animal proteins and micronutrients. This scenario is in accordance with other studies such as e.g. Buckwell and Nadeu (2018) who state that: "*a conservative estimate is that about half of the current ruminant livestock in the EU could be justified in their role of making use of the available permanent pastures, including rough grazing*". Considering ecosystem boundaries, Meier and Moakes (2018) propose a similar reduction of the cattle population in Switzerland as Zimmermann et al. (2017) (-37%, feed no food scenario). The population of swine would fall by 59% and the population of poultry by 88%.

*6-2 Livestock populations according to the reference and LMP/Kal scenario of Zimmermann et al.* (2017).

| Livestock Units | Reference | LMP/Kal | % Difference |
|---|---|---|---|
| Dairy Cattle | 563'373 | 427'129 | -24% |
| Breeding Cattle | 179'274 | 98'323 | -45% |
| Fattening Calves | 8'471 | 1'239 | -85% |
| Fattening Cattle | 48'155 | 13'184 | -73% |
| Suckler Cows | 94'310 | 9'746 | -90% |
| Suckler Calves and Cattle | 23'052 | 4'053 | -82% |
| *Total Cattle* | *916'635* | *553'674* | -40% |
| Swine | 183'492 | 41'603 | -77% |
| Poultry | 60'055 | 48'002 | -20% |
| Sheep | 39'545 | 12'584 | -68% |
| Goats | 10'819 | 24'360 | 125% |
| Horses | 44'805 | 19'475 | -57% |
| **Total** | **1'255'351** | **699'698** | **-44%** |

Feed rations of the individual livestock categories changes considerably under a scenario for a sustainable and healthy diet such as LMP/Kal. Ruminants are mainly fed based on roughage from permanent grassland and leys in arable crop rotations. Since the total agricultural area is maintained constant, permanent grassland can be used more extensively while still producing sufficient feedstuff. The amount of silage maize that is currently mainly used in cattle husbandry is reduced massively (-90% of the respective cropping area). Furthermore, the results from Zimmermann et al. (2017) suggest that feed imports could be reduced almost to zero due to the much-reduced demand for feed concentrates. Additionally, in Switzerland more cropland will become available for crop production directly for human consumption (e.g. grains, vegetables, root crops, oilseeds).

The degree of food sovereignty in Switzerland would increase considerably with the shift to a more healthy and sustainable diet. Zimmermann et al. (2017) estimate that both gross- and net- (subtracting production based on imported feed) self-sufficiency in terms of food calories could augment to over 80% compared to <60% respectively 50% today.

## Consequences for Food System Policies

Based on the study of Zimmermann et al. (2017) we suggest limiting livestock populations in Switzerland to the numbers of the LMP/Kal scenario as provided in Table 1. The number of livestock units should be fixed for ruminants (cattle, sheep, goats) and monogastric animals (swine, poultry) with some flexibility within these groups. Animal feed should be restricted as far as possible to feedstuff not edible for humans and stocking densities should be adapted to local feed availability. To achieve this, we suggest the following policy measures:

# Policy 6.20: Import of Animal Products and Productivity

To ensure that the following measures concerning livestock production in Switzerland lead to a reduction of GHG emissions in total and are not compensated by more emissions, land use and bad agricultural practices in other countries through more imports, it is essential to have a productive domestic agriculture sector. The Swiss population needs to be supplied to the highest possible degree from domestically produced food. The degree of self-sufficiency should at least stay the same if not increase with all the suggested policies. This should be a key target in any agriculture politics and has a further advantage of leading to less transport emissions. We want to ensure this through the "feed no food" principle, which allows more calories and nutrition being produced per hectare and with further support of different practices and alternatives described in policy 6.9, 6.26 and 6.27.
To reach that target, implementing the following two import regulations are important:

- Import of animal sourced food products is only allowed when it is produced under the same framework conditions as in Switzerland ("feed no food" principle and observance of maximum local stocking densities). The concepts of the "feed no food" principle and the maximum stocking densities should be promoted by Switzerland on an international level. It will be consistently represented in trade relations and international cooperation and research projects. The development of respective international trade regulations should be pursued (see policy 6.1).

- Furthermore, the following policies, foremost the once to reduce the proportion of animal sourced food production, need to come together with a shift in diets in Switzerland and should not lead to more ASF being imported (even if it is produced under the same sustainability framework as in Switzerland, it will increase the demand for meat and lead others to the consumption of more harmful produced ASF or take away the land and possibility for others to eat ASF). The above policies concerning Swiss food consumption should help to make that shift possible. But to guarantee it, there is the need for a cap for imported ASF at the level it is today, decreasing until 2030 to a maximum of 10% of the amount of what is produced in Switzerland.

It can be a support for achieving both measures, to adapt a border tax adjustment in the direction of action of policy 6.11 and 6.12.

These two measures and the aspect of a productive agriculture allow the change in Swiss agriculture to have a real impact on the fight against climate crisis. By changing both, the way we produce food, and the way and amount we consume, we will enable both parts to have great impacts and to be an evident part towards a sustainable food system having a global relevance: First as a good example to show that it is possible and second to already bring up solutions for the global food system that can be used further or adapted by others.

# Policy 6.21: No Subsidies for Feed Production on Arable Land

All subsidies or any other support for feed production on arable land except for leys in arable crop rotations should be reduced continuously and stopped by 2030. Arable lands could be defined as the crop rotation areas as designated in ARE (2006). Alternatively, the elaboration of a respective policy system could consider the area- and food-competition as proposed by Zumwald et al. (2019). The subsidies should instead be shifted towards sustainable practices and techniques as suggested in the policies 6.27 and 6.28: Alternative proteins/incomes.

The impact and further details can be found in the overview and framework for future livestock production in Switzerland. Important questions such as financing or social or cultural compatibility are answered by the accompanying measures, both previous and following.

# Policy 6.22: No Imports of Animal Feedstuff

An increasing tax on imported feedstuff should lead to its reduction to zero by 2030, year where it should be banned. Incomes generated by the taxes should be used to create other income possibilities for farmers (Policy 6.28).
The impact and further details can be found in the overview and framework for future livestock production in Switzerland. Important questions such as financing or social or cultural compatibility are answered by the accompanying measures, both previous and following.

# Policy 6.23: Limit Stocking Densities for Ruminants

The stocking densities for ruminants on permanent grassland should be limited to one livestock unit per hectare on average. The maximum stocking density may be adjusted regionally to take into account the differences in local production potentials.
The impact and further details can be found in the overview and framework for future livestock production in Switzerland. Important questions such as financing or social or cultural compatibility are answered by the accompanying measures, both previous and following.

# Policy 6.24: Limit Populations of Non-Ruminant Animals

The populations of non-ruminant animals should also be limited to values provided in Table 6-2 or to numbers that can be supported with feedstuff from by-products of the regional food industry that are not edible by humans, if this is lower.

The impact and further details can be found in the overview and framework for future livestock production in Switzerland. Important questions such as financing or social or cultural compatibility are answered by the accompanying measures, both previous and following.

# Policy 6.25: Consider Maximum Stocking Densities for New Projects

For the approval of new construction or renovation of old infrastructure (e.g. stables) and for the guarantee of credits or any other long-term support investments the regional maximum stocking densities need to be considered.

The impact and further details can be found in the overview and framework for future livestock production in Switzerland. Important questions such as financing or social or cultural compatibility are answered by the accompanying measures, both previous and following.

# Policy 6.26: Promote Research and Development

In order to optimize grassland-based animal production and convert food industry by-products to animal feed, research and development should be promoted - for instance in precision feeding as proposed by Andeweg and Reisinger (2015).

Further GHG reduction potentials may be achieved with technical measures. This includes in particular an increased longevity for cattle animals (Grandl et al. 2018, Meier et al. 2017), nitrogen optimized feeding strategies (Bracher et al. 2011, Kupper et al. 2018), and low emission stable- and manure management systems (see policy 6.33.) (Daniel Bretscher et al. 2018). So far, there is no scientific consensus whether pasture or stall-feeding systems are more beneficial in terms of GHG-emissions (Zollitsch, Hörtenhuber, and Lindenthal 2010; Zumwald et al. 2019). For animal-welfare reasons we suggest letting animals graze if possible. In general, it is expected that the technical measures for the reduction of GHG emissions in practice are of limited potential and difficult to implement. Nonetheless, they should be promoted as far as possible. This could include e.g. bans for unsustainable practices, regulations and/or capacity building programs. Financial incentives should be used with reluctance and only granted to cover additional costs as they shall not reinforce structures of livestock activities beyond the ecological system boundaries.

# Policy 6.27: Pro mote Alternatives to Animal Proteins

Alternatives to animal proteins i.e. plant-based protein sources like leguminous crops should be specifically promoted and supported as well as the research on breeding and cultivation of those alternatives in appropriate scale in Switzerland.

The impact and further details can be found in the overview and framework for future livestock production in Switzerland. Important questions such as financing or social or cultural compatibility are answered by the accompanying measures, both previous and following.

# Policy 6.28: Promote Alternative Income Possibilities

Farmers depending on livestock production today should be supported by promoting alternative income possibilities as support for transition to crop productions, additional energy production or concerning policy 6.9 possibilities for direct selling of their products in the farm or in association with the processing sector. Accordingly, framework conditions need to be designed in a way that allows for alternative economic activities. Difficulties and challenges in arable crop production such as seasonally uneven distribution of workload and income and risks for crop failure due to extreme events must be addressed in order to strengthen the attractiveness and feasibility of this activity.

# Minimize GHG intensive practices

Nitrous oxide (N2O) emissions from agricultural soils are the second largest GHG emission source in the agricultural sector (1.58 Mt CO2 eq.; see Current Situation). They are mostly a result of nitrogen transformation processes in animal manure and agricultural soils. The production and use of nitrogen containing fertilizers (mineral fertilizer and animal manure) are the cause of most N2O emissions. Among the additional nitrogen sources are decaying crop residues, nitrogen mineralization in soils and inputs from atmospheric deposition of nitrogen species leading to N2O emissions. Particularly high nitrogen supplies beyond requirements of crops lead to hot spots of N2O emissions.

However, any overabundance of nitrogen, also when coming from high additions of compost, will lead to N2O emissions. In addition to on-farm greenhouse gas emissions from fertilizers, emissions of around 0.81 Mt CO2 eq. are incurred during the production of agricultural inputs abroad, mineral fertilizers and animal feed. The use of organic soils for arable farming or grazing is another major source of GHG emissions (mainly CO2) in Swiss agriculture. Additionally, CO2 emissions from the combustion of fossil fuels in agricultural machinery and buildings amount to 0.63 Mt CO2 eq. and therefore contribute 10% of the GHG emissions from agricultural production in Switzerland. To reduce all these emissions from agricultural production, several measures are proposed below.

# Policy 6.29: Promote Low-Input Agriculture

## Description

For the Swiss agricultural production system and for the Swiss farmers, to sustain the shift towards a less input-intensive production system the production portfolio must be adapted in a way that allows sustainable low-input agriculture. To this end and in accordance with article 104 of the Swiss constitution, the use of cultures and varieties as well as animal species and breeds that are adapted to climatic, soil and topographical conditions should be supported. Accordingly, the need for external inputs should be lower, as less fertilizers and agrochemicals are necessary in order to maintain agricultural production against fundamental ecological constraints. This policy suggests production system contributions within the direct payment framework for previously specified low-input agricultural practices incorporating agroecological principles and lowering the GHG emissions in comparison to currently established systems.

## Financing

The described direct policy could be financed by the redistribution of the direct payment budget, reducing the payments for animal husbandry and redirecting these payments towards locally adapted low-input agricultural practices.

## Impact

This policy is mainly necessary to sustain the policies aiming at reducing GHG emitting inputs in the agricultural system. The direct emission reduction effect is hard to calculate.

## Social Compatibility

Due to its character as a supporting measure for the policies mentioned below, this measure should increase the acceptance of the policies aiming at reducing harmful inputs in agricultural systems.

# Policy 6.30: Tax on Nitrogen Inputs that Exceed Plant Demand & Cap for Synthetic Fertilizer Application (SFA)

## Description

An overabundance of freely available nitrogen in the soil can lead to high N2O emissions. The temporal and spatial nitrogen supply should match the plant's demand as close as possible. In Switzerland Bosshard et al. (2012) report that there is a substantial potential for improving nitrogen use efficiency in Switzerland. Since amounts of nitrogen emissions not only depend on the source but mainly on the amount of nitrogen applied (Necpalova et al. 2018), nitrogen addition should be monitored very closely and inputs that are beyond the plant supply should be taxed. For this, a user-friendly tool should be made available to farmers that accounts for e.g. the nutrient demand of plants, the availability of nitrogen in the soil, the type of fertilizer used and the application technique. As a complementary measure an incentive tax on synthetic fertilizers can be raised. The revenues of this incentive tax can then be redistributed to the farmers directly or via investments in research and development of more efficient nutrient managing techniques.

To complement the tax-based measures aiming at a reduction of N2O emissions a stronger incentive for farmers to use their crop rotation and organic fertilizers as nutrient sources can be applied. To this end we suggest a cap for synthetic fertilizer application (SFA) based on local conditions as part of a compulsory fertilization balance for all farmers. This cap will be lowered in a stepwise manner guaranteeing both the aimed reduction and the possibility for farmers to adapt to the new situation. This policy is independent of the direct payment regulation and can also be applied if incentives based on taxes do not lead to any change in the $N_2O$ emissions.

## Impact

An increase in nitrogen use efficiency of manure management could lead to a reduction of 0.261 Mt CO2 eq. per year (Daniel Bretscher et al. 2018). Therefore, an improvement of mineral fertilizer management could result in 16.5% lower soil N2O emissions. The complete waiving of the use of synthetic fertilizers could reduce the emission of GHGs directly emitted by soils by 15%. Additionally, a substantial part of the 0.81 Mt CO2 eq emitted by the production of agricultural inputs abroad could be reduced by the renunciation of synthetic fertilizer. Accounting half of the emissions from the production of agricultural inputs abroad to synthetic fertilizer, a waiving of mineral fertilizers would lead to a reduction of GHG emissions from agriculture by approximately 0.64 MT CO2 eq per year. This accounts for a reduction of 10% of the agricultural GHG emissions. Since policies are aiming at the reduction and not at the complete renunciation of organic fertilizers the suggested policies would result in GHG emission reduction in accordance with the proportion of mineral fertilizer reduced.

### Financing

The costs of this measure will be covered by the farmers themselves. However, better education on climate-friendly agricultural practices, particularly higher nitrogen use efficiency and an increased use of nitrogen fixing crops, and the general reduction of nitrogen inefficient livestock husbandry will lead to a higher nutrient use efficiency. Therefore, overall production of food calories and -proteins will not decline and no additional costs should arise.

### Social Compatibility

Enhancing nutrient (mainly nitrogen) use efficiency should not lead to lower yields and therefore a reduction in fertilizer use should not come at a cost or might even be financially beneficial for farmers. Studies have shown that intensive crop management does not necessarily increase GHG emissions per unit of crop production (Snyder et al. 2009).
A complete renunciation from synthetic fertilizers will possibly lead to lower outputs (Necpalova et al. 2018). To maintain our current production level of energies, proteins and nutrients a simultaneous withdrawal from the production of animal feed on agricultural areas is necessary. However, the initial increase of production costs might cause temporary problems with a lack of income for the farmers. This should be overcome by a fairer pricing system accounting for more sustainable production systems. Further thorough consulting and a step by step implementation are necessary accompanying measures to guarantee a smooth transition.

## Policy 6.31: Rewetting of Organic Soils

The use of organic soils for arable farming or grazing is another major source of GHG emissions. These soils are formed by the anaerobic, incomplete decomposition of plant matter in water-saturated soil in peatlands (fens or bogs). Typically, farming requires the drainage of these soils. Upon drainage however, the peat becomes exposed to oxygen and a high amount of carbon which has accumulated over thousands of years is released to the atmosphere in the form of CO2. Despite their long history of drainage, large amounts of carbon are still stored in organic soils. These stocks (equivalent to about two years of total Swiss GHG emissions) should be preserved by rewetting, thereby reducing GHG emissions. Over longer time scales rewetting can also, under favorable conditions, renew the C-sink function of these soils.

### Financing

Currently farmers receive direct payments for very general services (e.g. Versorgungssicherheitsbeiträge/ Contributions à la sécurité de l'approvisionnement/ Contributi per la sicurezza dell'approvvigionamento). Part of these subsidies are also invested in the cultivation of organic soils. Furthermore, the government invests large amounts of money in the renewal and maintenance of drainage systems (about CHF 1000 per hectare) and will have to invest 1.7 billion in the next 10-15 years (SRF 2017). These funds should be used for rewetting and renaturation projects. The costs to rewet these soils are very high on a per area basis and are additionally associated with a decrease in agricultural production. Additional funds should therefore be used to incentivize alternative income sources for affected farmers. CO2 certificates are another option. A program that is already running for raised bogs is *max.moor*. Current prices are too low and would need to be roughly doubled (Ferré et al. 2019).

### Impact

The mitigation potential of organic soils under agricultural use (intact or degraded peaty soils) is large, as they emit about 0.6 Mio. t $CO_2$-eq. per year (about 10% of the agricultural emissions, see "Current situation").

### Social Compatibility

Rewetted organic soils could be used for paludicultures (wetland plants). Examples are *Phragmites australis* (for paper and pulp production or as fuel), *Typha* sp. (cattail, as insulation or construction material or as fuel), *Sphagnum* sp. (alternative for peat in horticulture), *Alnus glutinosa* (as construction or furniture wood, fuel). Experiments with rice have been performed in the Seeland and have shown that rice would offer an economically as well as ecologically (especially for biodiversity) very interesting option (SRF 2019b; 2019a). Whether significant amounts of methane are emitted has yet to be assessed.
Organic soils are very important for vegetable farming. An alternative might be to farm vegetables on *Hors-Sol* in vertical farms.

## Policy 6.32: Apply Standard Mineral Oil Tax to Agriculture

### Description

$CO_2$ emissions from the combustion of fossil fuels in agricultural machinery and buildings amount to 0.63 Mt $CO_2$ eq. and therefore contribute 10% of the GHG emissions from agricultural production in Switzerland. To increase the efficiency of the use of agricultural machinery standard mineral oil tax should be applied for agricultural production. With this measure, additional policies aiming at an establishment of Truth of Costs and changes in the mobility sector can automatically be applied to mobility in the agricultural sector as well.

### Financing

The costs of this measure will be covered by the farmers themselves. However, a redistribution of subsidies can support the shift towards emission-free energy alternatives here as well. Furthermore, the improved use of fossil fuels and heavy machinery in many cases lowers or even neutralizes the economic impact of this measure for farmers.

### Impact

The improved use of fossil fuels and heavy machinery in agriculture is estimated to reduce the amount of $CO_2$ eq. of the combustion of fossil fuels in agriculture by ⅓.

## Policy 6.33: Promotion of Individual Technical Mitigation Measures

### Overview

Many organizations and institutions already elaborated compilations of technical measures to reduce GHG emissions. Instead of discussing the individual measures here again, we rather focus on this contribution on the general aspects and findings.
The highly complex biochemical emission processes with a great number of different microorganisms involve generally difficult technical reduction potentials on agricultural farms. Additionally, the great number of individual emission sources are often interconnected among each other's exacerbating effective mitigation measures. Numerous negative side effects, trade-offs with other pollutants and/or animal welfare as well as high implementation costs are additional challenges of technical reduction measures. After decades of intensive research on agricultural GHG emissions no technical solution or set of reduction measures with a potential that would be sufficient to meet the necessary reduction for the 2 °C target (even less so for the 1.5 °C target) is in sight (Bajzelj et al. 2014; Bryngelsson et al. 2016; Garnett 2011; Hedenus, Wirsenius, and Johansson 2014). This is particularly true for the most important emission sources: methane emissions from enteric fermentation and nitrous oxide emissions from soils.
Supposedly effective reduction measures based on chemical enzyme blockers such as nitrification inhibitors (3,4-Dimethylpyrazolphosphat (DMPP), Dicyandiamid (DCD), Nitrapyrin, Etridiazol) or methane inhibitors for enteric fermentation (3-nitrooxypropanol (3NOP)) run the risk of yet unknown negative side effects and should be dealt with restraint under strict observance of the Precautionary Principle (UNESCO 2020). Furthermore, consumers can be very sensitive to chemical substances used in agriculture. Bad experiences with nitrification inhibitors in New Zealand advice to pursue these seemingly promising mitigation measures with caution.
Major potentials might be situated in the field of soil carbon sequestration. In particular, soil application of biochar or deep ploughing of arable land may lead to the build-up of higher stocks of soil organic carbon. However, several drawbacks such as large uncertainties, reversibility and saturation effects should be clarified.
One way forward might be a target-oriented program that promotes the simultaneous implementation of many technical measures. Examples are a system of maximum allowable nitrogen surpluses or a points-based system that prescribes a minimal score for different farm types. Such arrangements allow flexibility for individual farms to exploit site-specific potentials. The effect of the latter, however, remains limited if the major emission sources from enteric fermentation and manure management are not addressed.
In conclusion, technical measures on the production side are characterized by low reduction potentials and/or by trade-offs with other environmental impacts, as well as by technical problems with implementation and/or prohibitive costs. First experiences with pilot projects in Switzerland and abroad confirm this finding. Given this, a mitigation strategy based solely on technical, production-side measures does not seem a viable way to reach the goals of the Paris Agreement (1.5 °C or 2 °C target). This finding is also supported by the fact that agricultural GHG emissions in OECD(Organisation for Economic Co-operation and Development) -countries did hardly decline in the past decade, despite significant investments in research and development (OECD 2013). Furthermore, the lacking progress in reducing the ammonia- and nitrogen surplus problem should make us cautious regarding promised technical potentials. Accordingly, false trust in technical solutions should under no circumstances delay urgent action that address agricultural structures through a change in human diet and reduced food waste.

## Policies

All policies, namely financial incentives, should be designed in a way that they do not consolidate agricultural structures and production processes that cause negative environmental and social impacts. Any lock-in situation due to high investments that exacerbate further mitigation action must be avoided. Technical mitigation measures should also not hamper locally adapted production and should be designed in a way that does not contradict the fundamental properties of a climate friendly production system (Figure 6-3). A thorough analysis of all technical policy measures in this respect is essential.

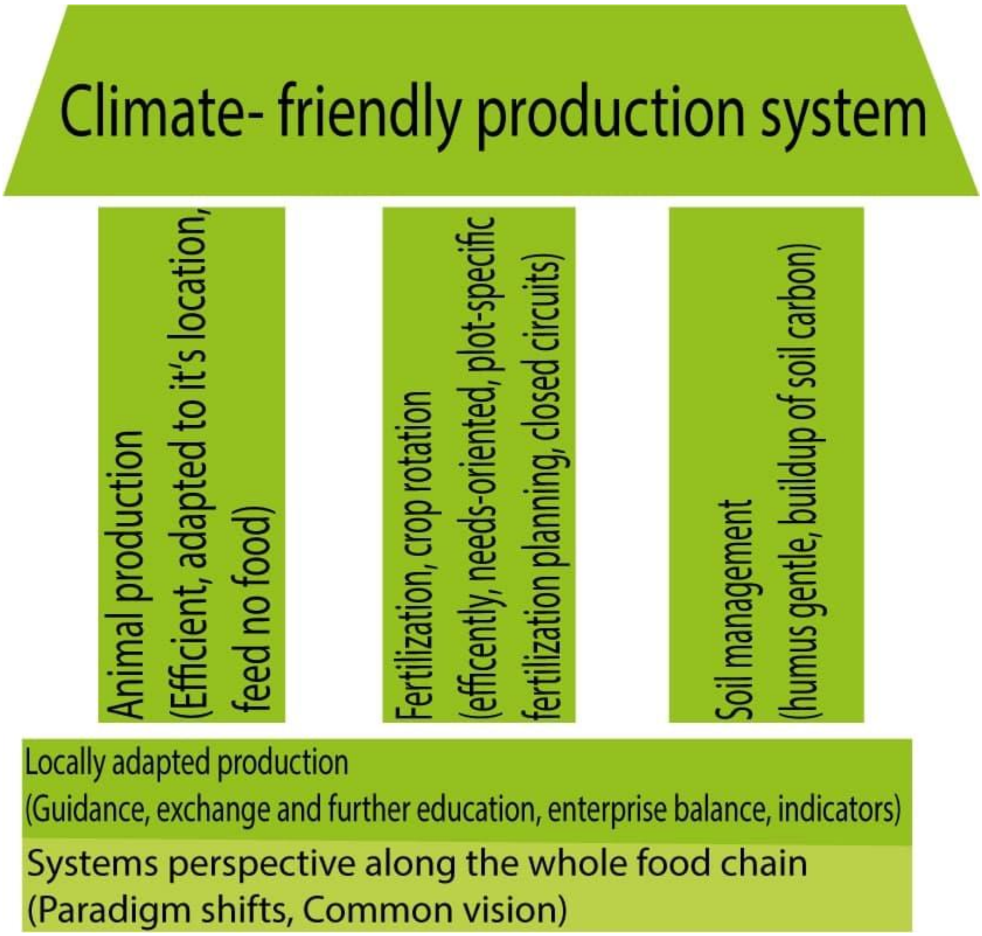



*Figure 6-3 Climate-Friendly Production System (original graphic in German:* (D. Bretscher and Felder 2019)*)*

## Economic Incentives that Allow the Implementation of Technical Measures

Ideally the producer price for the farmers should be high enough in order to allow the implementation of technical measures and produce accordingly to the best available and sustainable management practices. Internalizing all environmental and social costs can therefore be a prerequisite to this policy. The income of the farmers should allow them to dedicate sufficient time in the observation, analysis and optimization of their production system (soils, plants, animals, infrastructure). Likewise, farmers should be able to participate in capacity building programs and benefit from consultation services. As a last option individual technical measure can directly be subsidized.

## Research and Development

Research and development of promising mitigation measures such as feed additives to reduce methane emissions from enteric fermentation or measures to promote soil organic carbon sequestration should be promoted by dedication of sufficient financial resources. Applied research and investigation of implementation mechanisms on the farms should be strengthened. Among this, research studies that analyze the sociocultural background of the farmers and how their engagement can be raised.

## Overarching Programs and Access to Information

Overarching programs such as low emission breeding programs for livestock or geographical information systems to promote locally adapted agriculture should be financed and supported. Farmers should have free access to any other kind of information (scientific results, meteorological data, soil information etc.) that contributes to an optimized management.

# 7 Negative Emissions



# Current Situation

## Introduction

In the Special Report on Global Warming of 1.5 °C, the IPCC collected all emissions pathways published in scientific literature compatible with the 1.5 °C target. All of the 90 climate scenarios require the large-scale utilization of Negative Emissions Technologies (NETs, technologies to perform Carbon Dioxide Removal, CDR), starting between 2020-2030 and removing on average 32% of the 1990's annual emissions by 2050. NETs are used to extract CO2 from flue gases or directly from the atmosphere and store the CO2 securely away from the atmosphere for centuries to come. NETs are no alternative or excuse to mitigation but a needed addition if respective carbon budgets are exceeded. The technical, permanent removal of CO2 is energy intensive and expensive, therefore mitigation will be the economically most viable option in many cases. There exists a vast diversity of NETs, some are purely technological, others use plants or algae to extract the CO2 as a capturing method. The global potential

storage capacity is assessed to be more than 2000 Gt CO2 (IPCC 2018). All NETs are based on natural analogues, for example CO2 is stored in geological formations (sandstone sealed with clay and marl) in Montmiral in France since 15 million years (Pearce et al. 2004) or weathering of stone has been the main CO2 sink for the past 850’000 years.
Most likely, there will not be the single NET to be implemented globally, but rather selected NETs based on regional conditions. What all NETs have in common is their low level of deployment in 2020 and the subsequent lack of the economy of scale leading to high costs.

This chapter discusses the socio-economic effects of NETs, summarizes the most established NETs, their potential in Switzerland, and their price. In Switzerland, the most promising NETs are Biochar, Direct Air Carbon dioxide Capture and Storage (DACCS, if financed by Switzerland but securely implemented abroad), Carbon dioxide Capture and Storage (CCS) in Swiss cement- and waste incinerator plants, and soil carbon content/sequestration. These technologies are key for Switzerland to meet its share on achieving the 1.5 °C target. Hence, its prompt incorporation into any future emissions strategies is vital.

# Scientific Background

The need for prompt action is evident at least since the time of the first IPCC report in 1990 and has consolidated ever since. Research has shown that global warming is roughly proportional to the total amount of carbon dioxide released into the atmosphere (of which a substantial fraction remains in the atmosphere for thousands of years (Knutti and Rogelj 2015). Independently of the global mean temperature to be achieved (e.g. +1.5, +2, +4.5 °C) the earth keeps warming if CO2 emissions continue such that CO2 in the atmosphere accumulates (emissions exceed net zero) (Zickfeld et al. 2009).

The near-proportionality between cumulative CO2 emissions and global temperature also makes it possible to estimate the remaining carbon budget: the total amount of anthropogenic carbon dioxide that can still be emitted into the atmosphere while holding the global average temperature increase to the limit set by the Paris Agreement (Rogelj et al. 2019). This already shows the need for negative emissions, as eliminating all anthropogenic CO2 emissions seems highly unrealistic.

Negative emissions are realized when carbon dioxide is removed from the atmosphere and sequestered for a long period, through technological or biological processes. An example for a technological process is the capture of CO2 from ambient air done by Climeworks in Switzerland, and storing it permanently in deep geologic formations. This technology is, apart from large scale funding, ready for implementation. An example for a biological process is the removal of CO2 from the atmosphere by trees and the storage as wood. The wood can be used as construction material to avoid re-emitting captured GHGs back into the atmosphere. Currently, Switzerland exhibits only negative emissions in the sector LULUCF (Land use, land use change and forestry).

It should be highlighted that negative emissions are not a substitute for other mitigation efforts, but a completion. The goal is not to develop large scale carbon dioxide removal, but rather to stay within the extremely small remaining carbon budget to reach the 1.5 °C goal.

While negative emission technologies can compensate emissions and help to reach net zero, it is often assumed that after reaching net zero emissions it will be required to remove more CO2 from the atmosphere than is actually brought in, in order to limit global warming to 1.5 °C. The term for this scenario is called ‘net negative emissions’ (in contrast to NETs - negative emission technologies).

# Negative emissions in the IPCC scenarios

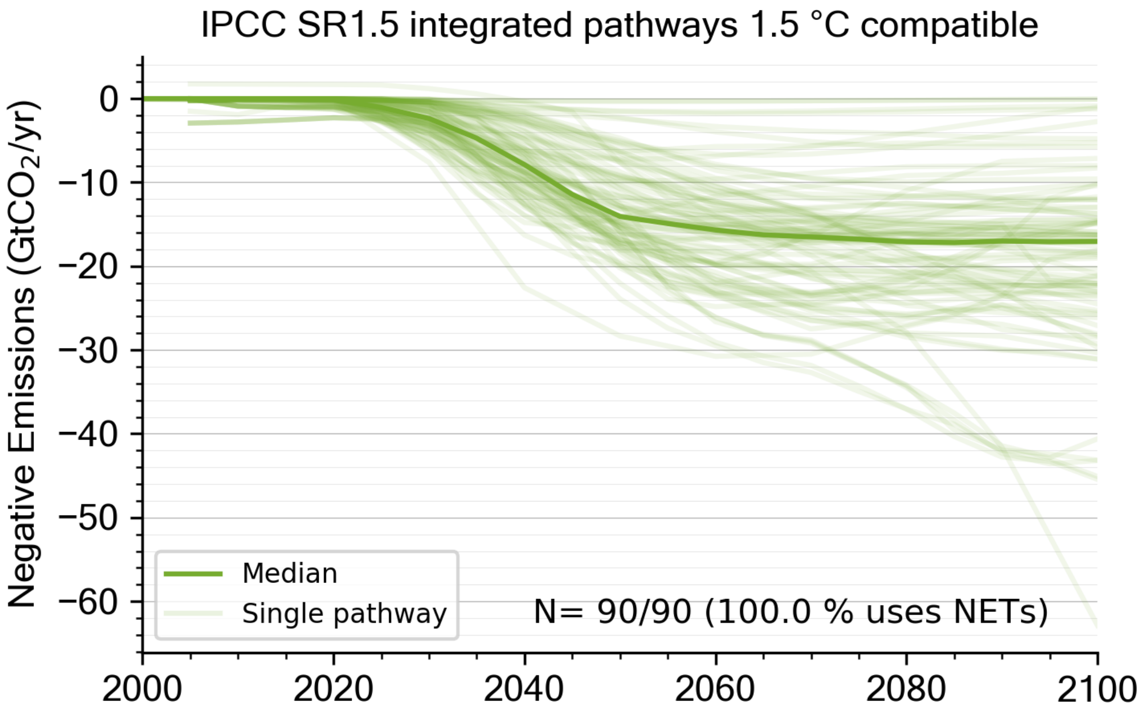



*Figure 7-1 Global Negative Emissions used in the 1.5 °C compatible integrated pathways of the 2018 IPCC Special Report Global Warming of 1.5 °C over time (Huppmann et al. 2018). All 90 pathways use NETs. The median of the pathways starts the usage of NETs by 2021.*

The total NET (technologies to perform Carbon dioxide removal, CDR, as referred to in the IPCC reports) deployment levels within the different 1.5 °C compatible scenarios with no or limited overshoot cover between 100 and 1000 Gt CO2 until the year 2100 (IPCC 2018) central role of NETs in the latest IPCC reports is a consequence of previous failures in global climate protection (FOEN 2019e).

All of the scenarios compatible with the 1.5-degree goal do not only use NETs to reach net zero, but after 2050 also to achieve total net negative emissions. I.E. they exceed the remaining carbon budget on the assumption that the exceeded amount will be taken out of the air by future generations.

The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net negative emissions after mid-century to return warming to 1.5°C (IPCC 2018).
An overshoot in atmospheric GHG concentrations for a few decades results in irreversible loss of biodiversity, e.g. a fish, which has died in hot water, cannot be simply brought back to life by lowering the water's temperature. Also, the overshoot might trigger tipping points, which upset the global ecosystems and make a return to the original state much harder.

A linear reduction of the global $CO_2$ emissions from 2020 until 2050 would exceed the remaining carbon budget for a 67%-chance to reach the 1.5 °C goal by about 260 Gt $CO_2$. Thus, the 1.5 °C goal, together with the goal net zero until 2050, always means a heavy reliance on net negative emissions.
For high (per capita) emitting countries like Switzerland, which have already used a large amount of the remaining carbon budget starting in 2018, net zero until 2050 is even less compatible with the 1.5 °C goal. Distributing the global remaining carbon budget from 2019 on (320 minus 40 Gt $CO_2$) equally under all word citizens would give Switzerland (annual consumption based $CO_2$ emissions of about 100 Mt $CO_2$) a remaining carbon budget of about 205 Mt $CO_2$ ((280/world population)*swiss population - swiss emissions since 2019). This means a linear reduction from now until 2024 is required from all Swiss residents, and not 2050, in order to stay within the 1.5 °C carbon budget.

There are enormous problems associated with reliance on net negative emissions.
One problem of the scenarios featured in the IPCC SR1.5 is that discounting rates of integrated assessment models (IAMs) were too high. “To ensure inter-generational equity and be coherent with cost-benefit analysis normative choices, we suggest that IAMs should use lower discount rates than the ones currently adopted” (Emmerling et al. 2019).
But the main problem might be that the models produce lowest-cost-scenarios, independent of the question whether these costs will be paid (Bednar et al. 2019). If more $CO_2$ should be taken out of the atmosphere than put into, the possibility of NETs financed by the polluters ceases to exist. This is the most important difference between the notions ‘negative emissions’ and ‘net negative emissions’.

Furthermore, there is no guarantee that all countries will participate in net $CO_2$ removal. On the contrary: not participating might be attractive. And countries who participated might punish the free riders by declining cooperation.
In addition, limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of carbon dioxide removal to decline temperatures after a peak (IPCC 2018).

Last but not least, reliance on future negative emissions are used to justify delays in mitigation efforts. The promise of future and cost-optimal NETs is more politically appealing than the prospect of developing policies to deliver rapid and deep mitigation now (Anderson and Peters 2016).
To understand the fundamental difference between the promise of negative emissions and the implementation of negative emissions, consider the result of the following two rules:

1. “What you emit today will be removed later”.
2. “You have to remove today what you emit today.”

The first rule means further delay in climate mitigation, the second rule means net zero emissions and at the same time provides an incentive to avoid emissions completely. Our policies give an approach how the second rule can be made enforceable as fast as possible.

All in all, the reliance on future net negative emissions, and also the promise of future negative emissions (not necessarily net negative), must be seen as an intergenerational deception. Therefore, we have to strictly reject overshoots – a period of warming over 1.5 degrees – as this might as well trigger tipping points in the climate system and go beyond other irreversible thresholds relating to, for example, biodiversity loss. We should rather try to stay within the global remaining carbon budget left to reach the 1.5 °C goal: Rapid emissions reductions and carbon capture from point sources as well as application of NETs as soon as possible.

Another possible point of view is, that we will need net negative emissions either because Switzerland has already exceeded its fair share of the global remaining carbon budget because of all historic emissions, or, for the case that all measures won't succeed and we will exceed the remaining budget of approx. 206 Mt CO2.
In our chapter we do not further consider such cases with net negative emissions for the following reasons:

- The problems arising with net negative emissions described above show that we should not plan to have net negative emissions.
- The first and most important challenge is to reach net zero as fast as possible. If afterwards net negative emissions will be declared necessary, we will have to face the difficulties described above.
- While trying to convince the population of the need for negative emissions, we already face difficulties without including all historic emissions. Thus, we try to focus on the current goal to reach net zero as fast as possible.

# Need of Near-Term Implementation of Negative Emissions

This chapter does not promote any promise of the possibility to remove current emissions later. It rather explains why we have to make negative emissions ready as fast as possible in order to facilitate real time removal of emissions that cannot be eliminated fast enough.

If Switzerland is to provide a minimally fair share to contain the global temperature increase as agreed in Paris, it must keep its remaining carbon budget below less than 265 Mt CO2 calculated in chapter political and economic structure (205 Mt CO2 if the global remaining carbon budget is distributed equally under all world citizens already from 2019 on), and reduce its non-CO2 greenhouse gases to net zero until 2030 for the following reasons:

- Switzerland produces most of its consumption-based emissions abroad (BFS 2018), where it cannot directly influence the production and transport process.
- Switzerland has a relatively low-carbon intensity, due to its low-carbon total primary energy supply (supported by 26% of renewable sources of energy, with 13% hydro and 23% nuclear) and its economy dominated by the service sector, with about a quarter share of GDP from industry where the manufacturing sector and energy-intensive process industries play a miniscule role (IEA, n.d.) Switzerland thus faces less difficulties to become carbon neutral than other countries.
- Switzerland's high gross domestic product per capita might lead to a bigger responsibility.
- Switzerland finances greenhouse gas emissions abroad. (see chapter international climate finance and collaboration and chapter financial sector.)
- Switzerland has relatively high historic per-capita-emissions. Thus, one could distribute the global CO2-Budget from an earlier point in history, such that Switzerland's remaining share of the global carbon budget from 2020 on would be much smaller.

Also, it is clear that some greenhouse gas emissions are inevitable, even with an enormous effort. None of the non-CO2 forcers reach zero in the 1.5 °C IPCC scenarios until 2100. If these GHG emissions are not eliminated, they have to be counterbalanced by negative emissions. Examples are remaining

nitrous oxide and methane emissions by agriculture or remaining carbon emissions by cement production and aviation.
Regarding the very small remaining greenhouse gas budget, it is irresponsible to keep postponing negative emissions on the assumption that our efforts to reduce our GHG emissions will succeed and GHG emissions will come down fast enough. As opposed to this, implementing negative emissions alongside all other mitigation efforts accelerates the greenhouse gas emissions reduction, and negative emission technologies (NETs) in particular accelerate the transition to a renewable energy supply.

Another reason for a fast implementation of NETs is, that in global comparison, Switzerland has already a very strong position in various carbon dioxide removal approaches, and should therefore already promote a corresponding structural change today in order to establish a leading position (first mover advantage) (Christoph Beuttler Jens Leifeld, Martin Schmid et al. 2019)

EASAC (2018) writes: “Despite the limitations of NETs (negative emission technologies), halting increases in the concentration of GHGs in the atmosphere remains a race against time, and humanity will require all possible tools to limit warming to within Paris Agreement targets.” In this Chapter we will show which kinds of negative emissions can be counted as “possible tools” for Switzerland.

In our chapter we do not further consider cases with net negative emissions as the problems arising with net negative emissions described earlier in the chapter show that we should not plan to have net negative emissions and the most important challenge is to reach net zero as fast as possible.

# Concerns and Misunderstandings about Negative Emissions

Nevertheless, there are concerns and misunderstandings about negative emissions. Being aware of them helps us to develop a concept that will serve its purpose.
In literature, it is mostly not distinguished between ‘negative emissions’ and ‘net negative emissions’, and studies that criticize the reliance on future negative emissions tend to question NETs as a whole due to their costs, energy demand, sustainability or immaturity, despite the fact that there are major differences across the wide range of NETs concerning these criteria. Examples are Anderson Peters (2016), Lawrence Schäfer (2019) and New Climate Institute (2019). The title of Anderson Peters (2016) is simply “The trouble with negative emissions”. This could lead to the misunderstanding that negative emissions should not be used at all. The point is, that costs and immaturity do not count as an argument against them: First, it is clear that a fast transition to net zero leads to costs, and second, immaturity is simply a consequence of lack of political will to implement carbon dioxide removal technology. NETs will always remain untested at the required scale, if no one will be obliged to pay for the industrial implementation. EASAC writes in its report (2018): “At present, economic incentives for deploying CCS are inadequate (whether through the very low carbon price or targeted government support), while those for NET development are lacking.”
While the difference between ‘negative emissions` and ‘net negative emissions` (which will always remain crucial, as explained above) is mostly ignored, problems with NETs that would be solvable within a near-term implementation are highlighted.
All in all, this leads to a further delay of the necessary negative emission policies.

Sometimes reports and studies even question the technologies as a whole, but do not question the assumption that these technologies will be used later in the century. An example is Proclim (2018).

The CIEL report (2019), as another example, criticizes technological approaches as a whole (but assumes natural net negative emissions (AFOLU) apart from 2050, according to the IPCC low energy demand scenario P1.)
One of these scenarios depending only on plant-based NETs is described in Grubler et al. (2018). This study concludes that meeting the 1.5°C goal is still possible without non-natural NET deployment, but the scenario of this study includes an afforestation of 300 million hectares and 168 Gt CO2 absorbed by forest sinks between 2020 and 2100. (Comparison: globally 205 Gt Carbon storage potential (758.5 Gt CO2) found by the ETH study Bastin et al. 2019). This might be still quite optimistic, if you consider the total warming effect of forests in snow covered regions, the reduced potential area due to global warming, and the fact that forests are no permanent carbon storages.

Also, critics are concerning the advantages fossil fuel industry tries to get out of NETs: Today, EOR (Enhanced Oil Recovery) is the only industrial use of CO2 that has reached an appreciable scale. (vox 2019) Carbon capture and storage is commercially valuable for oil producers because of carbon dioxide's usefulness in enhanced oil recovery. (CIEL 2019) It is clear that fossil fuel companies are interested in developing and investing in NETs and also active in the development and promotion of CCS (CIEL 2019), for example through the Global CCS Institute (CIEL 2019).

As a consequence, policies to implement NETs must be constructed in a way that avoids subsidizing the fossil fuel industry, and thus avoids prolonging and expanding a business model that needs to be radically phased down.
One of these policy measures could be a high greenhouse gas levy for any net greenhouse gas emissions. CO2 sequestration from the air (for example through DACCS, direct air carbon capture and sequestration), in return, should be awarded a premium. That premium can be paid from the revenue collected through the CO2-levy.
Actors who would emit CO2, (for example cement plants) but store some of this CO2 permanently, will pay the greenhouse gas levy only for the remaining amount of CO2 emitted. Like this, avoiding emissions would be more attractive than producing them and removing them afterwards.

The levy should at any time exceed the premium paid for sequestration — in order to avoid subsidizing fossil energy use into the future. If the CO2-levy stands much higher than the sequestration premium, CO2 utilization for the production of carbon-based synfuels are incentivized as well. Energy required for the removal must be renewable energy. This could lead to an additional boost for renewables. Realmonte et al. (2019), for example, concludes that deploying DACCS significantly reduces mitigation costs, and that it should be developed and deployed alongside, rather than instead of, other mitigation options.
This should illustrate that possible problems arising from the implementation of NETs, mentioned by CIEL (2018) for example, are solvable, and avoiding (or postponing) NETs does not mean choosing the most cost-efficient way.

# Vision

Switzerland exercises its responsibility with determination. In 2021 it starts realizing a just, socially accepted and environmentally compatible way of including negative emissions into its mitigation efforts, in order to stay within its small remaining carbon budget of not more than 265 Mt CO2eq, counterbalances unavoidable non-CO2 greenhouse gas emissions until 2030 and provides other countries its knowledge about including carbon dioxide removal into mitigation policies.

# Policy Measures

The goal is to have a socially detrimental pathway for net zero greenhouse gas emissions. Emissions should be prevented from 2030 onwards - or if this is not possible - compensated with NETs.
From a physics point of view, Switzerland's greenhouse gas emissions do not have to be removed within Switzerland. Crucially, for all negative emissions to be climatologically effective, long term storage has to be achieved. This has to be controlled and guaranteed when deploying negative emissions abroad e.g. by an independent international body. In addition, negative effects on the foreign environment or population have to be ruled out.

## Policy 7.1: Negative Emissions Financing through Greenhouse Gas Pricing

Assumption: NET costs 200 Fr./t in 2030 (mean value of the assumptions of Fuss et al. 2018)
Goal: a socially and economically acceptable way that all greenhouse gas emissions are either avoided or compensated in real terms via NETs in 2030 - i.e. net zero is reached in 2030. From 2030 onwards, only greenhouse gas emissions compensated in real terms by NETs are allowed. To ensure that NETs are available at affordable costs in 2030, an annually increasing portion of the CO2 tax must flow into NET projects as start-up financing from now on. In this way, the plants are manufactured industrially and become more cost-effective - the goal is to achieve costs below 200 Fr./t. In addition to the CO2 tax, the air ticket tax is also suitable as start-up financing.

- Initially for example 5% of the increasing CO2 tax of CHF 120 starting 2021 and CHF 525/t CO2 by 2030 must be used for the real compensation of emissions with NETs, the rest is redistributed per capita. The proportion that flows into NETs is increased by 5% each year. It can be assumed that by then the price of NETs will have fallen to 200 Fr./t and thus with the CO2 tax all emissions can be removed from the air in real terms (net zero).
- The path of the slowly increasing NETs share in the subsidy levy is socially and economically compatible: CO2 emissions will decrease sharply, thereby stabilizing per capita spending on NETs at a low level.

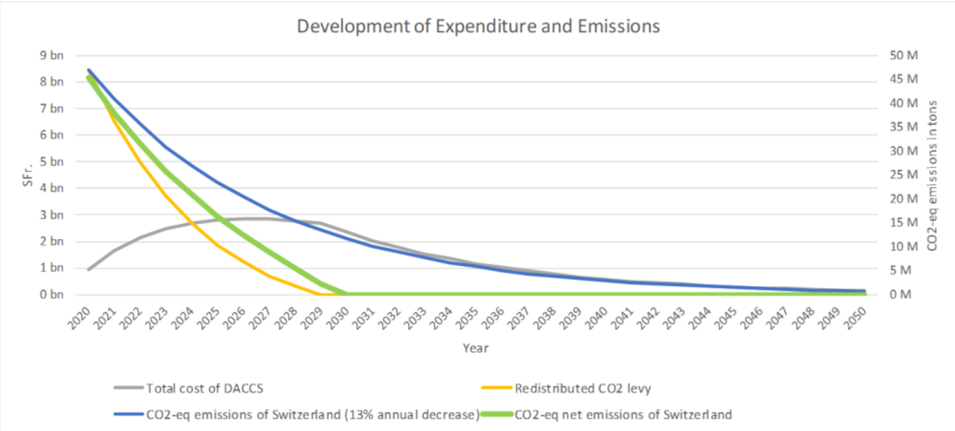



*Figure 7-2 Possible emission pathway for Switzerland with 13% annual decrease and the usage and costs of NETs reaching net 0 GHG emissions by 2030.*

Further remarks:

- The $CO_2$ levy might not lead to a sufficiently strong reduction in emissions - therefore it is important that DACCS is reserved for emissions that are difficult to avoid and that easily substitutable applications such as combustion engines, oil and gas heating systems etc. are banned. To achieve net zero only through prices would require enormously high $CO_2$ taxes.
- The tax is called $CO_2$ tax - but it should apply to all greenhouse gas emissions - simply converted to $CO_2eq$
- This tax requires a border tax adjustment to protect the domestic industry from competitors who do not have a comparable $CO_2$ tax.
- If the price of NETs continues to fall after 2030, $CO_2$ emitters can use NETs to buy themselves free from the $CO_2$ tax - the government tax of 200 Fr./t is therefore the upper limit.
- A sensible distribution key between the different NETs has to be elaborated.
- However, only negative emission technologies are allowed, where a storage of $CO_2$ of >90% over at least 100 years can be expected to be as good as certain (virtually certain). This excludes compensation methods that only simulate artificial $CO_2$ compensation, such as forestation or protection against deforestation.
- Investments must also be made in technologies that are not the cheapest from the outset, but have the potential to store large quantities of $CO_2$ and become attractively priced (start-up financing).

# Policy 7.2: Obligation to Compensate Emissions of Imported Goods

Switzerland neutralizes its consumption based GHG emissions. The emissions from the production and utilization of all imported goods/energy carriers into Switzerland must be negatively compensated by 1% in 2022. The fraction of total emissions for which negative emissions have to be bought increases to 2% in 2023, 4% in 2024, 8% in 2025, 16% in 2026, 32% in 2027, 64% in 2028, 85% in 2029 and remains at 100% in/after 2030, thereby mimicking a learning curve. The importers pay providers to remove this percentage of $CO_2$ out of the atmosphere and store it for the long term. This creates a market that sets a real $CO_2$ price and reduces the demand for GHG intensive goods and services. It also ensures that $CO_2$ will be offset in the long term and that net zero will be reached in 2030, which is in line with the 2015 Paris Agreement. An economic incentive is also created to either mitigate, or not to mitigate and, in turn, pay for the disposal of the resulting emissions. Purchases of negative emissions are possible in Switzerland or abroad and can be credited in an equivalent manner. Independently of the storage location, only negative emission technologies are permitted in which $CO_2$ storage of more than 90% for at least 100 years is expected to be virtually certain. This excludes simple afforestation or forest preservation, well established methods to artificially offset $CO_2$ in 2020. Methane and nitrous oxide emissions have to be compensated with negative $CO_2$ emissions, with an identical annual increase in percentage. The amount of $CO_2$ to compensate is calculated using $CO_2$ equivalents (e.g. 1 t methane emitted = 34 t $CO_2$ to be negatively compensated, 1t nitrous oxide = 298 t $CO_2$). A product specific cross-border adjustment should be introduced for imports and exports of greenhouse gas intensive products. It would be paid at importing from and received at exporting to countries with less strict $CO_2$ policies.

# Policy 7.3: Subsidy of NETs with Refunded General Greenhouse Gas Levy

In order to attract investments into NET-technologies, investors need security of investment. This policy guarantees companies or privates a fixed subsidy for each ton of CO2 verifiably removed from the atmosphere over a predetermined period of time. The subsidy per ton of removed CO2 is gradually reduced as Switzerland's NET capacity is scaled up. During the scale up the costs per ton of removed CO2 decreases steadily over time and approaches the level of the implemented steering tax at some point in the future.
The subsidy per ton of CO2 removed is specific to the NET involved. The level of compensation applied to each NET is determined by the NETs portfolio Switzerland aims for post-decarbonization. The composition of that portfolio requires a comprehensive analysis of benefits and risks of constituent NETs, including potential scalability, cost, side-effects and so on.

With this approach, a clear incentive towards a technology portfolio of choice could be provided, avoiding long-term costs resulting from lock-in effects arising from the scale-up of inappropriate NETs due to short-term business considerations. This extends the incentive structure not merely away from fossil fuels (arising from a greenhouse gas levy), but towards a desired end state. It would also reduce one of the main impediments for the flow of capital into novel technological endeavors: investor risk aversion. By guaranteeing compensation, the fat-tail of losses in the return on investment distribution are curtailed. Thus, with downsides managed, investors can focus on potential upsides, which will increase investment. Third, the approach can be naturally combined with any greenhouse gas levy laid out above. The financing of the subsidies can be implemented flexibly.

# Recommendations

## Until when do these Policies have to be Implemented?

As seen above, there are several political approaches on how Negative Emission Methods could be implemented. However it is crucial to understand that without political support of these technologies, Switzerland will not be able to stay on the pathways necessary for the Paris Agreement (IPCC 2018). The political approaches must be implemented as quickly as possible.

## Distribution of Financial Support in Between the Different NETs

In the first and the third approach mentioned above the state will have to decide how much money will be invested into which negative emission method. At this point we would like to refer to the illustration in the first part of the synthesis which compares the potential, cost and side-effects of each negative emission method for Switzerland.
Since some of the methods still need more research for a clear estimation of their potential in Switzerland it would make sense to create a group of experts which works out a strategy on how to invest into the different technologies. Another possibility would be to create a market for negative emissions and compensate as many emissions as possible with the available money (taking sustainability aspects into account).

## Alternatives to Levy on Greenhouse Gases

Taking into account that not all swiss people rely on fossil fuels the same way (for example rural vs urban regions), the money for the financing of NETs could also be raised with a tax independent of the

fossil fuel consumption of each individual. This might give financial relief for the people with a high dependency on fossil fuels, but it would not be compatible with the polluter pays principle, which is written down in article 2 of the environmental protection act (USG) and article 74 in the Federal Constitution in Switzerland.
For further proposals on greenhouse gas pricing, see chapter cross-sectoral policies.

# Negative Emission Technologies

$CO_2$ removed from the atmosphere can either be stored directly in suitable, secure long-term geological reservoirs, by accelerated natural weathering processes of rock, or converted by plants into biomass, which can then be additionally injected into the soil as a carbon-rich substance.

## Carbon Storage

### Description of Policy

In Switzerland, saline aquifers should be made accessible to act as storage facilities for CCS projects: Create a legal framework for the safe geological storage of carbon dioxide, similar to the EU's CCS directive that has been in place since 2009. In this directive, it is for example written that a site can only be selected if a prior analysis shows that, under the proposed conditions of use, there is no significant risk of leakage or damage to human health or the environment.

The capture of $CO_2$ can be described as noncritical and will probably be regulated by conventional building permit procedures. The Pipeline Act would also be responsible for the legal framework of $CO_2$ transport (Sutter et al. 2013).

Before Switzerland's saline aquifers are accessible, the effort on the demonstrator of a full CCS chain at KVA Lindt with storage below the North Sea should be scaled up (ETH Zürich, n.d.). Demonstrate the end-to-end feasibility by implementing the 100'000t project in Linth.

- Design of a transport network, for collection of the $CO_2$ within Switzerland and connection to continental storage facilities.
- Make the 32 large point-emitters "capture-ready" through coordination of all ongoing feasibility studies and consistent build-up, sharing and pooling of $CO_2$-specific technical knowledge.
- Develop the necessary regulatory framework (Safety regulations for $CO_2$-transport within Switzerland and cross-border, integration of permanent storage in climate change law, liability and insurance in case of failure of the transport or storage facility, contract with storage company, international agreement between emitting and storing countries).
- Set up the long-term financing (polluter-pay principle, climate fund, compensation project, tax, etc.)

The following laws and acts need to be supplemented by CCS regulations:
- Federal Act on the protection of waters (GSchG, Art. 6-9 und 22-25)
- Waters protection Ordinance (GSchV, Art. 10)
- $CO_2$- law

The technologies DACCS and BECCS (bioenergy carbon capture and storage) require large amounts of inexpensive renewable energy, being more abundant abroad than in Switzerland. To make DACCS and BECCS usable for Switzerland, a legal framework for geological carbon dioxide storage abroad is required.

Misconceptions and misinformation lead to negative perceptions of geological storage in porous rocks, but it has been proven to be safe. For example geological CO2 retention was assessed as 98% over 10,000 years for well-managed reservoirs, and 78% for poorly regulated ones (Alcalde et al. 2018). Natural geological CO2 storage, which has existed for millions of years (Pearce et al. 2004), and anthropogenic analogs (seasonal natural gas geological storage) have additionally demonstrated long term safety.
A specific example for carbon storage abroad are the northern European offshore storage projects (either CO2 transport or local capture via DACCS). For example, Norway is considering to open up their offshore geological reservoirs to all European CO2 emitters by 2024. The Norwegian Parliament will make an investment decision for the project in 2020/2021. The project will then be able to commence operations in 2023/2024 with a planned capacity of approximately 5 million tons of CO2 per year (Eckle et al., 2019).

## Description of Technology

Highly concentrated CO2 from the flue gas or from ambient air is extracted and pumped to underground rock formations, capable of providing long term geological storage. The CO2 is thereby first trapped in pores of porous rock, such as sandstone. In a second step, it is dissolved into the already present brine, forming carbonic acid within the brine. The brine reacts in a third step with minerals to form carbonates. A suitable underground geological formation is also equipped with an impermeable cap rock to provide redundancy. An analogue technology has been used for seasonal natural gas storage in Europe and the US for more than 45 years. In the US alone 3720 billion cubic feet of natural gas are stored between seasons (eia 2020). The volume is equivalent to 229 Mt of CO2. The seasonally stored volume of natural gas in Germany is equivalent to 61 Mt of CO2.
Globally, CO2 can be stored in different geological formations (Fuss et al. 2018):

- Empty oil and gas wells. These were gas-tight for millions of years and thus enabled the formation and storage of these fossil hydrocarbons.
- Coal seams that have not been mined: Carbon can store CO2 like "activated carbon".
- Basalt rock: young basalt rock reacts with CO2 to form carbonate rock. CO2 is thus securely bound (Snæbjörnsdóttir et al. 2014)
- Saline aquifers: deep, water-bearing rock strata - these could probably absorb 500 Mt CO2 in Switzerland (see subsection impact below), worldwide the potential is many times bigger (IPCC 2018).

## Impact

According to the IPCC SR 1.5 report, there are huge storage capacities of at least 2,000 Gt and a maximum of 55,000 Gt CO2 available worldwide (for comparison: currently less than 40 Gt CO2 are emitted worldwide per year). The security of the storage facilities is considered high in IPCC SR 1.5. Thus, worse CO2 storage facilities should retain 78% of the CO2 over 10,000 years, whereas good CO2 storage facilities should retain 98%.
The bottleneck is not the storage option, but the separation of CO2 from the air or exhaust gases. Upon contact with Prof. Dr. Larryn Diamond, a leading Swiss geologist in the field of carbon storage, the potential storage in Switzerland is in the order of 500 Mt CO2. There is an opportunity to investigate the suitability of Switzerland’s subsurface for CO2 storage in conjunction with the current subsidy programs intended to characterize the subsurface for geothermal energy utilization (Eckle et al. 2019).

## Financing

The storage of CO2 in underground rock formations is the same for the capturing methods DACCS, BECCS and CCS. For information about the prices see the regarding subchapters.

# Carbon Usage

## Description of Technology

Instead of storing the CO2 in a safe deposit, it could be used as a raw material. The demand for CO2 itself is extremely low compared to the emissions. It is suitable as a refrigerant, as carbon dioxide for beverages, for fire extinguishers, etc. A much higher demand results if the CO2 is converted into other substances with a high energy input. In this way, CO2-neutral fuels "Synfuels", plastics and chemicals for the chemical industry can be produced. In principle, this requires reversing the combustion of the carbon with the help of renewable energies - the CO2 must be reduced again. This is done in reactors, where the CO2 is reacted with regeneratively produced hydrogen and suitable catalysts.
It is important to note that the use of CO2 does not contribute to negative emissions, as the substances produced from it are re-combusted relatively quickly, thus releasing the CO2 back into the atmosphere.

## Impact

The impact is expected to be small. If it is possible to safely store CO2 in suitable geological formations as predicted in the studies, there is little reason to believe that CO2 removed from exhaust gases or air will be converted back into synfuels or chemicals with a high energy input instead of being disposed of directly. Calculations by Gabrielle et al. (2020) and Hostettler (2020) have shown that the demand for renewable energies for the production of synfuels from CO2 is five to seven times higher (Hostettler 2019) than if kerosene is burned conventionally and then neutralized by DACCS. Gabrielle et al. (2020) arrive at comparable results for the question of whether raw materials for the chemical industry should be produced using CCUs (Carbon capture and usage).

## Financing

Due to the enormously high energy demand, this technology will have a very difficult economic position compared to the further use of oil as a raw material in combination with DACCS or CCS for CO2 extraction. As the global demand for crude oil will collapse due to climate protection, the prices for crude oil for non-substitutable applications (plastics, aviation, chemical industry, etc.) will fall sharply, as crude oil will only be extracted from the most suitable sources - even in combination with DACCS or CCS low costs will result, while CCU and DACCU are very costly, especially due to the downstream conversion of CO2.

# Carbon Capturing (DACC)

## Description of Policy

It must be stipulated by law that DACCS installations financed by Switzerland abroad are credited to Switzerland as negative emissions. This is possible because of the Paris Agreement 2015 Article 6.2, 6.3, 6.4 (Christoph Beuttler Jens Leifeld et. al 2019).
There are many indications that DACCS is an interesting and important option for Switzerland, but that the procedure itself will not be carried out on Swiss soil. The main arguments against this are the large demand for renewable energies and the fact that it makes sense to carry out DAC only in places where the CO2 can be stored immediately. Only in this way high transport costs can be avoided.

## Description of Technology

Direct Air Carbon Capture and Storage (DACCS) means that CO2 is extracted directly from the air. The systems suck in normal air and bring it into contact with a sorbent that reacts selectively with CO2, thereby absorbing it. Once the CO2 absorption capacity of the sorbent is reached, it is heated to release the CO2 as a pure substance. The sorbent can then be used again for CO2 removal.

The sorbent can either be a granulate that binds CO2 to itself on the surface or a liquid that can absorb CO2 in large quantities. Suitable granules are amine-functionalized substances (climeworks, n.d.) while the liquid used in many chemical processes is sodium hydroxide solution.

Since CO2 is present in the atmosphere with a concentration of only 0.04 %, the energy requirement for "filtering out" the CO2 with approx. 250 kWh of electrical energy and approx. 1800 kWh of thermal energy per ton of CO2 is relatively high (Fasihi, Efimova, and Breyer 2019). Most of the energy is required as thermal energy for heating the sorbent so that it can release the CO2. A smaller part is required in the form of electrical energy, mainly for the operation of the fans.

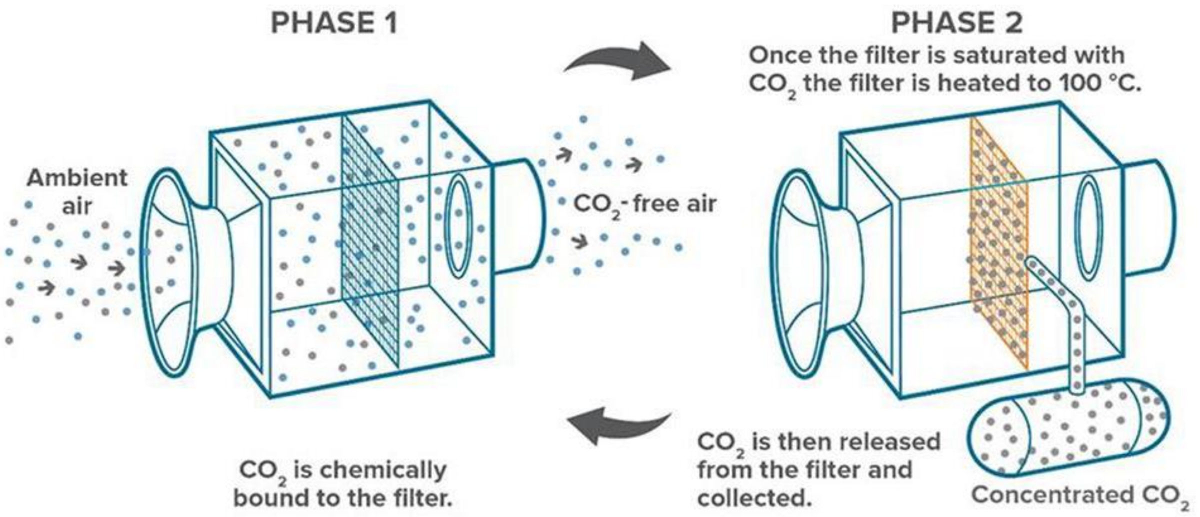



*Figure 7-3 Schematic representation of CO2 removal from the air (DAC) (Beuttler et al., 2019)*

## Impact

The IPCC SR 1.5 Report refers in chapter 4.3.7.5 on Carbon Dioxide Removal mainly to the study by Fuss et al., (2018) According to this study, DACCS will be able to remove 0.5-5 Gt CO2 per year from the air at a cost of 100-300 US$/t CO2.
In Switzerland itself, the potential of DACCS will be very small: no very cheap renewable energies are available. However, if plants built by Switzerland abroad are allowed to remove CO2 from the atmosphere and this CO2 is credited to Switzerland, the technology has enormous potential.

The limit is thus set by the cost: the cost of DACCS will make it more attractive for most applications to avoid CO2 emissions instead of having the CO2 subsequently removed from the air by DACCS. From a global perspective, the storage capacities for CO2 extracted from the air are sufficiently large: minimum 2,000 Gt CO2, maximum 55,000 Gt CO2 (IPCC 2018).

## Financing

Although the technology has been researched, no major facilities are yet in operation, so the current price is between 600-800 Swiss francs per ton of captured and sequestered CO2. It is assumed that the price will decrease to about 100-300 US$ per ton (Fasihi, Efimova, and Breyer 2019) as soon as the technology is used on a larger scale.

### Social Compatibility

If it should be necessary to use NETs abroad, negative effects on the foreign environment or population have to be ruled out.

### Questions and Uncertainties

As long as it is free to dispose of CO2 in the atmosphere, DACCS cannot work at all - there is no market for CO2 removal from the air. Even today's existing CO2 control levies are far from the current price of DACCS, which is currently in the range of 600 - 800 Swiss francs per ton of CO2. By contrast, future CO2 levies are likely to be higher than the likely price of DACCS in the future (approx. 100-300 Fr./t), so the method in itself has enormous future potential. The open question remains as to who will finance the scaling up of this technology and thus help to reduce costs while it is still more expensive than the CO2 taxes. This hurdle must be overcome in order to make the breakthrough possible.

# Carbon Capturing (Bioenergy Carbon Capture)

### Description of Technology

Bio-energy with carbon capture and storage (BECCS) is a negative emission technology to extract CO2 from the carbon cycle (atmosphere, lakes or ocean) and store it securely in geological underground formations for millennia. It is a negative emission technology highly advocated by the IPCC Special Report on Global Warming of 1.5 °C because of its renewable energy allocation, low cost, low ecological footprint and long-term storage capability. However, the high land use (scientifically justified), loss of biodiversity (scientifically justified), and safety concerns of geological storage (scientifically unsupported) are critics of the technology.
Fast growing biomass, e.g. algae, grass, bushes and trees are grown, thereby locking ambient CO2. The heat during the subsequent incineration process can be used to generate electric power or provide heat for the industry or to feed a district heat network. Highly concentrated CO2 from the flue gas is extracted and pumped to underground rock formations, capable of providing long term geological storage. The CO2 is thereby first trapped in pores of porous rock, such as sandstone. In a second step, it is dissolved into the already present brine, forming carbonic acid within the brine. The brine reacts in a third step with minerals to form carbonates. A suitable underground geological formation is also equipped with an impermeable cap rock to provide redundancy. An analogue technology has been used for seasonal natural gas storage in Europe and the US for more than 45 years. In the US alone 3720 billion cubic feet of natural gas are stored between seasons (eia 2020). The volume is equivalent to 229 Mt of CO2. The seasonally stored volume of natural gas in Germany is equivalent to 61 Mt of CO2.
Compared to afforestation, BECCS needs 2.5 times less land use to sequester the same amount of CO2. However, direct air capture and storage (DACCS) needs an additional 750 times less land use (including PV to power DACCS)(climeworks n.d.) and is therefore the preferable technology compared to BECCS, despite the higher price at this point in time. Besides, water usage is close to non-existing in DACCS.

### Impact

The predicted future potential for BECCS is sufficient to remove a substantial part of Switzerland's emissions. The two main challenges for large-scale implementation are biomass production and further research in identifying suitable geological storage locations. Biomass production is in close competition with food production, in Switzerland and globally. Biomass as a waste product of food production can be utilized for BECCS. Dedicated analysis for Switzerland is non-existing at this time. The Biomass of crop residues captures approximately 1.4 Mt CO2/year (see section biochar). The IEA Greenhouse Gas Technology Collaboration Program (IEAGHG) assessed the global potential for BECCS to 10 Gt CO2 per year (IEAGHG 2019).

## Financing

No pricing estimations exist so far for Switzerland. Global assessments estimate 100-200 $/t CO2 (Fuss et al. 2018).

## Social Compatibility

Unjustified fear of geological CO2 storage is evident amongst Swiss citizens. False friends, e.g. fracking, geological heat or nuclear waste storage produce negative affections towards the technology. In addition, the immense land use footprint is competing with food production and lowers biodiversity, if not well controlled and optimized for CO2 sequestration.

# Carbon Capture in Industry

## Description of Technology

CCS (carbon capture and storage) is the process of capturing waste CO2 usually from large point sources, transporting it to an underground facility and storing it permanently. Due to higher CO2 concentrations at point sources than in ambient air, the capturing process is more energy efficient at point sources.
In Switzerland there are currently about 32 big point sources (cement industry, waste incinerator plants, refineries, 1 gas power plant, chemical industry and biomass plants). Together, they emit about 5 million tons of fossil CO2, plus 2 million tons of biogenic CO2 (ETH Zürich, n.d.).

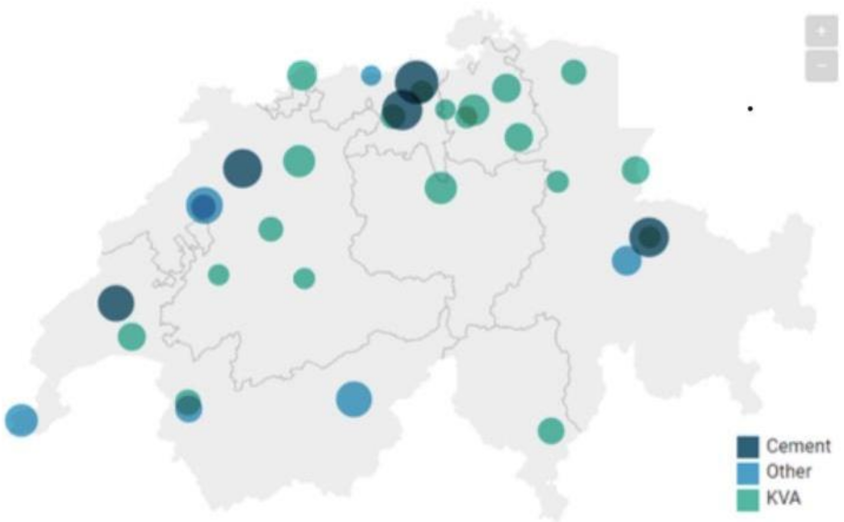



*Figure 7-4 ETH Zürich: NET ZERO by 2050. Decarbonizing large emitters in Switzerland (Group for Sustainability and Technology ETH Zürich)*

The following reasons indicate that CCS appears to be the most promising path to drastically reduce CO2 emissions in swiss industry (ETH Zürich, n.d.):

- From a climate protection perspective, taking action to decarbonize large emitters is a must. Capturing CO2 and storing it in deep geological formations is much better than continuing CO2 release in the atmosphere
- From a physical perspective, the mechanism governing storage and long-term stability are well understood. CO2 will be trapped in microscopic rock pores, the same mechanism that has trapped natural gas for millions of years.
- From a technical point of view, storing more than 23 Mt of CO2 over the course of 20 years at Sleipner and other sites in Norway show that CCS works.
- From a safety point of view, the long-term stability of the storage can be monitored. It is possible to measure where the CO2 is and that it stays there. In the Northern Lights project, extensive testing of the measurement equipment is currently underway in preparation of opening the first storage site (Aurora).
- From a legal point of view, the EU has already set the regulatory framework in 2009 with the Directive on Geological Storage of Carbon Dioxide (EU CCS Directive). The Norwegian Aurora site will comply with the EU CCS Directive. Further examples of CCS-Regulations can also be found outside Europe (California).

The chemical industry for example faces a special challenge in being desilicated, as an overwhelmingly large fraction of chemical products contains carbon, mostly originating from fossil-C. Gabrielle et al. (2020) compared three technology chains (CCU route, Bio-route and CCS route) that enable a carbon neutral chemical industry, and highlighted the following advantages of the CCS route:

- It can exploit the existing technology and the infrastructure in place of the current petrochemical and chemical industry, without the need of a complete reshaping of it.
- In the case of methanol production, the CCU route results in an electricity consumption 10 to 25 times higher than that of the CCS and BIO routes (excluding the electricity required for heat production), mostly due to the electricity required to produce hydrogen, and the Bio route requires a land capacity about 40 and 400 times higher than that required by the CCU and CCS routes, respectively.
- CO2 capture from point sources and/or from air plus permanent CO2 storage in geological formations constitute the key elements of the negative emissions technologies, on which future scenarios targeting a global warming below 1.5 ° or 2 °C rely.

If applied to flue gas from fossil based materials or cement production, CCS is at best carbon neutral. It only produces negative emissions when carbon dioxide from biogenic material combustion is captured (which is denoted as BECCS, see 3.2.2). Nevertheless, it plays a major role in decarbonizing the industry sector in the context of 1.5 °C and 2 °C pathways, especially in industries with higher process emissions, such as cement, iron and steel industries. IPCC (2018) states: “In the IPCC 1.5 °C-overshoot pathways, CCS in industry reaches globally 3 GtCO2 yr−1 by 2050, albeit with strong variations across pathways. Given the projected long-lead times and need for technological innovation, early scale-up of industry-sector CCS is essential to achieving the stringent temperature target. Development and demonstration of such projects has been slow, however. Currently, only two large-scale industrial CCS projects outside of oil and gas processing are in operation (Global CCS Institute, 2016).”

Volkart et al. (2013) found that the implementation of CCS leads to life cycle GHG emission reductions of 68–92% for fossil power generation and 39–78% for cement production whilst to negative ones for wood power generation.
CCS was already discussed in the context of the need for up to seven natural gas combined cycle (NGCC) power plants after the decision to phase out nuclear energy (Sutter et al. 2013), (Wallquist and Mischa Werner, n.d.), (Thalmann and Vielle 2019).

Broadly speaking, there are three different $CO_2$ capturing methods:
- pre-combustion capture (fossil fuel is decarbonized before the combustion) (no installation into existing plants possible)
- post-combustion capture (installation into existing plants possible)
- oxyfuel combustion capture (nitrogen is isolated from the process, which leads to a pure $CO_2$ waste gas stream)

CCS should be applied in the following two industrial processes in Switzerland:

**Cement sector**

There are 5 cement plants in Switzerland, each of which emits between 500'000 and 600'000 t $CO_2$ per year, together 2.7 Mt$CO_2$ per year, which is 38% of the $CO_2$ rich flue gases in Switzerland (Kober et al. 2019)

These emissions occur from different processes:
"Emissions of geogenic $CO_2$ occur during the production of clinker, which is an intermediate component in the cement manufacturing process. During the production of clinker, limestone, which is mainly calcium carbonate ($CaCO_3$), is heated (calcined) to produce lime (CaO) and $CO_2$ as by-product. The CaO reacts subsequently with minerals in the raw materials and yields clinker. During this reaction step no further $CO_2$ is emitted. Clinker is then mixed with other components such as gypsum to make cement. Blasting operations in the limestone quarries are another source of emissions for both $CO_2$ and precursor greenhouse gases such as $NO_x$, CO, NMVOC and $SO_2$." (Switzerland's Greenhouse Gas Inventory).

Total annual geogenic $CO_2$ emissions: about 2 Mt $CO_2$ (Chapter Industry), total $CO_2$ emissions from fossil fuel combustion: 378000 t $CO_2$ in 2018.
An additional amount of the cement plant's $CO_2$ emissions occurs from fossil fuel combustion. If the total annual emissions from cement industry are assumed to be 2.7 million t $CO_2$ (Kober et al. 2019), using the values of the life cycle analysis by Volkart et al. (2013), cement plants could reduce their $CO_2$ emissions by between 1 and 2.1 million t $CO_2$. Between 0.6 million and 1.7 million tons $CO_2$ would remain (under current production rates) and would have to be counterbalanced through other negative emissions methods, if the moratorium on new infrastructure demanded in chapter cross-sectoral policies is not implemented.

**Waste incinerator plants**

There are 30 waste incinerator plants in Switzerland (ETH Zürich, n.d.). Together, they emit a total of approximately 4.4 million tons of $CO_2$ per year - about half of these emissions are fossil-based, and the other half biogenic (ETH Zürich, n.d.). While Carbon Capture has been done for decades (for example in the chemical industry at Lonza, ammonia-based), the application to waste-to-energy plants is starting now. One waste-to-energy plant in the Netherlands uses CCS since 2019 (Duiven, NL). At KVA Lindt, there is currently a demonstrator for the full CCS chain in preparation.

Amine-based $CO_2$ capture can be implemented at scale at Waste-to-Energy-plants with a $CO_2$ capture efficiency of about 90% (vbsa 2019). A recent IEAGHG study suggests that increasing $CO_2$ capture rate to 99% could be achieved at an 8% cost increase. Thus, more than 90% of the biogenic 2.1 Mt $CO_2$ could be counted as BECCS, and thus negative emissions.

As $CO_2$ capture requires substantial amounts of thermal energy and this thermal energy could be converted to electricity, using it for $CO_2$ capture has an opportunity cost for power generation of

approximately CHF 46 per ton of $CO_2$ captured, rising to CHF 75 if the energy-intensive steps of purification and liquefaction are included.
Although VBSA/ASED/ASID expects the waste composition to shift toward less plastic waste and more biogenic waste, the overall $CO_2$ emissions from WtE-plants (waste-to-energy plants) will most likely rise, and decarbonization of the waste sector will need to come from capturing $CO_2$ emissions at WtE plants, as the total quantity of waste for incineration is not expected to go down materially until 2050 (Eckle et al. 2019).

For the following industrial processes, feasibility of CCS should be verified:

**If realized: natural gas combined cycle (NGCC) power plants** (approx. 1.3 Mt $CO_2$ per year), existing power plants: Axpo Tegra AG Domat/Ems, Monthel AG Monthey

**Chemical industry** (Lonza AG Visp)
For example ammonia production, carbide production, ethylene production, niacin production. Note: Processes releasing other greenhouse gases, such as $N_2O$, must be addressed by methods beyond CCS.

## Impact

Regarding the life cycle analyses (Volkart, Bauer, and Boulet 2013) and the numbers of capturing efficiency (Eckle et al. 2019), CCS can contribute significantly to decarbonize Switzerland's industry, plus provide a negative emissions potential of at least 2 million tons $CO_2$ through waste incinerator plants.

## Financing

CCS in waste incinerator plants:
"Current very rough estimates indicate the cost for $CO_2$ capture, transport, injection and monitoring costs of around CHF 340 per ton of $CO_2$ with the expectation to go down to CHF 110 per ton of $CO_2$ in the next 10 years (amounting to CHF 1.3 and 0.4 billion, respectively, in annual costs for all Swiss WtE $CO_2$)" (Eckle et al. 2019).

CCS elsewhere:
The estimated current cost of $CO_2$ avoided (in USD2015) ranges from \$20–27 $tCO_2^{-1}$ for gas processing and bio- ethanol production, and \$60–138 $tCO_2^{-1}$ for fossil fuel-fired power generation up to \$104–188 $tCO_2^{-1}$ for cement production (Irlam, 2017) (IPCC 2018).

## Social Compatibility

Identified key hurdles include the availability, accessibility, and acceptance of $CO_2$ storage sites, but not their safety, which has been extensively proven (Kissinger, Herold, and De Sy 2012).

## Questions and Uncertainties

The capture technology requires additional energy resulting in higher energy (electric or fuel) consumption. This could be compensated by a high $CO_2$ price to make this economically feasible.

# Enhanced Weathering

## Description of Policy

For the implementation of Enhanced Weathering on a large scale in Switzerland, the legal framework is sufficient, while financial incentives are required to make its application rewarding for landowners.

## Description of Technology

Weathering is a slow natural process removing a fraction of the $CO_2$ from the atmosphere by the formation of carbonate mineral rocks. It has been the main $CO_2$ sink over the past 850 millennia removing 1.2-1.9 ppm over 1000 years (Barnola et al., 2003). $CO_2$ forms carbonic acid with water, e.g. in raindrops, which react with alkaline rocks such as calcite ($CaCO_3$, limestone or chalk) or forsterite ($Mg_2SiO_4$). Calcite dissolved by $H_2CO_3$ (carbonic acid) will form $Ca(HCO_3)_2$ which can only exist in a solution. All $CO_2$ absorbed into ocean water through the addition of ground calcite will slowly be converted into carbonate minerals by calcifying organisms.

For enhanced weathering or enhanced silicate rock weathering, favorable minerals are slashed and ground into a fine powder. The powder is then mixed with soil in agriculture, thereby also fertilizing the soil with Calcium, Magnesium, and Silicon. A positive effect on crop yield is to be expected. Alkaline rock powders (calcite etc.) are only applied to agricultural soils with lower-than-desired pH (pH<5.5). The reaction of calcite with acidic soil leads to calcium bicarbonate, which is soluble. As mentioned before, dissolved carbonates are prone to outgassing, especially in agricultural soils, where stronger acids (nitric acid, sulfuric acid) are present in larger amounts (plant nutrients) and are able to displace bicarbonates. On a global scale, enhanced weathering offers also the potential to reduce ocean acidification. If the milled powder is directly added to the ocean, the technique is referred to as ocean alkalization.
Another approach is to recycle finely ground cement rather than calcite or forsterite. During the cement production calcite is processed to slaked lime in a kiln. The calcite thereby releases $CO_2$ which the slaked lime partially takes up again during the curing process of the cement. Milled and dispersed cement still contains slaked lime which takes up carbonic acid much more efficiently and results in a net $CO_2$ take up if the $CO_2$ released while processing the calcite in the kiln is captured.

### Impact

Beuttler et al. (2019) estimates 2.5Mt $CO_2$/year (from recycled cement, which also requires a sustainable $CO_2$ source, e.g. DAC). Beerling et al. (2020) calculated potentials for Germany (77 Mt $CO_2$/y), Italy (43 Mt $CO_2$/y) and France (104 Mt $CO_2$/y). For Switzerland 3.4-4.0 Mt $CO_2$/y are estimated if the previously stated values are scaled from each countries to Switzerland's cropland area.

To remove the annual direct (indirect) Swiss $CO_2$ emissions of 44 (112) Mt $CO_2$ a total of 100 (255) Mt of pure calcite or 35 (89) Mt forsterite is needed. Calcite is abundant in Switzerland's Jurasian mountains.

### Financing

160-190 CHF/t $CO_2$ Cost adopted from calculations for Germany (Beerling et al. 2020)
20 - 1000 CHF/t $CO_2$ (Fuss et al. 2018).

### Social Compatibility

Enhanced weathering is reducing the acidification of the oceans (likely) and increasing crop yield (likely). The risks and indirect consequences as result of locally increased alkalinity are uncertain. Acceptance with farmers and landowners in using enhanced weathering has to be developed, as soon as enhanced weathering is proven to be safe.

# Afforestation, Reforestation and Wood Usage

## Description of Policy

Create the legal framework to tap the full potential of $CO_2$ storage through reforestation and afforestation and wood usage in Switzerland, without compromising biodiversity.

## Description of Technology

This section covers wood-related negative emission technologies. On one hand forest policies are discussed. They include active afforestation, natural reforestation and the management of existing forests. On the other hand, climate-friendly options for the wood usage are described.

Afforestation is the active establishment of a forest or stand of trees in an area where there was no previous tree cover for the last 50 years or more. In contrast, reforestation is a natural process in areas covered by trees in the past. An improved forest management is the third pillar of forest policies.

From a global point of view, photosynthetic carbon capture by trees is likely to be among one of the most effective global strategies to limit the rise of $CO_2$ concentrations. Consequently, a number of international initiatives [such as the Bonn Challenge, the related AFR100, and the New York Declaration on Forests have established ambitious targets to promote forest conservation, afforestation and restoration at a global scale. The latest special report by the Intergovernmental Panel on Climate Change (IPCC) suggests that an increase of 1 billion ha of forest will be necessary to limit global warming to 1.5 °C by 2050.

A climate-friendly usage of wood provides possibilities of energy and material substitution and additional mid-term $CO_2$ sequestration. A certain ratio of harvested wood can be used in long-lived wood products, mainly in construction and furniture, and thereby store $CO_2$ during their lifetime.

Furthermore, wood used as construction material can substitute energy intensive materials (concrete and steel). This substitution effect is the most important in the long-term and might reduce the $CO_2$ emissions significantly related to cement production. At the end of its lifetime, the wood products - together with wood explicitly harvested for this purpose - can be used for energy production where it substitutes fossil energy sources. The combination of wood combustion with CCS technologies as BECCS provides authentic negative emission potential beyond the substitution potential.

In 2011 the Swiss government defined the strategic direction of the forest policy (Hilaire et al. 2019). The second of the 11 main objectives is the mitigation of climate change by dedicated forest policy and wood usage while maintaining resilient forests under changed climate conditions. The strongly related "Wood Action Plan" aims at a sustainable wood production and cascaded use of wood including climate-friendly construction (IPCC 2018).

## Impact

Since 1990 $CO_2$ uptake by **afforestation** in Switzerland has been small (about 20 kt $CO_2$ eq. per year) and outweighed by deforestation by more than seven times. The afforestation area is very small (about 0.05 kha per year compared to forest management area of 1'250 kha) and consequently, the potential for carbon dioxide removal is very small. In contrast, the potential to store $CO_2$ through natural **reforestation** is about 730 kt $CO_2$ per year. However, abandoned areas are decreasing. The potential for carbon dioxide removal by forest management is significantly larger. During the last three decades, the Swiss forest sink provided between 1.6 million t CO2 eq. per year (2014) and 4.6 million t CO2 eq. per year (1995) in CO2 storage, with the exception of year 2000 when the forest constituted a source of 4.2 million t CO2 eq. per year after the catastrophic storm “Lothar”(FOEN 2019e).

Different wood management strategies can lead to very different short- and long-term effects (Hofer et al. 2007). A strategy of reduced forest maintenance is only efficient in the first decades before the forest turns into a CO2 source. Forests that are not maintained properly have a higher risk to become a massive source of CO2 in case of natural disasters, like storms or wildfires. Therefore, forest resilience is an important objective for climate policy. In general, the CO2 sinks in natural and civilization wood cycles are limited and will be exhausted somewhen between 2050 and 2100 depending on the wood strategy.

The Swiss domestic wood harvest is rather constant with 5.2 million $m^3$/year in 2018. But it could be sustainably increased to 9 million $m^3$/year (Fischlin et al. 2006). Apart from increasing wood production, increased import of wood can be considered, but poses danger of “Land Grabbing” or deforestation abroad. In 2018, Switzerland used 11.2 million $m^3$ of wood, thereof 54% for energy production, 24% for massive wood products, 19% for paper and cardboard (BAFU 2019). Swiss buildings currently store 45 Mt CO2 eq. with around 15% of all Swiss buildings being wood constructions (Starck 2016). In 2018, 14.2% of all new constructions were wood based (BAFU 2019). Only 4.2% of the Swiss primary energy consumption is provided by wood. Therefore, there is still a big potential for enhancing the wood usage in Switzerland.

Material substitution with domestic wood alone could provide a CO2 long-term reduction of -1.6 Mt CO2 eq. per year, energy substitution could provide -4.0 Mt CO2 eq. per year (Hofer et al. 2007). As the CO2 is likely to be re-emitted, these strategies are carbon neutral at best. True negative emissions can be created by applying CCS techniques in the wood combustion. This might offer another potential CO2 reduction close to the CO2 saving by energy substitution.

Hence, the wood management strategy should combine different measures. Primarily maximizing the sustainable production of wood and long-lived wood products. Secondly, to maximize the use of raw wood and wood products (cascaded use) as an energy source whereby CCS techniques should be applied.

Compared to other negative emission technologies the wood related techniques are broadly known. The technology is ready for large scale implementation (Fuss et al. 2018). Forest management strategies with focus on reducing CO2 emissions are already being implemented by forest corporations in order to sell CO2 certificates on the National voluntary market (Christoph Beuttler Jens Leifeld, Martin Schmid et al. 2019) The proposed strategy is ready to be implemented and could be stimulated by known measures.

The potential of carbon storage by growing forest masses is limited and could be exhausted in a few decades. But strategic use of wood products offers additional CO2 reduction and increases the time spans for active CO2 removals. CO2 can be stored in wood used as long living construction materials. More importantly, wood can substitute CO2 intensive materials such as concrete and steel.

## Financing

The estimated costs per saved ton of CO2 eq. for afforestation / reforestation range between 1 and 100$ globally (Fuss et al. 2018) A more narrow estimate is reported between 5 and 50 USD (Fuss et al. 2018).

## Social Compatibility and Risks

Afforestation and reforestation reduce the area available for agriculture. Food security might therefore be an issue, in particular if Switzerland does not want to rely on foreign food supply. Also, biodiversity might be affected negatively because afforestation and reforestation might reduce the abundance of traditional cultivated land ecosystems.

The emission of particulate matter is expected to increase if more wood is used as an energy source, in particular if burned in private houses, which may have health consequences that need to be taken into account.
The $CO_2$ uptake of forests and bushes decreases with time and reaches near zero after typically 100-200 years when the forest becomes mature. To maintain a high level of $CO_2$ uptake, forests have to be well-managed by removing old trees and shrubs. Forests have a lower albedo than open land (Schwaab et al. 2015) meaning less sunlight is reflected back to space and creates additional heat. This reduces the mitigation effect in particular in mountainous areas (Schwaab et al. 2015). However, in Switzerland the total effect of additional forest is always positive in terms of negative emissions.

As the potential of afforestation in Switzerland is limited, afforestation abroad might be a targeted strategy. Additional substantial risks are "Land Grabbing" or afforestation on agricultural land, which is currently much needed to provide food for the local population.

Afforestation cannot be considered as a reliable permanent NET, due to possible loss of stored carbon because of storms, fires etc. Afforestation should only serve as an additional method not counting as a NET. Biochar or BECCS with biomass from afforestation on the other hand provides this reliability.

# Biochar

## Description of Policy

Residual biomass from agriculture and forestry can be transformed to biochar by pyrolysis ("charring"). The biochar is then mixed with soil to allow long term storage. The mean residence time of biochar in Swiss soils must be evaluated and controlled in order to evaluate the efficiency of biochar in Switzerland as a NET.

## Description of Technology

Residual biomass from agriculture (various types of straw/stover, preferentially low in nitrogen) and forestry (bark, sawdust, branches) are dried or harvested in a dry state, compressed if necessary and heated in an inert atmosphere to 500-600°C. At this temperature, biomass releases a mixture of flammable gases and is chemically transformed into a chemically profoundly altered material: charcoal. Once ignited, the process releases around 50 % of the caloric value of the dry biomass. This translates to heat energy in the order of 2.1-2.8 MWh per ton of biomass. For every ton of dry biomass, between 200 kg and 250 kg C is sequestered in a stable form (IUCN, n.d.), provided the pyrolysis conditions were as mentioned before. This translates to 732-915 kg sequestered $CO_2$ per ton of pyrolyzed biomass. The removal and pyrolysis of agricultural residue from fields as well as the application of the resulting biochar have a number of beneficial agronomic effects, such as:

- removal of plant pathogens and insect pests
- reduction in competition for plant nutrients between soil microorganisms and plants (Bastin et al. 2019)
- fast and virtually limitless increase in soil carbon content
- improvement in soil water holding capacity, conductivity and infiltration
- reduction of $CH_4$ and $N_2O$ emissions in certain soils (IPCC 2018)

Technical challenges in the implementation of wide scale biochar generation are:

- elevated moisture content at harvest of some agricultural residues

- lack of pyrolytic burners able to generate biochar under optimal conditions
- lack of efficient heat utilization systems
- need for decentralization of biochar production to minimize transport of very lightweight feedstock
- Logistics of biochar: conventional combustion of biomass leaves little solid residue whereas large amounts of biochar needs dedicated transport of goods.
- Permanence of biochar, stored in agricultural soils: depending on soil type and pyrolysis method between a few decades and several centuries (FOEN 2019d) and (IPCC 2018) - mean residence times lie between 44-610 years.
- Permanence of biochar stored in clay (anaerobic conditions in a final repository): stable conditions for millennials (similar to lignite / hard coal)

## Impact

There is no data for agricultural residue production in Switzerland, but it is safe to assume that in cereals, biomass is allocated at least 50% to the straw fraction (UN 2014) Knowing that the cereal yield was 0.88Mt in 2018 (Griscom et al. 2017), straw biomass was at least 0.88Mt.

Although there is no clear data on forestry waste generation, Gregg and Smith (2010) estimate that forestry residue is slightly more abundant than cereal straw in Switzerland. Assuming 0.88Mt cereal straw and 1Mt forestry residue, around 1.4Mt CO2 could be sequestered annually using the biochar technology.

## Financing

Currently, a commercially available, shipping container sized pyrolysis unit (PYREG) can process 750 t dry biomass per year (equivalent to straw from 100-150 hectares of cereal cultivation), resulting in 150-187 t of sequestered C annually. The purchase price of the unit is CHF 400’000 and it can generate at least 1500 MWh/yr of heat energy. When calculated with a heat energy price of CHF 0.07 per kWh, the unit can generate around CHF 100’000 worth of energy per year. Loose cereal straw is worth CHF 60 per ton resulting in feedstock costs of CHF 45’000 per pyrolysis unit. Economical payback is therefore reached in less than 10 years, excluding the value of biochar and related carbon credits. For maximum economic feasibility, it is important to design the pyrolysis unit according to the heat energy needs, not feedstock availability.

## Social Compatibility

As with all dry biomass/fuel handling, precautions need to be taken to minimize the risk of dust explosions. Unlike other combustion technologies, pyrolysis creates large amounts of solid combustion residues (biochar) that need to be handled. This can be a logistical challenge in densely populated areas.

## Questions and Uncertainties

Of all vegetation types found in Switzerland, only grasslands do not produce a harvestable residue suitable for conversion into biochar. Grasslands, however, constitute a large proportion of land area in Switzerland. Fall harvested crops (grain corn, sunflowers, soy beans) typically have elevated residual moisture, requiring some kind of drying in order to be pyrolyzed. Open air passive drying techniques need to be developed for maximum energy efficiency. The PYREG pyrolysis unit produces 210-280 kW heat power, suitable for heating between 50 and 100 households. Smaller pyrolytic heating systems are required for large scale adoption of this technology. Biochar pick up and distribution on the agricultural land needs to be well organized. As mentioned above the mean residence time of biochar has not been determined for Swiss soil yet.

# Soil Carbon Content/ Sequestration

## Description of Policy

The technological readiness of soil carbon sequestration (SCS) is high. Thus, implementation is mainly hampered by difficulties in political coordination, monitoring and appropriate attribution of cost.

- Establishment of a comprehensive SCS modeling and monitoring framework in Switzerland with the potential to scale to other countries and contexts.
- Set up a funding structure for SCS in Switzerland alongside a broad information campaign on how to take up SCS for potential practitioners.
- Embed SCS into Swiss NETs policy framework, with appropriate consideration of the benefits and risks of SCS in the Swiss NET portfolio.

## Description of Technology

Soil carbon sequestration (SCS) denotes methods of land management that increase the soil organic carbon content in a manner that leads to a net removal of CO2 from the atmosphere (Griscom et al. 2017). How much carbon is retained in the soil depends on the balance of carbon inputs into the soil (e.g. from litter, residues, roots, manure) and carbon losses from the soil (mostly through respiration, increased by soil disturbance) (Griscom et al. 2017). Thus, practices that either increase inputs, or reduce losses or both, can promote SCS (Griscom et al. 2017). In short, SCS is a collection of land use management techniques that tip the balance of carbon inputs vs outputs in favor of building up carbon in soils.
More concretely, practices that are estimated to add net carbon to the soil include: Use of cover crops, leaving harvest residues on the field, return of organic residues on the field via fertilization (here the fertilizers are farmyard manure, slurry, compost), planting deep rooting crops, grass clover leys in crops rotations, agroforestry, diversified crop rotations, deep ploughing and no-tillage practices (Lewis et al. 2019).

## Impact

Current carbon stock changes in soil are estimated by the Swiss Soil Monitoring Network. The component that most contributes to carbon losses or gains estimated by FOEN is termed "net carbon stock changes in soils due to use of mineral and organic soils due to land use changes", which may be interpreted as the rate of SCS in Switzerland resulting from the few currently utilized land use management techniques (which are not optimized for SCS). Switzerland has 4100 kha of mineral soil and 27 kha of organic soil. The rate of SCS in Switzerland for the last two decades has been negligible.

To our knowledge, only one report has provided an estimate for the potential - that is, what might be sequestered by instead of what is sequestered - of SCS technology in Switzerland. Beuttler et al. estimate that the combined potential for SCS in Switzerland from both agricultural (0.7 Mio t CO2 per year) and soil (1.9 Mio t CO2 per year) (Lewis et al. 2019) sequestration is **2.6 Mio t CO2 per year.**

One French study estimated the potential for SCS on agricultural land is 0.63 ton carbon per hectare per year (UN 2014). Extrapolation of this potential to the entire Swiss cropland gives a potential of 925 kt CO2 per year. Swiss long term experiments for SCS on grassland yield a SCS potential of 0.28 t C per hectare per year (Bastin et al. 2019). This sums up to a total Swiss grassland potential of 945 kt CO2 per year. Taken together, these two give a potential of 1.87 Mio t CO2 per year (Lewis et al. 2019). This corresponds to about 4-5% of total production-based Swiss CO2 emissions. These estimates lie in between the minimum 0.03 t C per year and maximum 1 t C per hectare per year given by Smith et al. for cropland and grassland on a global average (FOEN 2019d).

A different approach, deep ploughing, may provide additional SCS potential. Studies from Germany (Thürig and Traub 2015) and New Zealand show that the shift of non-easily decomposable carbon into greater depths of the soil, where it is sequestered due to longer residence times, yields gains in carbon sequestration. Beuttler et al. (2019) estimate that applying this deep soiling technique on 5000 ha on an annual basis could offer a potential of 15.4 Mio t CO2 over 20 years. This corresponds to a yearly potential of 770 kt CO2 per year.

These estimates come with a great caveat: carbon stocks tend to reach a saturation point. Once the saturation point is reached, further carbon inputs cease to translate into greater soil carbon content. Beuttler et al. (2019) estimate that at the rates here considered, soils would saturate after about two decades. However, the estimate of the saturation time is uncertain. For example, West and Post estimated that across 67 long term experiments the time to saturation for soils under crop rotation and no-till practices is around 15 year (FOEN 2019d). Smith estimates that soil carbon saturation ensues after 10-100 years, depending on soil, climate and SCS characteristics (FOEN 2019d). The IPCC uses a default saturation time of 20 years (Griscom et al. 2017). The total cumulative sum for SCS in soils would then amount to 37.4 Mio t CO2 in twenty years (Lewis et al. 2019). This corresponds to about a full year of emissions in Switzerland. For deep ploughing, the total cumulative SCS over two decades would amount to 15.4 Mio t CO2 (Lewis et al. 2019). Furthermore, SCS practices would need to be maintained in order to avoid losing carbon back to the atmosphere: thus, a risk of reversion of the carbon gains exists if practices are not stabilized. This also means that costs associated with SCS practices will persist once soils have saturated.

Global SCS potentials are orders of magnitude larger than Swiss potentials. Fuss et al.'s literature review over twenty three different studies gives an estimate of a mean global SCS potential of 4.28 Gt CO2 per year and a median potential of 3.68 Gt CO2 per year (Griscom et al. 2017). This corresponds to about 9-11% of current global emissions. A more recent estimate by Lal gives a much higher potential of about 9 Gt CO2 per year, corresponding to about 23% of global emissions per year. Lenton estimates that a maximum yearly potential of about 3.3 Gt CO2 per year may be achieved for ca. 12.5 years (Hofer et al. 2007). It should be noted though, that due to saturation effects and possible re-release of carbon after cessation of SCS practices the total cumulative potential of SCS is limited.

## Financing

Several different estimates do exist, but these depend strongly on geographic location and soil composition. In a review, Fuss et al. (2018) report only three papers that provide estimates for the cost of SCS, namely (FOEN 2019d) (Schwaab et al. 2015). According to Smith's estimates, about 20% of global SCS could be realized at negative cost, ranging from -45$ to 0$ per t CO2 eq. About 80% could be realized at a cost between 0$ - 10$ per t CO2 eq (Griscom et al. 2017). Total costs for global implementation under these conditions would amount -7.7 B$. These estimates suggest great potential for scalability.
In Switzerland, the only cost estimate for SCS is given by Beuttler et al., and amounts to 0-80 CHF per t CO2 (2019).

To our knowledge, these estimates ignore the opportunity costs of carbon: The costs from climate damages incurred by not implementing SCS. These costs are substantial: Nordhaus estimates them to lie around 30$ per t CO2 (Hilaire et al. 2019).

## Social Compatibility

The risks of SCS are manifold. The amount of carbon soils can sequester is limited. Influx rates saturate with the cumulative amount of sequestered carbon. Sequestered soil carbon can be re-released into the atmosphere if SCS practices are not maintained. Thus, benefits from SCS practices will provide ever smaller marginal benefits as soil carbon stocks reach saturation levels. Finally, there may exist trade-

offs between minimizing CO2 emissions by SCS and minimizing other greenhouse gas emissions from soils.
However, as laid out in Fuss et al., there are substantial benefits to SCS. Most importantly, SCS does not compete for land with food production. SCS leads to improved soil quality and health (BAFU 2013) and improved and more stable crop yield (BAFU 2017). SCS's water footprint over large land areas is estimated to be negligible (FOEN 2019d). Additional benefits are the reduction of environmental impacts of fertilization (smaller nitrate leaching and reduction of NO2 emissions), improved water retention and infiltration of the soil (by use of cover crops), reduced risk of erosion (cover crops) and improved drought resistance due to the use of deep rooting crops (Lewis et al. 2019). Several of these benefits are effective measures to combat climate change associated risks. Lastly, a central benefit lies in the scalability of SCS approaches: Well-tested approaches could be deployed globally. In particular, SCS appears to be the only negative emissions technology where a substantial fraction of possible adopters could implement SCS at an economic benefit. This adds to the scalability potential of the technology.

## Questions and Uncertainties

- It remains uncertain how validation that soil has been sequestered in a particular agricultural field of interest (monitoring of successful sequestration) may be implemented. This is an active field of research, with progress being made (BAFU 2019).
- How can it be avoided that other greenhouse gases are emitted (for example N2O) instead of CO2? Where are there trade-offs? Can these trade-offs be overcome? Smith notes that many of the adverse effects constituting these trade-offs can be overcome with the appropriate portfolio of SCS techniques (FOEN 2019d).
- It is uncertain where the saturation levels for carbon retention lie given a specific type of soil.
- Reversibility of soil carbon sequestration efforts: Soil carbon sequestration is vulnerable to reversal if the land management techniques are changed in a detrimental way. It remains uncertain how fast the re-release would be. It remains uncertain how the lack of permanence may be addressed by different methods, for example by approaches increasing suberin in plant roots.
- The build-up of soil carbon requires added plant nutrient matter, in particular nitrogen, phosphorus and potassium (Griscom et al. 2017). Adding these without appropriate management techniques could lead to an exacerbation of fertilizer-associated leakage into water courses.

# Synthesis

## Comparison of Technologies

Potential and cost of negative emission technologies in Switzerland:

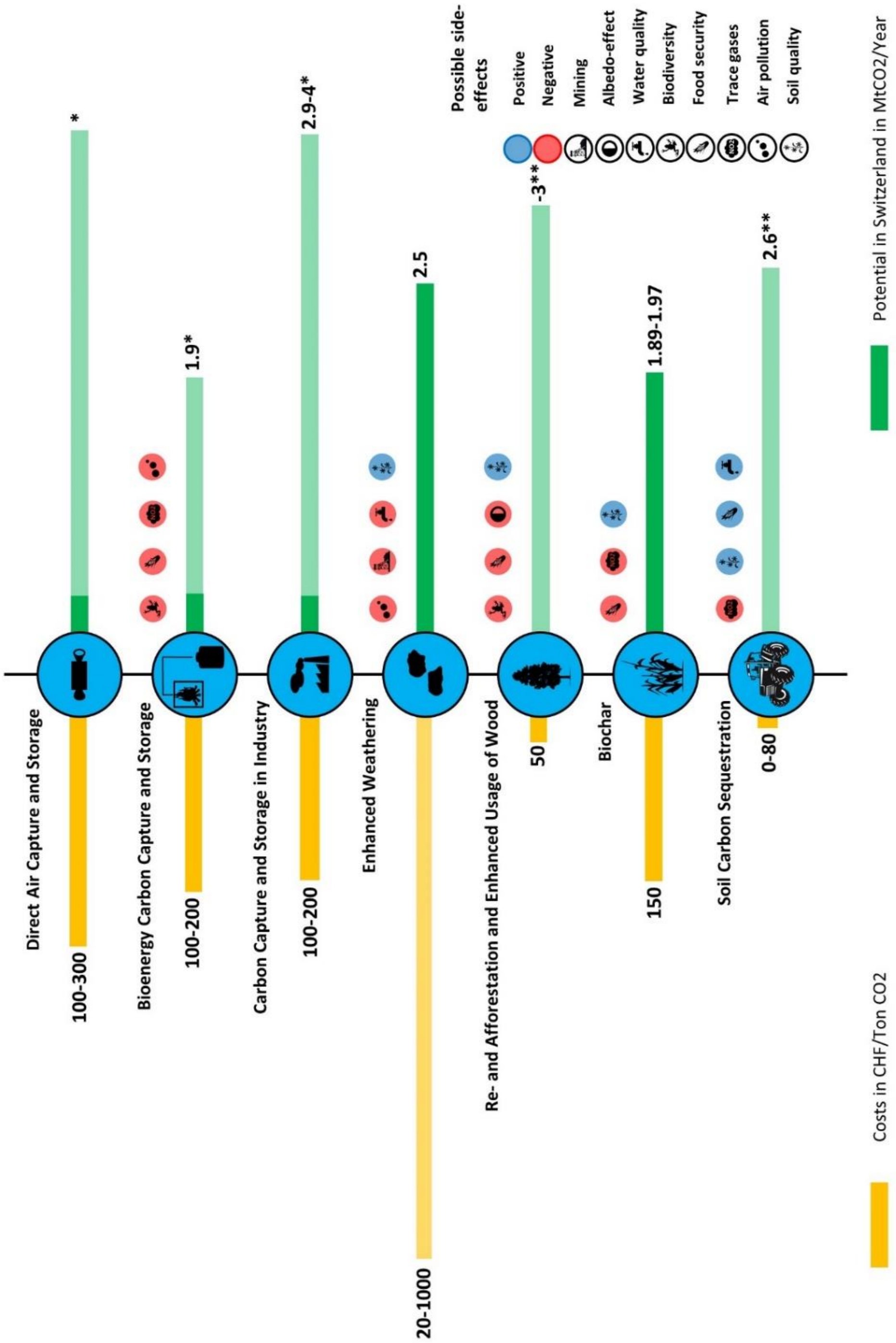



*Figure 7-5 *in Switzerland 500Mt CO2 in total (dark green), abroad at least 2000 Gt (light green). ** Potential fully exploited when saturated (light green)*

# Conclusion

In order to limit global warming to 1.5 °C, the large-scale application of negative emission technologies is required (Hilaire et al. 2019), and this will be necessary as early as 2025 (IPCC 2018). In general, a stable global temperature can only be achieved if greenhouse gas emissions are net zero. For residual emissions that cannot be avoided (cement, aviation, chemical industry, agriculture) negative emissions are needed to achieve net zero emissions. The globally permissible CO2 budget for 1.5°C must not be exceeded: On one hand, this will likely cause irreversible damage to ecosystems and human suffering, and on the other hand, it would only postpone the problem, which is still solvable today, into the near future, thus leaving society with a huge mortgage, the future financing of which will cause major problems, as the polluters today can no longer be prosecuted. If Switzerland can take a leading position in the development of NETs, it would be able to provide other countries with the necessary NETs in the event of their CO2 budget being exceeded, thus making a major contribution to the global solution.

This chapter summarizes the most important techniques for extracting and storing CO2 from the atmosphere (NETs). The potential of NETs possible in Switzerland exceeds Switzerland's domestic and grey greenhouse gas emissions for the year 2018. The most promising technologies are Biochar, Soil Carbon Sequestration, Carbon Dioxide Capture (CCS) at point sources of CO2 such as cement plants and waste incinerators, and Direct Air Carbon dioxide Capture and Storage. All proposed technologies are considered to be very safe and have minimal environmental impact.

The necessary technologies are already relatively advanced and several of them could be operated in Switzerland:

**Direct Air Capture and Storage**
With Direct Air Capture, CO2 is extracted from the ambient air using technical equipment. The CO2 thus extracted in Switzerland is safely stored (sequestered) in the earth's crust, either in Switzerland (capacity expected to be 2.68 Gt), or abroad (capacity according to IPCC certainly over 2000 Gt - with global emissions of approx. 40 Gt annually). The storage of CO2 in soil has been going on for 40 years, so far about 260 Mt CO2 (Global CCS Institute 2019). It is considered very safe. Alternatively, Direct Air Capture could also be operated abroad to avoid the transport route and benefit from cheap renewable energies.

**Carbon Storage and Carbon Usage**
By burning biomass (e.g. plant waste, wood residues, etc.), heat or electricity can be generated and the CO2 emitted from the exhaust gases can be stored in the ground, as with DACCS. This allows carbon to be removed from the carbon cycle and safely stored.

**Carbon Capturing**
In industrial point sources such as waste incineration plants or cement production, CO2 can be filtered out in a targeted manner due to its high concentration and stored in the ground as with DACCS.

**Enhanced Weathering**
In the process of Enhanced Weathering, crushed mineral rocks are distributed over fields. By crushing the rock, it reacts more quickly with the CO2 bound in the rainwater - its natural weathering process is thus accelerated. Washed into the sea via water bodies, the CO2 is stored there as carbonate rock for the long term. This process thus also counteracts ocean acidification. The potential in Switzerland lies around 2.5-4.0 Mt CO2/year with a price of 160-190 CHF/t CO2.

**Afforestation, Reforestation and Wood Usage**

Through reforestation, forest management and increased use of wood in buildings, up to 3 Mt CO2 can theoretically be stored in Switzerland each year. Afforestation has very limited potential in Switzerland.

**Biochar**
It is also possible to convert fast-growing plants or waste from food production into vegetable carbon under great heat and then store it in the soil. The waste heat can be used directly or converted into electricity.

**Soil Carbon Content/ Sequestration**
Changes in agricultural land use can also increase the carbon content of soils, which would also improve soil quality.

Many of these technologies could store between two and three megatons of CO2 per year in Switzerland. Depending on the technology, the price is between 50 and 300 CHF per ton of CO2 and, in the case of soil carbon sequestration, could even lead to an increase in agricultural yields that exceeds the price of the resources used. At the moment, however, the prices of these technologies are much higher due to a lack of demand. In order to achieve sufficient development and application, NETs must be financially supported. Various political strategies for implementing these technologies are listed at the beginning of the main part of this chapter (2. Negative Emission Methods).

# "Call to action"

Negative emission technologies (NETs) are practically indispensable to meet the 1.5 target for two reasons:

- They allow processes for which no CO2-free alternatives currently exist to continue to be used. These include cement production, air traffic, agriculture, the chemical industry, etc. Without NETs, these areas would have to be completely shut down or converted to synfuels by 2030, but their production is many times more costly compared to NETs.
- Switzerland must be prepared for the fact that net negative emissions (more remote than emitted CO2) will be needed if the global CO2 budget is exceeded - we must therefore invest in these technologies as soon as possible.

NETs need the support of politics and society - they will not be able to assert themselves on their own; this would require either draconian laws or very high CO2 prices. It makes much more sense to ramp up NETs with government aid, while the learning curve makes these technologies cheaper and cheaper and within about a decade a CO2 tax is reached which is then twice the cost of NETs - net zero would be reached.
NETs enable net zero to be implemented in a socially and economically acceptable way - but they are in no way a free ticket for "business as usual" and should therefore be combined with measures that are part of the CAP and described in the other chapters.

# 8 Financial Sector



# Current situation

The Paris Agreement requires countries to harmonize their financial flows with the objectives of the Paris Agreement. (Article 2.1.c of the Paris Agreement (United Nations 2016)).

The impact of the financial sector on the climate crisis cannot be deduced as directly as, for example, in the transport sector, where a car running on petrol directly emits CO2. Rather, the problem here is that all branches of the economy and sectors that emit CO2 directly receive their money through financial institutions. Banks, pension funds, insurance companies etc. are so-called "financial intermediaries", i.e. they mediate between the supply and demand for capital. Through them, the money of customers who want to invest their money flows to all kinds of companies, which can be climate-friendly, climate-damaging or climate-neutral. For example, the company includes companies that produce crude oil or carry out fracking abroad. These financial intermediaries help these companies to raise more capital, which in turn helps them to remain profitable despite the competition from renewable energies. This example shows that the market is not simply neutral. Risks are wrongly assessed by the financial market because many financial institutions have not built up expertise internally about the climate and financial risks of fossil fuels and the opportunities offered by alternative investments. So as a financial institution, you feel safer and more comfortable investing in the time-tested fossil infrastructures instead of promoting a change in thinking. Many financial institutions have long denied their responsibility to the climate and society. Financial intermediaries are not just passive vessels through which money flows, they can actively control where the money goes and therefore have a great responsibility and obligation. Unfortunately, very few financial institutions do this.

So, if the Paris Agreement states that financial flows must be brought into harmony with the 1.5 °C objective, this means that money must no longer be allowed to flow into fossil infrastructure. Our economy and society must make the transition to a net zero economy and society. Even if all the technological achievements are in place, this will not work as long as financial intermediaries continue to direct financial flows towards the promotion of fossil energy or other emitting projects.

The Bank of International Settlements (BIS) made clear in a new report in early 2020 that the climate crisis is a major financial, material risk and that all financial market regulators and central banks must immediately start to address climate change (Bolton et al. 2020).

In order to meet the objectives of the Paris Agreement, various international initiatives have been formed in recent years. The Addis Ababa Action Agenda (United Nations 2015) creates a global framework to make financing flows compatible with the Sustainable Development Goals (SDGs). The UNEP FI (United Nations Environment Programme Finance Initiative) initiatives of the UN (UNEP Finance Initiative n.d.) create a platform for commitments of financial institutions, both banks and insurance companies. The NGFS (Network for Greening the Financial System) (NGFS n.d.) creates a platform for central banks and regulators to address the issue.
Many other initiatives create the basis for SDG (sustainable development goals) and ESG (ecological, social and governance) reporting standards and transparency, but it is often difficult to assess whether these commitments are merely lip service. So far, there has been too little sign of a noticeable change in the Swiss financial sector.
The FOEN concludes in a report in 2015 that Swiss financial flows alone support a climate warming scenario of 4-6 °C (Oehri et al. 2015; Thomä et al. 2017). The FOEN emphasizes here above all the financial risks and losses for the Swiss financial sector that will follow if the world complies with the goals of the Paris Agreement. In this context, economists speak of the "carbon bubble" (Clark 2015). The financial sector runs the risk of overestimating the yield from fossil fuels. If this bubble bursts, this could lead to considerable losses for the Swiss financial sector.

Some countries, such as the United Kingdom and more recently the EU, are taking a leading role in implementing these demands. For example, years ago, the former governor of the Bank of England, Mark Carney, obliged British banks to carry out stress tests on climate risks (Bank of England 2020). In Switzerland there has been a lack of comparable forward thinking so far. The EU is also tackling the issue proactively. It is committed to a far-reaching and ambitious reform of the financial system. In 2018, the EU Commission published the action plan for financing sustainable growth (European Union n.d.). The new EU laws will also have a major impact on Switzerland. There are no measures or projects on the Swiss side comparable to those that have been pushed forward for years in other European countries, but so far the regulators and the financial sector have avoided the issue. In terms of the size and importance of its financial sector, Switzerland brings up the rear in Europe.

It would be particularly important for Switzerland to address this issue. With its financial sector, Switzerland has a large climate lever which, if consistently implemented, can bring great benefits for the global climate and also for the Swiss economy. On the one hand, financial markets should be protected against climate risks, such as stranded assets or losses due to extreme weather events. On the other hand, capital needs to be diverted away from fossil fuels towards renewable, efficient technologies to enable the transition of our economy and society to a net zero economy and society.

The Swiss financial sector, in particular Zurich and Geneva, is one of the most important in the world and Switzerland is one of the most important global asset managers (GFCI 2018). Our financial sector therefore has particularly strong leverage in international climate policy and the global economy, which is an opportunity for Switzerland to reduce its foreign emissions and a commitment to the world, because if we do not do so, the whole world will never be able to achieve the targets of the Paris

Agreement. It is in keeping with the polluter-pays principle to demand action from the Swiss financial sector and regulators now.

But the Swiss financial institutions also have a great deal of leverage here in Switzerland. A few large banks have many capital investments abroad, but smaller banks, such as cantonal banks, mainly grant loans in Switzerland. Mortgage lending accounts for the largest part of their business. The building sector has the second highest share of domestic CO2 emissions after transport, as many buildings are not energy efficient or have oil heating systems. In other European countries, the transparent information of market participants through mandatory energy efficiency labels for buildings has been enforced to address this problem. In Switzerland, however, the corresponding building energy certificate issued by the cantons (GEAK/CECB/CECE) has so far mostly been voluntary. In this respect, banks could intensify their activities in the field of building refurbishment (Cousse, Kubli, and Wüstenhagen 2020). Companies operating in Switzerland, for example industrial companies or those involved in transport, are also financed by loans from banks. Here too, banks are not only passive vessels through which money flows, they can also actively make claims. In addition, on the financing side in general, more commitment can also be made by domestic banks. In summary, the financial sector has the power to drive forward the transition of our entire economy, both here in Switzerland and globally. And with great power comes great responsibility, as is well known.

# Vision

Today, the Swiss financial sector is responsible for a heating scenario of 4-6 °C, which not only falls far short of the goals of the Paris Agreement, but will also have devastating consequences for humanity, biodiversity, the environment and everything we know, and last but not least threatens to destabilize the financial market itself. But it could also be quite different. This is how we envision the Swiss financial sector of the future:

The Swiss financial sector will be climate-neutral in terms of direct and indirect investments by 2030.

There is transparency about financial flows, not only in the climate area. Both as an investor and as a customer, you have the right to know exactly where the money is flowing to and what effect it has.

Divestment and investment are two sides of the same coin: By 2030, financial players will have found ways to replace the previous income from financing fossil fuels with value creation in the area of financing low-emission technologies and projects.
The Swiss financial sector has built up a great reputation worldwide in the field of sustainable investment and is considered a leader in this field. It is a pioneer in the field of digital technologies for financing climate-friendly products (Clean Fintech). Switzerland of the future is also a center for international green funds.
Today there are a handful of systemically important financial institutions. These are "systemically relevant" because they are so large that if one of them makes bad decisions and thus falls into a crisis, they can pull the entire Swiss economy into a crisis. This is not only unfair, it also harms the stability of our economy. Furthermore, a few large financial institutions have particularly strong power in the market and can distort it in their favor. In such cases, one speaks of oligopolists.

The financial sector of the future is more diverse and is not dominated by a few oligopolists. The Swiss financial sector is therefore no longer a cluster risk for our economy and contributes to its stability.

In the future, the tasks of the Swiss National Bank will focus more strongly than today on pursuing a comprehensive understanding of the long-term stability of the financial markets. Acting in the best interests of the Swiss economy also means consistently pursuing climate neutrality and sustainability goals.
As part of the solution, the entire financial sector will contribute to making mankind better prepared for future crises! In particular, it proactively supports the early identification of negative external effects in the area of the climate crisis and beyond, and the development of solutions.

# Introduction

Different actors play different roles in regulating the financial sector. We subdivide the chapter into regulators and financial institutions to better distinguish what regulators can do and what private actors would have to do.

The most important instruments for this are the following:

**Divestment**: The withdrawal of capital from emission-intensive parts of the economy, for example oil companies.
**Investment**: Capital is directed specifically into climate-friendly sectors or companies that are necessary for the transition of the entire economy to a CO2-neutral economy.
Engagement: If CO2-intensive companies are not able to drive change internally, they will not be able to survive on the market in the long term. It is preferable that the management in these areas actively approaches the change on its own initiative. However, management is often reluctant to face the facts and develop new strategies. Shareholders can actively exercise their voting rights and influence to drive internal change in such parts of the economy.
**Transparency**: A major problem is the lack of transparency about the climate-damaging effects of financial flows or information about financial flows in general. Customers, both private and institutional, are not well informed and cannot make conscious decisions, even if they want to invest their money climate consciously. Such information and transparency provide the basis for informed customers to express their demand for sustainable financial products. This information also provides the basis for science, which can only make meaningful analyses in this way.

The policy proposals in this chapter revolve largely around these instruments and various approaches to their use. We focus primarily on measures that can be implemented in the current system rather than on fundamental criticism of the system itself. Time is running out, and it is becoming more challenging every year, week by week, day by day, to achieve the goals of the Paris Agreement. However, the solutions are ready, and this chapter should make a significant contribution to bringing these implementable solutions to the general public, politics and business. More fundamental criticism of the system is discussed in more detail in the chapter Economic and Political Structures.

# Introduction of Regulators

The Swiss financial sector is mainly regulated by the Swiss Financial Market Supervisory Authority (FINMA). The Federal Constitution as well as various laws and ordinances of the Federal Council provide the legal basis on which FINMA operates. Its competences are very broad and are implemented in the FINMA Act (Die Bundesversammlung der Schweizerischen Eidgenossenschaft 2007).

FINMA's objective is to protect creditors, investors and insured persons and to maintain the functionality and systemic stability of the financial markets. In practice, this means in concrete terms: combating money laundering, monitoring companies under their control, providing an overview in the event of bankruptcy proceedings, etc. FINMA is empowered to issue its own ordinances of a legislative nature. However, the financial market is largely self-regulating. The Swiss Bankers Association (Swiss-Banking) adopts rules of conduct and other guidelines which can be recognized by FINMA as minimum standards.
Finally, it is the Swiss Federal Assembly that creates the legal framework for FINMA's activities. It is also entitled to lay down drastic regulations in the law, even if it does not usually do so.

The Swiss National Bank is the second regulatory body of the Swiss financial sector. The SNB itself is also a financial intermediary, in fact the largest in Switzerland. The SNB's objective is to ensure the stability of the economy and price stability. In practice, the SNB regulates the financial sector primarily through its interest rate policy, by reacting to fluctuating economic conditions (recession or boom). The legal basis for the SNB is also explained in our legislation and in the constitution. The SNB is an independent national bank, which means that the legislator, i.e. the parliament, can very rarely intervene in its investment or interest rate policy. Nevertheless, the SNB is free to intervene in the financial market in other regulatory ways, as the Bank of England, another independent national bank, does.

# The State/FINMA/Swiss Banking

## Policy 8.1: Legislative Reduction Targets / Adaptation of the CO2 Law

At the fourth national meeting, the climate strike adopted the following demands, among others, by consensus (Klimastreik Schweiz 2019):

"We call for a reduction of the direct and indirect greenhouse gas emissions of the Swiss financial sector to a net 0 by 2030, in particular a halt to financing, investment and insurance services for fossil fuels.

1. From now on no new investments, credits and insurance services for projects and companies active in fossil fuel extraction! This includes coal companies, the tar sand industry, natural gas and oil.
2. The financial institutions should present clear plans by the end of 2020 with concrete goals and measures to bring their financial flows (loans, investments and insurance services) to a net zero by 2030."

These points could be anchored in the CO2 law as well as in the financial laws. The new CO2 law, which has now been passed but has not yet come into force, does not envisage any intervention in the financial sector today. Individual proposals that were part of this directive were rejected. This appears to be disproportionate.

### Description

Concrete implementations of these demands by legislators and regulators could look like this

- The CO2 law already sets reduction targets for other sectors. The majority of the emissions caused by direct and indirect financing of the financial sector are generated abroad, but here too Switzerland should anchor reduction targets for financial institutions for their scope 1-3 emissions in the CO2 law. More concretely, a complete reduction of all direct and indirect greenhouse gas emissions through financing, investments and insurance services, particularly in fossil fuels, so that the financial sector reaches a net zero by 2030, should be enshrined in law.
- All new investments, direct or indirect, in fossil energies must be prohibited. It is up to the regulatory authorities to decide how such a ban will be implemented and enforced and how much time will be allowed for this implementation.
- Target agreements with individual financial institutions that are responsible for a particularly large number of emissions would also be desirable. These financial institutions would then have to prepare regular reports.
- These targets should also be included in the Swiss NDCs (Nationally Determined Contributions) and communicated to the UNFCCC (United Nations Framework Convention on Climate Change).

- All financial institutions should be obliged to develop net zero plans: All financial institutions should be obliged to develop a company-wide climate strategy that leads to complete decarbonization by 2030. This should include both the exercise of voting rights of shareholders and engagement strategies.

## Financing

No public funds need to be used to implement such regulations, or the wages and maintenance of the regulators' offices would have to be financed.

## Impact

Such legislation is a clear and unequivocal signal to the financial world. The impact of this measure is above all the clear commitment to the decarbonization targets and the initiation of the necessary steps. Necessary steps in this case are climate compatibility tests, climate risk stress tests and the development of implementation plans, which of course differ for individual financial institutions. For any financial institution, this transition is such a major undertaking, which is associated with many uncertainties, that it does not even start. The impact of this policy would be to create a uniform and binding framework for all market players, thus overcoming the hesitation that has existed to date.

The federal government is already providing financial institutions with expertise and know-how. For example, the FOEN has developed a climate compatibility test, PACTA. These offers of the test are open today, but not mandatory for financial institutions; such legislation would lead to the federal government's expertise being used.

## Social Compatibility

These laws would have an impact above all at the macro level. For example, it could be questionable what a sudden stop of new investments in fossil fuels could mean for workers in producing countries. This could be alleviated by targeted retraining programs. Investments in renewable energies and energy efficiency have a higher employment impact than the capital-intensive mining of coal, oil and gas. **In addition, even independently of climate protection, these jobs are endangered by the strong fluctuations in oil prices and the financial market risks triggered by the carbon bubble.**

## Questions and Uncertainties

In realpolitik, it takes a long time for such laws to come into being and/or be implemented. It is far more desirable for financial institutions to commit themselves to these goals on their own initiative now and to develop action plans to achieve net zero emissions by 2030. The confederation and regulators must help them to do so, for example in the form of climate compatibility tests (see Policy 2) or through expert knowledge.

An immediate ban on new investments in fossil fuels, as explicitly called for by the climate strike, could come too suddenly and pose a particular challenge for large financial institutions. With reference to the literature on the carbon bubble (Clark 2015), one could conclude that this would cause panic on the stock market. "Immediately" should therefore reasonably and consistently be understood as "as quickly as possible". It is desirable that regulators work with the financial sector to work out a transition that is compatible for the stock market and the economy. The earlier this challenge is actively addressed, the better the chances are of avoiding major distortions that would cause the carbon bubble to burst.

# Policy 8.2: Obliging Financial Institutions to Perform Stress Tests

## Description

The first necessary step for all financial institutions is to analyze the carbon footprint of their own financial flows. Financial institutions should undergo an annual climate compatibility test and disclose this information. Since 2017, the FOEN and the SIF (State Secretariat for International Finance) have been conducting voluntary pilot tests to analyze the climate compatibility of financial portfolios of pension funds and insurance companies (FOEN 2020c). This test should be made mandatory by law. The test should be mandatory for all financial institutions (banks, insurance companies, pension funds) and cover the entire investment universe, including loans and insurance.

The results of this test will only provide specific information about which scenario of temperature rise is supported by the respective portfolio (for example 2 °C/ 4-6 °C, etc.). However, climate risks and the associated physical and financial transition risks are also a threat to the stability of the economy (see information on Carbon Bubble in the section Current Situation).

In the UK, the Bank of England conducts stress tests on climate risks in the portfolios of financial institutions (Bank of England 2019). The FINMA and/or SNB should do the same as the Bank of England. All financial institutions should be required to perform such a stress test annually.

The Swiss Federal Statistical Office (FSO) and FINMA/SNB should collect these data on financial market stability and inform the public transparently about the results every year.

## Financing

The measure could be implemented by the existing institutions (FINMA, SNB, FOEN). At best, the relevant departments would have to be expanded to include additional specialists.

## Impact

Without a thorough analysis of the current situation, no targeted measures can be taken. The climate stress tests provide decision-makers within and outside the financial institutions with the necessary information basis for reducing the identified climate risks.

## Social Compatibility

The measure should contribute significantly to the well-being of the population, since a sustainable and stable financial sector does not represent a cluster risk for the entire economy.

## Questions and Uncertainties

It remains to be seen whether it makes more sense to delegate this task to the SNB or FINMA. However, this should not affect the impact of the policy, what counts is that such annual stress tests are institutionalized and conducted annually.

# Policy 8.3: Green Investment Facility

*In the Cross Sectoral Policies chapter the Climate Bank is described in more detail, the following policy is similar.*

## Description

The new CO2 law provides for a climate fund. Investments are urgently needed for the necessary building renovations, the turnaround in transport and not least the energy turnaround. Especially for the energy turnaround, public funds are needed so that new solutions, which already exist, can quickly enough establish themselves on the market. The climate fund is therefore a necessary step, but it is not sufficient. A Green Investment Facility could complement the existing funds by investing in climate-friendly energy projects (e.g. power generation from renewable energies, heating networks). The necessary funds and appropriate "Climate Agencies" which should receive them are explained in the Cross Sectoral Chapter as well as in the Transport, Building and Energy Chapters. The Green Investment Facility is intended to provide debt capital to companies and projects, for example in the form of Green Bonds. Thus, the market should become more attractive for private investors through public investments. Due to the still missing truth of costs caused by indirect subsidies for fossil energies and further hurdles for renewable energy sources, private investors estimate the risks as too unclear or high for corresponding projects. The Green Investment Facility can specifically create security for private investors. Furthermore, public funds are used responsibly by making them available as debt capital. During the Corona crisis, the Swiss government has proven that it is capable of a public-private partnership to effectively mobilize large amounts of private funds.

The climate fund proposed by the ESPEC-S (Environment, Spatial Planning and Energy Committees) could, as also proposed by the Commission, replace existing funding instruments such as the technology fund and the buildings program. However, the UREK-S proposal would only be effective in the medium to long term and would hardly help to achieve net zero by 2030. We therefore propose that the fund be filled up promptly, thereby triggering a green stimulus to counter the current recession. Economic measures are urgently needed in the current economic situation, and the federal government can thus provide targeted support for sustainable industries instead of pre-programming the next crisis with indiscriminate rescue measures for emission-intensive industries.

To ensure that the accelerated investments can be absorbed by the market, complementary measures should be taken (see Policy 8.11).
Within the framework of international treaties, Switzerland has declared itself willing to provide international funds for mitigation and adaptation efforts in countries of the Global South. This is currently done through the international Green Climate Fund. A Swiss Green Investment Facility could also mobilize private capital for mitigation and adaptation efforts in the international context.

## Financing

There are various financing options available, which should be combined for maximum effectiveness. A transfer payment from the SNB is proposed. In the current situation, the Green Investment Facility is to be used as an economic tool, so the SNB is an appropriate source of financing. The current financing can be supplemented by earmarking part of the CO2 tax or an air ticket tax. In any case, care must be taken to ensure that sufficient funds are available at the beginning of the decade and that they cannot be invested only shortly before 2030.

## Impact

The green stimulus that has been triggered can pull the economy out of recession again. As stated in other chapters, investments in energy system transformation, transport transformation and building refurbishment are now necessary if a consistent reduction path is to be followed, leading to net zero GHG emissions in 2030. In the medium to long term, private capital will also increasingly flow into technologies and infrastructure necessary for a climate-neutral society and economy. By reinvesting the proceeds of these initial investments, the effectiveness of the Green Investment Facility can be further increased over the years.

### Social Compatibility

The Green Investment Facility (together with the Climate Bank) would primarily trigger accelerated climate protection investments domestically and thus secure or create jobs in the skilled trades and construction industry. In contrast, these investments could lead to a decline in employment in the oil and gas sector, which should, however, be less significant in net terms due to the higher employment intensity of the former, and which are also less likely to be located domestically. When investing in rental buildings, care must be taken to ensure that costs and benefits are shared fairly between landlords and tenants (see chapter on buildings). Due to their greater potential of land for renewable energy projects, rural areas could benefit disproportionately from Green Investment Facility investments, which would benefit national cohesion and social cohesion. At a later stage, the expertise gained in the context of Swiss development cooperation could lead to better services and support for these countries.

### Questions and Uncertainties

The governance of the Green Investment Facility should ensure a balanced mix of technical expertise, democratic control and social transparency. Cooperation within the framework of a public-private partnership can increase acceptance of the new institution, but care must be taken to ensure a fair distribution of profits and losses between public and private shareholders. When designing the investment portfolio, it must be ensured that investments are mainly made in projects that will achieve emission-reducing effects in the next 10 years.

# Policy 8.4: Adopt EU Green Taxonomy

In order to be able to make sustainable investments, the financial sector needs a database. The climate-damaging and also climate-positive effects of companies are not always directly comprehensible. Emissions occur everywhere in the value chain of a company, which is why they are referred to as Scope 1, 2 or 3 emissions.

Financial institutions usually simply evaluate companies via their periodic financial statements. These do not contain any information about the climate compatibility of a company's overall economic activities. Financial institutions usually do not have the expertise to evaluate the climate impact of their financial flows. Therefore, financial institutions are required to perform climate change assessments (see policy 8.2).

In order to make it possible in the long term for financial institutions to competently take climate risks into account in their decisions without the need for such external tests, a classification or a so-called "Green Taxonomy" is needed.

The EU Taxonomy has developed a "Green Taxonomy", which has exactly this goal (Technical Expert Group on Sustainable Finance 2020). The EU Taxonomy identifies and classifies economic activities of companies in the most CO2 intensive industries according to climate criteria. These activities are examined whether they have a positive impact on the climate and/or a neutral impact on the climate. Economic activities that have a specific negative impact on the climate are not classified separately, so they are called "green" taxonomies, not "brown" taxonomies. Companies can use this taxonomy to issue so-called "green bonds", financial institutions can invest in them.

In the EU, this system will take effect from 2021. As in the EU, companies listed on the Swiss stock exchange and other large companies (e.g. over 500 employees and over CHF 500 mio turnover) should report EU Taxonomy compliant.
Financial institutions themselves, as companies listed on the stock exchange, would of course also have to do this. Such a measure creates more transparency and helps the financial sector to be able to invest specifically in the ecological transition of our economy.

## Financing

For companies there will be an additional effort in reporting. This will also involve more time and costs. Even if the Swiss financial market does not adopt the EU Taxonomy as proposed in this policy, companies operating in the EU area will have to do so anyway. Costs are lower if you follow the EU regulations. Furthermore, all kinds of companies will have to start making thorough analyses of their environmental footprint anyway, so they should already have this data available.

## Impact

Investment and Divestment are two sides of the same coin. Such taxonomies provide the basis with which net zero financial flows can be achieved. The impact of this policy would be accordingly immense and absolutely necessary for the change of our economy.
Even if these taxonomies are initially only binding for the European area, they have the potential to become a blueprint for the rest of the world.

# Policy 8.5: Carbon Accounting

In order to create transparency for the financial sector and for the general public, existing Swiss accounting standards (e.g. Swiss GAAP FER) should be extended to include the documentation of CO2 emissions, taking into account all scopes (Scopes 1-3). The inclusion of climate risks will thus be institutionalized not only for financial institutions, but for all companies that apply the corresponding accounting standards and are listed on the Swiss Stock Exchange. This extension should also become an admission requirement for the Swiss Stock Exchange. This would make carbon footprint analysis a standard practice and standard valuations would become a fixed part of it. On the one hand, financial institutions will be able to make informed decisions on the financing side, and on the other hand, listed companies will have to deal with their environmental footprint more intensively.

## Impact

As described above, this policy would have the effect of ensuring that the debate on climate risks is taken into account more intensively and thoroughly within the overall economy. Climate risks, like liquidity risks or the financial statements of a company in general, should be considered holistically. Such a policy would aim to achieve this.
It would also improve transparency for the public and all stakeholders. Today, many companies have corporate responsibility or sustainability reports, but these are often primarily a marketing tool and contain little concrete information and figures, but all the more buzzwords. This does not yet guarantee transparency. In fact, these reports are often only used as greenwashing tools.

## Open Questions and Uncertainties

Some companies are both part of the problem and part of the solution. Companies that develop and promote technologies that contribute to the transition of the economy as a whole are still emitting emissions today. However, it should be possible to show such efforts in the context of carbon accounting. Nevertheless, clear information and transparency are important to prevent greenwashing.

# Policy 8.6: Defining Fiduciary Duties More Clearly

For all who manage foreign money, the so-called "fiduciary duty" applies. First and foremost, these are pension funds and insurance companies. Basically, this refers to a responsible management of the insured persons' money "to the best of their knowledge and belief". This means, for example:

- Appropriate inclusion of risks and corresponding diversification of portfolios
- Duty of information and transparency towards the insured persons

One of the reasons often cited why financial institutions still invest heavily in fossil energy is precisely this portfolio diversification (Kohli 2019).
It is precisely this diversification that prevents many from exiting the fossil energy sector. In practice, diversified investment or supposedly diversified investment is merely a reflection of the entire index. In other words, one tries to invest in everything, including fossil energy. The desired effect is that the portfolios do not suffer massive losses due to possible fluctuations on the stock market.

Unfortunately, the fact that the inclusion of investments in fossil energy to the extent that it is done today is negligent is strongly neglected. Because, as already mentioned, there is the danger of a carbon bubble. Other countries, such as France and the Netherlands, already require their institutional investors to include climate and ESG factors in their investment policy and to disclose their portfolios and the climate risks they entail transparently. Other central banks, such as the Swedish and British central banks are now actively pursuing divestment, partly because they fear risks to financial market stability.

Various legal reports, including an expert report from the FOEN, one from the Climate Alliance, one from the WWF and also an expert report from the UNEP-FI Initiative, come to the conclusion that, on the one hand, the fiduciary duty is too imprecisely defined and, on the other hand, it contradicts the fiduciary duty if climate risks are not included in the diversification of portfolios (Eggen and Stengel 2019; Abegglen 2018). (Sullivan 2015)

The legal articles in the BVG/LPP and other relevant laws should be adapted so that climate risks are explicitly mentioned.
In addition, institutional investors should exercise their voting rights at general meetings of Swiss and foreign companies and vote in the interests of the insured persons.

## Impact

Pension funds and their trustees need legal clarity in order to be able to exercise their fiduciary duties. Insurance companies need to stay within the law when managing their clients' money, and given how important this money is, it is right and proper that they do so. It is described in detail above why this extension of fiduciary duty is justified. Its explicit rewriting in the legal texts is necessary so that insurance companies can exercise their fiduciary duty and have legal certainty.

In Switzerland, all investments are made in the second pillar. This gives pension funds an extremely large lever to help with the transition of the overall economy.

## Social Compatibility

The fiduciary duty in and of itself is a matter of social security. Thus, the clear definition of the fiduciary duty improves social security.

# Swiss National Bank

## Policy 8.7: Include Sustainability Targets for SNB

### Description

The purpose and objectives of the Swiss National Bank are anchored in the Constitution and the law. **The stability of the national economy thereby is the main objective of the SNB**. The corresponding federal constitutional and legal articles **should be supplemented by the concept of sustainability**. As already explained in the Current State, the unsustainable and short-term oriented economy of the Swiss financial center is a threat to the stability of the entire economy. Sustainability and the climate risks should be a top priority for the SNB. **This view is not shared by the SNB itself, as it sees itself primarily as a neutral and independent authority. It is questionable to what extent this positioning is compatible already with the current articles of the Federal Constitution.** In the longer term, even after the climate crisis has been overcome and for timely recognition and pro-active action against future crises, sustainability and long-term thinking will be necessary and should be explicitly mentioned in the relevant articles.

The Bank of England has been doing this for years. The ECB (European Central Bank) and other European central banks are currently also moving in this direction, for example by actively pursuing divestment strategies.

## Policy 8.8: SNB Shall Exercise Vote as Shareholder

An important term in the field of sustainable finance is "engagement". Engagement aims to ensure that large investors who own a significant part of a climate-damaging company actively exercise their voting rights and put pressure on the management of the company rather than selling the shares of these companies. Engagement, along with divestment and investment in climate-friendly financial products (e.g. green bonds), is an instrument that can be used by financial institutions for the transition of our economy.

Initiatives like Climate Action 100 pursue this goal (Climate Action 100+ 2020).

The SNB invests its money in a highly diversified manner, i.e. apart from a few human rights-related exclusion criteria, its investment policy tracks the major indices. The SNB is often among the top 40 shareholders of many companies that emit CO2 and thus potentially has a great deal of leverage on the corporate strategy of commodity traders and CO2-intensive companies.

According to its own statements, the SNB pursues an investment policy that is as neutral as possible, which prevents it from actively promoting the consideration of climate aspects by corporate management. It is wary of pursuing a climate policy. However, it is questionable to what extent the active use of voting rights or even divestment measures can be dismissed as climate policy when the stability of the entire economy is at stake, or whether the investment strategy, which the SNB calls "neutral", does not in fact show that the SNB is affected by the same market failure as the rest of the financial sector. The SNB is supposed to drive forward the transition of our economic system to one that is in harmony with the objectives of the Paris Agreement, because only in this way can it guarantee financial stability in the first place.

It is worth mentioning that other independent national banks, such as the Swedish, British and ECB, are doing this today or are committing themselves to it - on the grounds that it is part of financial stability and not a climate policy (Ambrose 2019; Gregory 2019).

Certain sectors, such as commodity trading or the extraction of fossil fuels, can no longer exist in a net zero world. If such companies are not able to drive change even internally, they will go bankrupt. It is preferable that the management in these areas take an active approach to change on their own initiative.

## Social Compatibility

Many people are financially dependent on climate-damaging economic activities. In Switzerland this is the case in the raw materials trade, in countries where fossil fuels are extracted this is much more the case, because in such countries the whole economy is often dependent on this sector. Commitment is the socially acceptable way to reach the goal. Not all investors are big enough to get involved, therefore divestment is more recommendable in many cases. For institutional investors such as the SNB, this approach should be actively pursued.

## Questions and Uncertainties

As mentioned above, engagement is a possible instrument besides divestment and investment. Other central banks pursue a divestment strategy, and we have decided to focus on engagement, also influenced by the fact that the SNB has in the past been strongly opposed to divestment. In practice, it is unclear how effective engagement actually is. There are significant examples where this strategy does not seem to pay off (Mufson 2017). It should also be mentioned that the SNB has a relatively small team of staff and experts. It is questionable whether they have the capacity to get involved. Of course, they are still free to work with experts in the field, such as Ethos (ethos n.d.) or SRP (SVVK-ASIR 2017), to name a few examples. But they are certainly able to pursue divestment strategies.

# Financial Institutions

## Introduction

The financial institutions themselves can play their own part in proactively implementing the regulatory measures required above internally with their own policies, without necessarily waiting for the regulator. The following sub-chapter contains suggestions for appropriate policies.

At this point, reference should be made to the Climate Strike Working Group Banks, which has concrete demands on the financial institutions themselves and is in dialogue with them:
https://climatestrike.ch/de/how-green-is-your-financial-institution

# Policy 8.9: Climate Reporting for Financial Institutions

## Description

In order to comply with the information obligations of financial service providers towards their private customers, financial institutions should inform their customers about the CO2 footprint of the money invested by the customer. This could take the form of an annual report, for example. In this way, customers would be sensitized to the issue and receive information about the climate risks to which they are also entitled.

## Impact

Many people are not aware of the issue. It is often very difficult to understand what their own bank account or insurance premiums have to do with the climate. The whole business is handed over to the financial service provider of their trust without really knowing what happens to it.
When customers are so ill-informed, they cannot even express their demand for climate-friendly financial products.

## Financing

This would mean additional work for financial institutions, but in the future, financial institutions should anyway record and analyze their own ecological footprints much better and have this data available to them accordingly. In addition, increased regulation by the EU will certainly mean that this effort will have to be made anyway, so the additional effort should be kept within limits.

# Policy 8.10: Education and Training for Employees of Pension Funds, Banks and Insurance Companies

## Description

The classic training of employees in the financial sector (e.g. Certified Financial Analyst, CFA) traditionally does not include a comprehensive examination of climate risks. Recently, the CFA training has been expanded accordingly (CFA Institute 2020), but still tens of thousands of employees of Swiss banks, insurance companies and pension funds are not sufficiently prepared for the central challenges of the future.
In the future, all consultants and employees are to be made aware of the issue, not only with regard to the investment side, but also in the credit business. Domestically active banks are mostly involved in the mortgage business. Here, too, advisors should be able to provide their customers with professional advice on topics such as building renovation, and the corresponding offers and tools that help with such advice should be expanded (eVALO 2020). Particularly in the lending business of domestic banks, training and further education should be expanded to include climate mathematics.

As part of an education and training offensive, companies in the Swiss financial sector should be required to train 10% of their employees in climate risks each year until 2030. Corresponding offers from universities and e-learning providers could be publicly promoted. The exchange of experience within the industry should also be intensified, for example by presenting regional best practices at learning roundtables of associations or companies.

## Impact

Education and training is an instrument that allows our overall economy and our labor market to remain flexible and to react to market conditions and changes. The climate crisis is a very good example of a striking change that needs to be responded to. It not only prevents unemployment, but also contributes to the competitiveness of the Swiss economy.

## Financing

Costs for education and training are covered by the rules both by the employee and the employer. It is highly desirable that the federal government supports this offensive with public funds, in view of the above-mentioned positive factors for the Swiss economy.

# Policy 8.11: Tax Incentives for Green Pillar 3a

The private retirement provision via the pillar 3a is today tax-privileged, but without making demands on the climate compatibility of the invested funds. If these funds are invested in fossil fuels, this not only has negative ecological consequences, but can also jeopardize the financial security of old-age provision through climate risks. In addition to the standard solution, many investment foundations today also offer portfolios with an equity component (e.g. 25/50/75 % shares). Similarly, green investments should also be made possible and tax-privileged. One simple measure could be to increase the tax-free allowance for Pillar 3a investments in climate-friendly investment products. This measure could also be made revenue-neutral through a bonus-malus system, in which the current tax-free amount of CHF 6826 per year is reduced by 10% for conventional investments in Pillar 3a and increased by 20% for climate-neutral investments, and the tax rates are adjusted accordingly in the following years on the basis of the observed changes in behavior.

## Financing

The financing is revenue-neutral for the tax authorities due to the bonus-malus system. The providers of conventional Pillar 3a products lose income, but they can compensate for this by offering Green Pillar 3a products.

## Impact

The retirement capital tied up in Pillar 3a currently amounts to more than CHF 120 bn, with annual contributions of around CHF 10 bn (Schüpbach 2019). Increased investment of these funds in climate-friendly investments can have a significant leverage effect on the other measures of the Climate Action Plan.

## Social Compatibility

A representative survey in 2018 showed that young people in particular (46% of those under 30) would be interested in a Green Pillar 3a (Cousse and Wüstenhagen 2018). With the Green Pillar 3a, this target group could already be actively involved in financing climate-friendly investments today instead of jeopardizing their future by investing their pension fund assets in a way that is harmful to the climate.
Open Questions and Uncertainties

The impact on tax revenues should be carefully monitored. If there is a major switch to the Green Pillar 3a (desirable from a climate perspective), the bonus-malus system should be readjusted in good time. In an initial phase, small investment foundations, for example, could be overburdened with the offer of a Green Pillar 3a; they could be supported with targeted advisory services (see e.g. Policy 1.9 in the chapter Cross Sectoral Policies).
To be highly effective, the introduction of a Green Pillar IIIa would have to be accompanied by communication. This could either be done by the banks or the tax offices could enclose appropriate information material when sending out tax returns. A "Green Default" would also be conceivable, i.e. that funds are automatically invested in the Green Pillar IIIa unless the insured explicitly request otherwise.

# 9 Economic and Political Structures

# Vision

Rapid Decarbonization Requires Radical Measures. In order to contribute a fair share to staying within 1.5 degrees Celsius of global warming above pre-industrial levels, the Swiss CAP proposes a rapid decarbonization of the Swiss economy in line with a goal to reach net zero emissions by 2030. Rapid decarbonization in roughly 10 years requires radical changes, and it will be impossible to be achieved without a reduction **of production and consumption of goods and services** that are fossil-fuel intensive. The absolute reduction of material production and consumption will be achieved through a combination of regulatory measures, bans, and taxes.
Such a vision is based on radical structural changes of the economy to transform the current economic growth oriented – capitalist system into a well-being economy that is compatible with the socio-ecological boundaries (Raworth 2017) and whose political and economic stability is not dependent on continued economic growth (Kallis 2017; Rosa, Dörre, and Lessenich 2016). In the transition to such a **well-being-oriented economy,** markets will continue playing a role in the allocation of resources, but they will be regulated to avoid social and environmental costs (e.g. sections 4-6). In such a well-being-oriented economy, people's welfare and retirement will not depend on having a job in fossil-fuel dependent industries. Obviously, the politics of distribution of societal gains produced through economic activities will have to be radically changed. With an economic pie that is not necessarily growing, and it will probably shrink (at least temporary), less has to be distributed more equally.

Such a rapid decarbonization of the economy will be based on **less working hours**, and it will lead to **fewer and fewer jobs in fossil-fuel intensive industries and services**. To ensure a just transition for all means to offer new job opportunities. The reduced amount of fossil fuel intensive jobs will be offset with **more green jobs** that will be created or supported by the state. A green and a just transition will be based on jobs in renewable energies, housing retrofitting, education, ecosystem care and regeneration (urban and rural), care of children and elderly, public space creation and care (urban gardens, sport facilities, parks, libraries, etc.).
Income losses due to less working hours will be compensated through a combination of higher wages or direct state payments, improved public services (such as healthcare and public transport), and smaller heating costs in retrofitted housing. Community-based services will be established or expanded to facilitate an **economy of exchange and repair.** A local economy of exchange and repair will promote a decoupling of well-being from excessive material consumption. The creation of new – green – job opportunities will further support this green transition (section 2).

To ensure a lower level of overall consumption of fossil fuel intensive goods and services, the prices of such products will be increased through taxes and levies, and some of them will be banned (see section 1 and other CAP chapters). Where possible, the production of goods and services will be made more sustainable through renewable energies. However, it will be impossible to achieve the goal of the CAP by simply replacing all fossil fuel-based goods and services with green energy powered goods and services (e.g. by electrifying individual transport). A decrease in consumption of energy, goods and services will be necessary. **A just transition must be a decolonizing transition.** It has to ensure that **we do not create massive new demands for rare earth and metals** (for wind and solar energy installations) that need to be extracted by mining communities in the Global South (Aronoff et al. 2019; Bernes 2019; Táíwò 2019b; 2019a) (see chapter International Collaboration and Climate Finance).

The **private sector** will commit to operate according to environmental and labor standards that are in line with a green and just transition. Shareholder value governed corporations will be gradually transitioning to **cooperatives** in order to reduce the pressure to grow (see chapter Industry and Service Sector). Businesses – irrespective of ownership structure and legal form - will be held accountable through a new set of **climate justice laws.** A smaller absolute level of consumption will ensure that we need to

employ as little negative emission technologies as possible. These technologies will only include what is technically feasible today or in the near future.
The **banking sector** will divest from fossil fuel investments and its role will be to support a green and just transition of the Swiss economy while also supporting climate change adaptation measures abroad. To ensure a climate compatible role for the Swiss banking sector, it will operate with new objectives. (see chapter Financial Sector).
Such a society-wide green and just transition will be supported through the **democratization** of decision making (see Boosting Democracy). Movements and Climate Councils will be empowered to reanimate democracy to transform society and economy in line with the goal to stay within 1.5 degree Celsius of global warming, while paying attention to principles of climate justice. We describe such a boosted democracy as a **transformational democracy**. Similar to advocating for climate justice laws, climate movements and councils will push for a set of **fast-track parliament decisions** to implement the CAP quickly.
To sum up, the CAP pursues a vision that - in the words of Riccardo Mastini - is based on “three distinct but interrelated goals: decreasing energy and material use, decommodifying the basic necessities of life, and democratizing economic production” (Mastini 2020).

# Current situation - Political Economy of Climate Change

This chapter does not offer concrete policies but rather an analysis of the current situation, on which policies should be based on. As the chapter illustrates, we do not limit our focus to GHG emissions being produced within the Swiss borders, even though this so-called territorial approach underpins the UNFCCC model. Given that the Swiss GHG footprint is driven by the consumption of imported goods and services, we take a more comprehensive, structural approach to how the entire Swiss footprint could be reduced in the next 10 years. Contrary to a limited focus of the territorial approach, the consumption-based approach allows us to account in an integrated and holistic way for emission "displacements and problem shifting through international trade" (Haberl et al. 2020, 3,12).

## Yearly GHG Emissions Since 1990 or Earlier and Business-As-Usual (BAU) Emission Projections

A) GHG Emissions of Switzerland (*territorial* perspective)

According to the latest greenhouse gas inventory report, 47.24 million tons of CO2-equivalents were emitted on Swiss territory in 2017, which equals 5.6 tons CO2-equivalents per capita. In 1990, total greenhouse gas emissions amounted to 53.71 million tons of CO2-equivalents, which corresponds to 8.1 tons CO2-equivalents per capita. This means a total reduction of 6.47 million tons of CO2-equivalents from 1990 until 2017, or 12% (FOEN 2019d).

The greenhouse gas inventory is yearly published by the FOEN and includes reporting elements under the Kyoto Protocol. For Switzerland's climate policies, the Kyoto Protocol and the CO2 law (for its implementation) are of central importance. The inventory includes the reporting of carbon dioxide emissions as well as methane (CH4), N20, HFCs, PFCx, SF6, NF3, as determined under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. On the contrary, the CO2 law only covers CO2 emissions and neglects further climate-acting gases.

Neither the CO2 law nor the Kyoto Protocol include international air or shipping traffic. However, those figures are provided in the greenhouse gas inventory. International air travel emissions that are attributable to Switzerland amount to 5.38 million tons of CO2-equivalents, international shipping amounts to 0.02 million tons of CO2-equivalents (2017). Land use, land-use change and forestry (LULUCF) are neither included, but data provided: LULUCF emissions amounted to 1.6 million tons of sequestered CO2-equivalents in 2017.
The following data refer to the greenhouse gas inventory and name carbon dioxide and further greenhouse gas emissions by gas and by sector, according to the frameworks of the CO2 law and Kyoto protocol as well as the CO2 ordinance (FOEN 2019a)

*Table 9-1* ***Territorial emissions by greenhouse gas*** *according to the CO2 law and Kyoto protocol. (FOEN 2019a)*

| | Million tons CO2-equivalents | | | | | Index |
|---|---|---|---|---|---|---|
| Year | CO2 | CH4 | N2O | Synthetic gases | Total | |
| Base | 44.52 | 6.09 | 2.85 | 0.25 | 53.71 | 100.0% |
| 1990 | 44.55 | 6.00 | 2.83 | 0.25 | 53.64 | 99.9% |
| 2017 | 38.25 | 4.85 | 2.39 | 1.74 | 47.24 | 88.0% |

*Table 9-2* ***Territorial emissions by sector*** *according to the CO2 Ordinance (Buildings, Traffic, Industry CO2-VO, other).*

| | Million tons CO2-equivalents | | | | Index | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Buildings | Traffic | Industry | Other | Buildings | Traffic | Industry | Other |
| Base | 17.09 | 14.88 | 13.00 | 8.73 | 100.0% | 100.0% | 100.0% | 100.0% |
| 1990 | 17.10 | 14.86 | 13.05 | 8.63 | 100.1% | 99..9% | 100.4% | 98.9% |
| 2017 | 12.95 | 15.05 | 10.70 | 8.94 | 73.6% | 100.9% | 82.3% | 102.4% |

**Energy-related emissions** from transportation and heating fuel account for the biggest share in greenhouse gas emissions. Figure 9-1 shows that emissions from heating fuels have slowly declined since 1990, which may be caused by the implementation of a carbon levy on combustibles. Transportation fuels, however, have remained untaxed and transport related emissions have not shrank but grown slightly (FOEN 2019a).

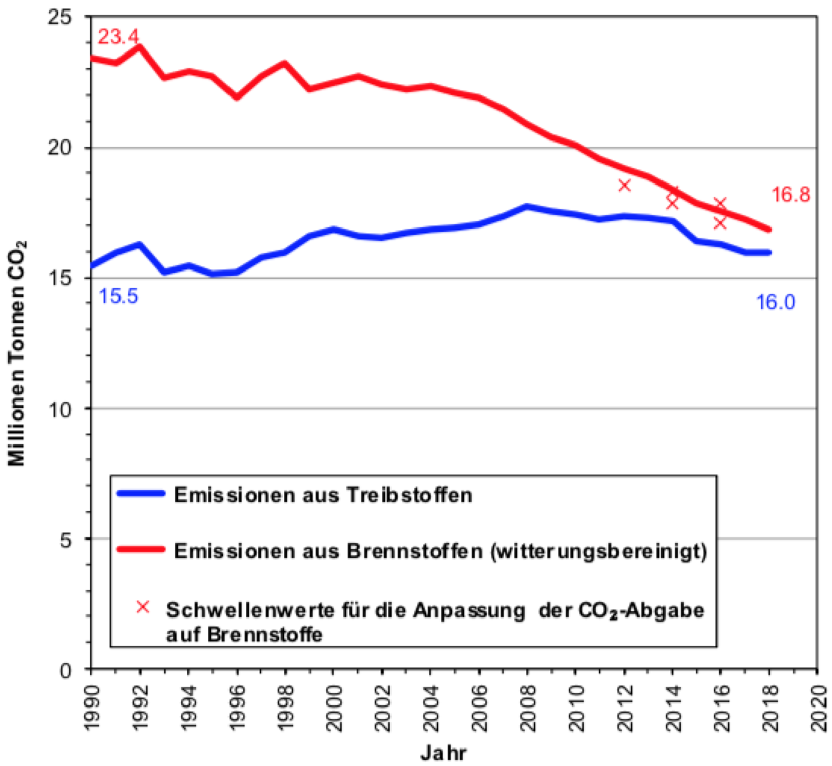



*Figure 9-1 Time series of energy related emissions from 1990 until 2018 Source:* (FOEN 2019d)

The CO2 law defines a reduction goal for domestic greenhouse gases by at least 20% from their 1990 level, by 2020. The CO2 Ordinance defines the reduction goals per sector, which are namely: at least 60% from the 1990 level for the building sector, at least 90% from the 1990 level for the traffic sector, at least 85% from the 1990 level for the industry sector.

The data reveals that greenhouse gas reduction goals 2020 (defined in the CO2 law) could be attained only in the industry sector, which may be in part due to the outsourcing of industrial production abroad that took place since 1990. On the other part, this is mainly due to the target agreements combined with the carbon levy, which has incentivized the industry to reduce emissions. While there was an observable reduction of greenhouse gas emissions in the building sector, the goal was not reached. More problematic is the situation in the traffic sector, where greenhouse gas emissions even have increased since 1990. As of the most recent data, the shares greenhouse gas emissions of each sector are namely:

- 32% by traffic (without air traffic)
- 26% by buildings
- 23% by industry
- 19% by agriculture, waste and synthetic gases

B) Territorial Emissions vs. Consumption-Based Emissions

The current legislation on climate policy, namely the CO2-Gesetz, the centerpiece of Swiss climate policy, focuses on domestic emissions only. However, this approach ignores greenhouse gas emissions that are emitted abroad to produce (and transport) goods which are consumed in Switzerland (imported emissions). Taking a consumption-based perspective, emissions in Switzerland are almost three times as large as domestic emissions (Figure 9-2), which makes Switzerland a case where the consumption-based approach is particularly relevant (Dao et al. 2015).

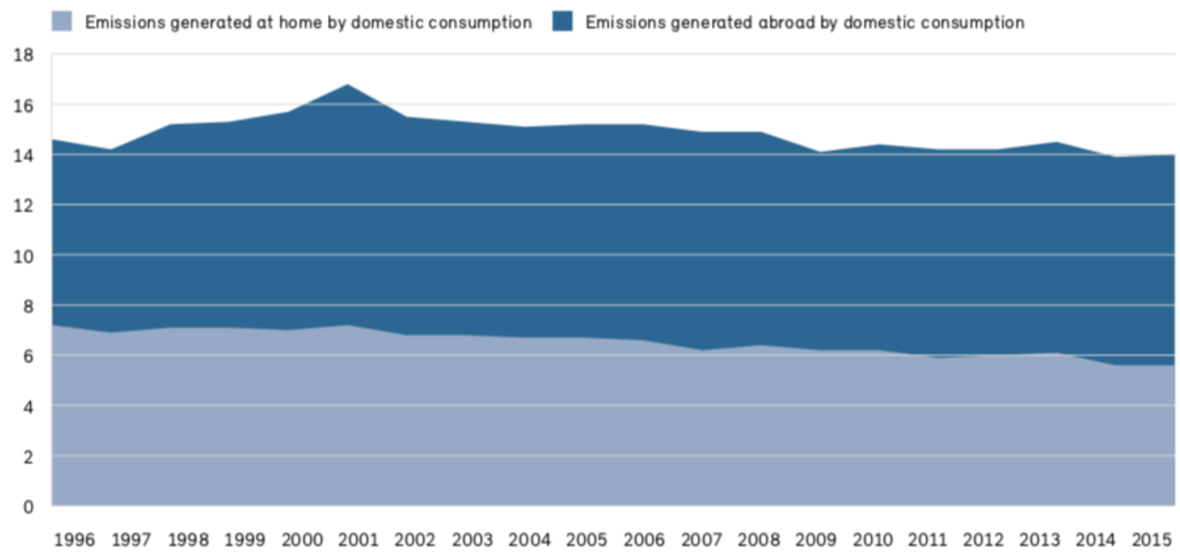



*Figure 9-2 Time series of energy related emissions from 1990 until 2018* (FOEN 2019d)

The Federal Office for the Environment calculates consumption-based emissions of 14 tons CO2-equivalents per capita or a total of 116 million tons CO2-equivalents (as of 2015) (Frischknecht et al. 2019). The so-called greenhouse gas footprint thereby reveals that Switzerland's total emissions from a consumption perspective are well above the global average of nearly 6 tons CO2-equivalents. Taking the concept of planetary boundaries of staying within 1.5 degrees Celsius of global warming, the Swiss per-capita climate footprint is 23 times higher than acceptable to stay within boundaries (Dao et al. 2015). For our goal to stay within 1.5 degrees, the challenge is even higher.

Taking into account further emissions which lay within Switzerland's responsibility, one must not neglect emissions caused by the financial sector. The total investments of the Swiss financial sector cause about 1,100 million tons CO2-equivalents per year, which means they exceed domestic emissions by more than 20 times. Thereby, a global warming scenario of 4 to 6°C is supported (Oehri et al. 2015) (see chapter Financial Sector).

# Global GHG Budget to Reach 1.5 Degrees Celsius and Switzerland's Share and Responsibility

## Remaining Global Carbon Budget

The IPCC special report "Global warming of 1.5 degrees" (SR1.5) gives us an overview of the remaining carbon budget as of the year 2018 (IPCC 2018). However, important uncertainties can substantially affect the size of the carbon budget. For instance, the uncertainty of the climate-cooling effect of aerosols on temperature could reduce the carbon budget by up to 400GtCO2 or increase it by up to 200GtCO2. The budget could also be further reduced by up to 100GtCO2 in 2100 due to Earth-system feedbacks, such as carbon released by melting permafrost that is generally not included in climate models. These feedbacks are less important over the short-term, but their effects may be substantial later in the century (Zeke Hausfather 2018).

If our **goal is to stay below global warming of 1.5 degrees Celsius with a 67% chance**, the IPCC (IPCC 2018, 108) gives us a global remaining carbon budget of 420 Gt CO2 from the beginning of 2018 on. In 2018 and 2019 combined, the world has emitted around 80 GT CO2. This gives us a remaining carbon budget of about 420-80=340 Gt CO2 as of 2020. The IPCC (IPCC 2018, 108) recommends reducing the global carbon budget by 100 Gt to account for unprecedented earth system feedbacks. **At the beginning of 2020 the remaining global carbon budget is thus at 240 Gt CO2**. Given an annual global CO2 output of around 40 Gt, in 6 years of emitting at the current rate the global carbon budget to stay below 1.5 degrees with a 67% chance will be used up.

The IPCC proposes different emission pathways that would stretch the remaining global carbon budget until a "net-zero emissions" point is reached sometime after 2040. Some of these scenarios allow an overshoot above 1.5 degrees (reaching temperatures as high as 1.8 °C by mid-century). All scenarios assume that at the "net-zero emissions" point we continue emitting greenhouse gases while we also rely on negative emission technologies to counterbalance positive emissions. These **negative emission technologies** range from bioenergy, to carbon capture and storage, to afforestation. None of them are available today at scale.
By setting mid-century (around 2050) for carbon neutrality as a goal, as the IPCC does it, we would implicitly leave it up to future generations to develop huge CO2 net negative emissions capacities – the risks are thus enormous. Viewed in this light, leading climate scientists suggest that mitigation action should "proceed on the premise that they will not work at scale" (Anderson and Peters 2016, 183). In other words, we should consider a reliance on future net negative emission technologies as too risky and concentrate on not exceeding the remaining carbon budget. (Near-term implementation of negative emission technologies that are technically already developed should be pursued. See CAP Chapter on negative emissions).
To avoid the problem of **mitigation deterrence** - "the idea that promises of future carbon removal might act as an excuse for avoiding the need to cut emissions today" (D. McLaren 2020), we follow Duncan McLaren (leading scholar studying political and social implications of negative emission technologies) in his proposal for how to "navigate the mitigation deterrence challenge" (D. McLaren 2020):

- Keep plans for carbon removal separate from those for emissions reduction (see D. P. McLaren et al. 2019)
- Constrain and strictly limit offsetting with carbon removal
- Minimize the risks of greenwashing and fraud through monitoring, reporting and verification techniques, and - here we go beyond McLaren - introduce tough penalties for fraudulent accounting

**Switzerland's Contribution**

So how much should Switzerland contribute to stay within the global remaining carbon budget? I.e. what is the remaining carbon budget for Switzerland?
Taking the **consumption-based approach** (imported and territorial emissions, including international aviation), the FSO has reported 116.2 mio t CO2eq for the year 2016, which roughly corresponds to 100 mio t CO2. Le Quéré et al. (2018) show higher numbers (Figure 9-3) but for the sake of simplicity we can assume 100 mio t CO2 per year as our starting point to calculate the Swiss remaining carbon budget.

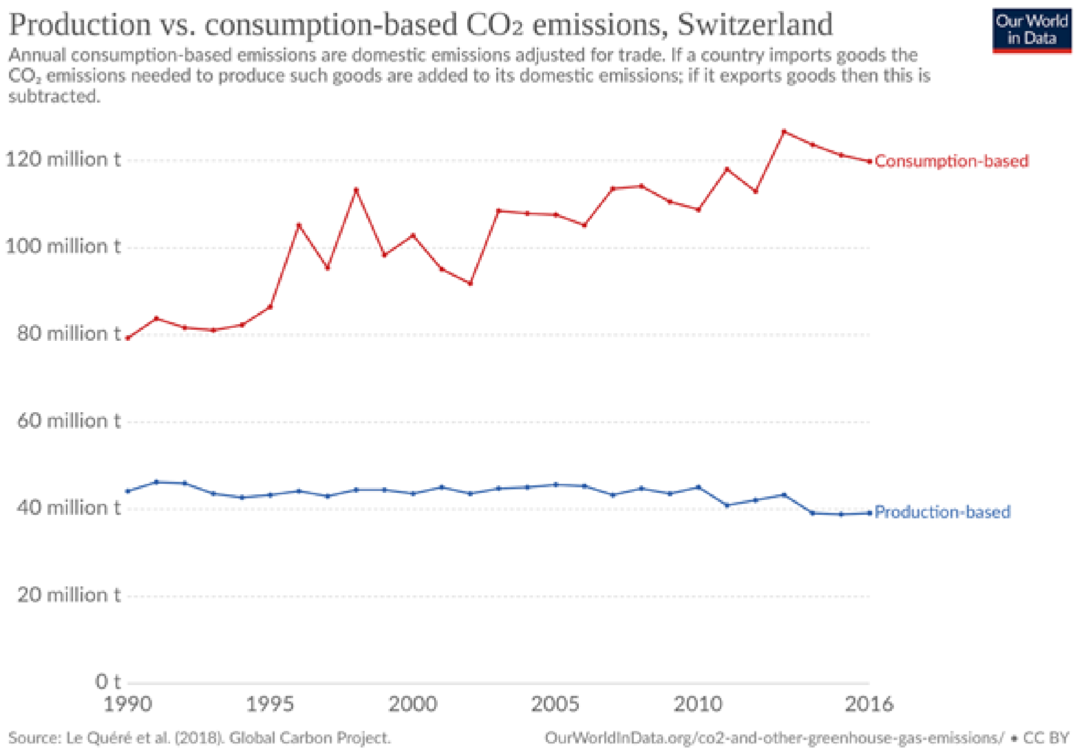



*Figure 9-3 Production vs. consumption-based CO2 Emissions, Switzerland*

If we assume a remaining global carbon budget of 240 Gt as of 2020 and calculate the Swiss share based on the share of global population living in Switzerland, we get:

(240Gt / world population) * Swiss population = 0.265 Gt, or **265 mio t CO2**.

With the current rate of emitting roughly 100 mio t CO2 per year, this budget will be gone in mid-**2022**.

Taking the **territorial approach** (also known as emissions under the Kyoto protocol, excluding international aviation), the Swiss carbon budget of 265 mio t CO2 would be gone mid-**2026**, assuming a current rate of emitting roughly 40 mio t CO2 per year.
Regardless which approach we use, it is obvious that we need to start reducing our emissions now, and at a significant and unprecedented rate, each year in this next decade. This radical challenge must not be evaded by simply further outsourcing our emissions abroad as it has been the case in the last decades (Figure 9-3).
If we take the concept of a global carbon budget seriously and apply it to Switzerland (265 mio t CO2), the pathway towards zero emission by 2030 would have to look as the following graphs illustrate, assuming no negative emissions in Figure 9-4 (territorial approach) and Figure 9-5 (consumption-based approach), and assuming negative emissions up to 5 mio t CO2 p.a. in Figure 9-6 (territorial approach) and Figure 9-7 (consumption-based approach). As illustrated, with a relatively small compensation through negative emission technologies applied domestically these pathways would look slightly less radical, but radical, nonetheless.

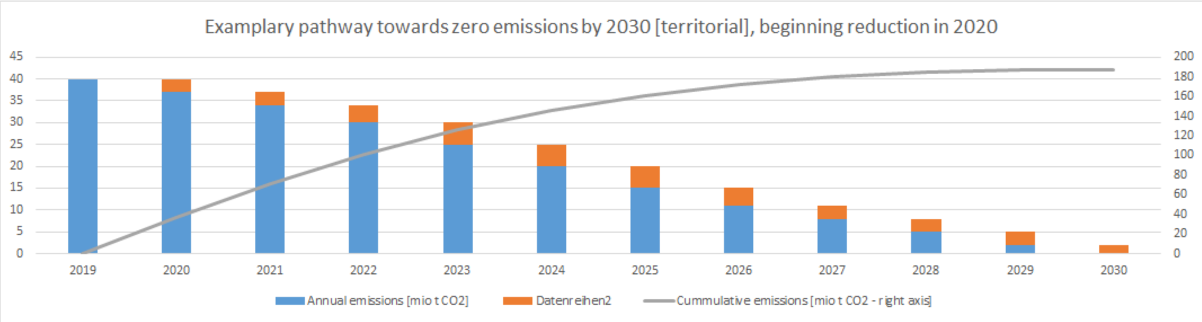



*Figure 9-4 Exemplary pathway towards zero emissions by 2030 (territorial), beginning reduction in 2020*

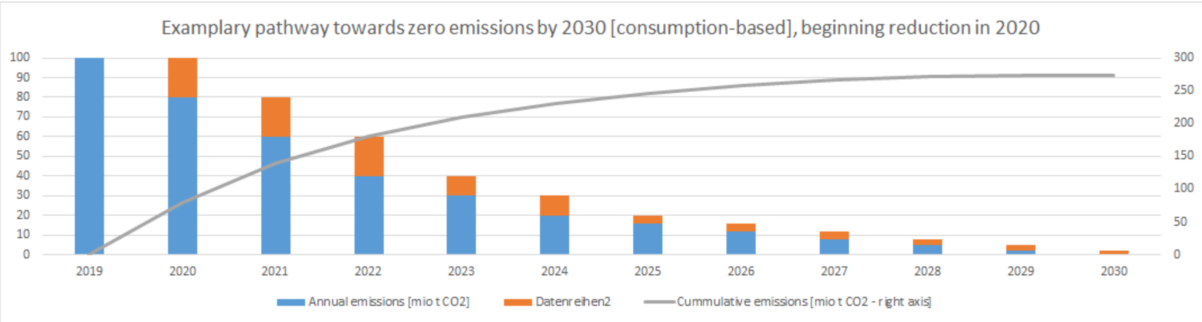



*Figure 9-5 Exemplary pathway towards zero emissions by 2030 (consumption-based), beginning reduction in 2020*

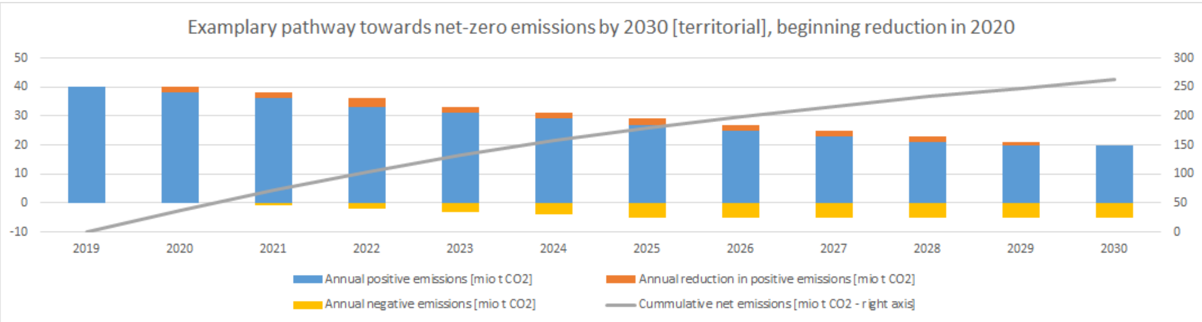



*Figure 9-6 Exemplary pathway towards net-zero emissions by 2030 (territorial), beginning reduction in 2020*

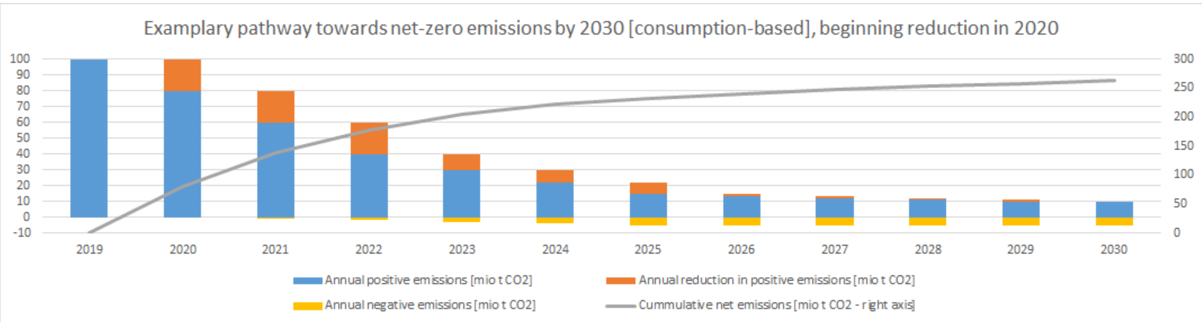



*Figure 9-7 Exemplary pathway towards net-zero emissions by 2030 (consumption-based), beginning reduction in 2020*

# Taking a Structural Approach to Analyze the Current Situation and Devise a Transformational Way Forward:

Dimitri Zenghelis (2015:176) summarized well the **structural challenge ahead** of us:

"Carbon is globally pervasive on a scale quite unlike other pollutants. Addressing it is therefore not a matter of marginalist economics in the neoclassical tradition. Eliminating carbon from capitalism is not about finding static equilibriums in markets corrected for minor failures. Because carbon is so central to capitalism it is a much larger task, involving a fundamental reshaping not just of individual technologies but of entire systems of production, distribution and consumption."

We need to take a structural approach to address the root causes of the climate crisis and to devise an effective set of solutions. A structural approach highlights how anthropogenic climate change is driven by industrial production of goods (and associated services) and their mass consumption in a capitalist world economy.

**Capitalism and its Relation to Climate Change**

Julia Steinberger argues that "taking climate change seriously means bringing down fossil capitalism, with its inbuilt drivers of accumulation, domination, exploitation and destruction" (Steinberger, 2018). Capitalism is an economic and political system that is driven by capital accumulation. It is based on a system of property relations that guarantee private ownership of the means of production in the hands of business owners and their shareholders. These businesses are primarily driven by the necessity to make profits in a competitive environment. In other words, capitalism is "a system of competitive accumulation" (Dale 2019). In such a system, GDP is not just another metric that could be simply replaced with a different one, for instance Sustainable Development Index, a Happiness Index, etc., (see Hickel 2020) while leaving political and economic structures unchanged (even though we plead for alternative indexes as a means to promote structural changes, see Policy 6). If these structures remain, policymakers would have to ignore new metrics and continue pursuing a growing GDP. The pursuit of economic growth is one of the most important policy goals of most governments around the world today (Schmelzer 2015; Mitchell 2011; Collins 2000). Switzerland is no exception. The state of the GDP is thus the expression of government success or failure. However, governments do not simply expand economies themselves. Rather, they ensure that market competition – the necessary condition for economic growth - is in place.

"[T]he relentless increase in global resource throughput and environmental despoliation is not principally the result of states aspiring to a metric – higher GDP – but of industrial and financial firms, driven by market competition to expand turnover, develop new products, and increase profits and interest."(Dale 2019).

Why is pursuit of economic growth such an important policy objective of governments? Without it, **economic and political stability** is at stake (Kallis 2017; Jackson 2016; Rosa, Dörre, and Lessenich 2016). Ensuring stability through economic growth is the upside of the "relentless increase in global resource throughput and environmental despoliation" (Dale 2019). It allows companies to "remain in business" and to pay its employees and shareholders. Businesses continue making money, employees are being paid, pensioners can count on their monthly pension, governments can refinance their debt, pay government employees, provide public services and maintain public infrastructure. Moreover, economic growth can counter capitalism's tendencies to further inequality (Piketty 2014). Keeping inequality in check through economic growth contributes to economic and political stability.

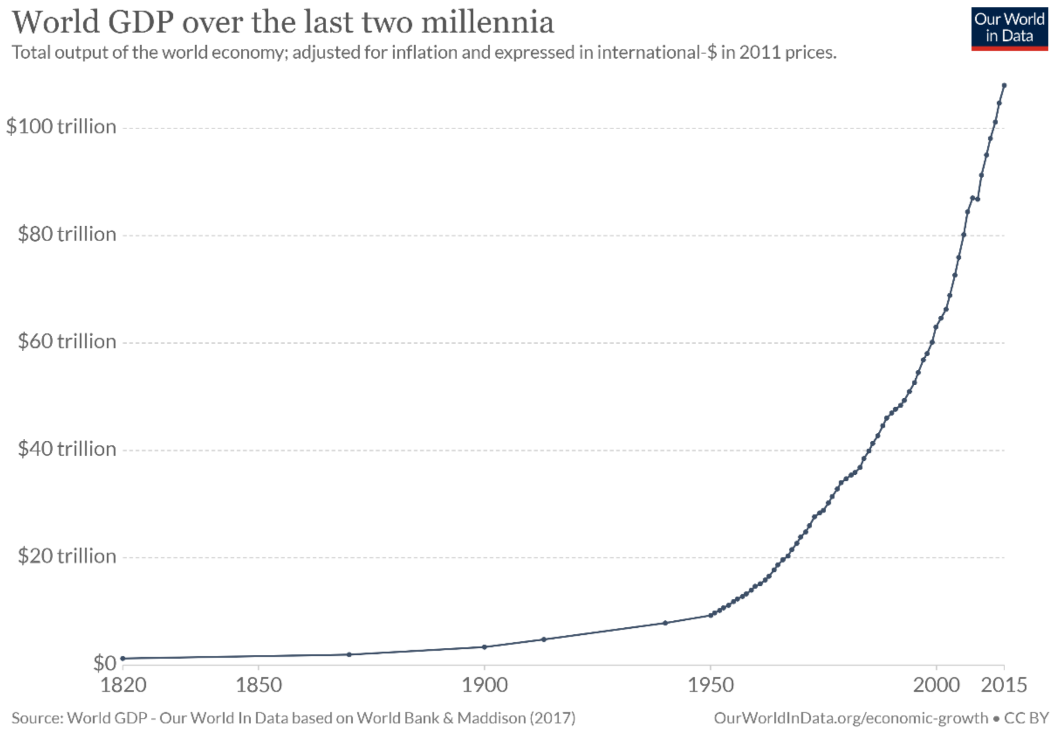
The downside is that capital accumulation is based on what economists call **social and environmental externalities**. This describes costs that are not generated in the process of profit making but are outsourced on individuals and society at large (Kallis 2017). If these costs were internalized, profit margins would decrease substantially, if they would be generated at all. Thus, any attempt to fully internalize social or environmental externalities would likely put a company that operates in a capitalist environment out of business. Hence, rather than understanding externalities as outcomes of what economists call ‘market failure’, they should be understood as cost-shifting ‘successes’ (Kallis 2017).

**Social externalities** entail claiming a share of the value that is generated collectively in the production of goods and services as a profit for business owners and their shareholders (also called 'surplus value'), and relying on the unpaid reproductive labor of mostly women who through their full time labor of raising children (also called 'care work', or the 'care economy') ensure that the capitalist economy is supplied with a workforce, for free.

**Environmental externalities** entail environmental pollution or degradation that is an outcome of the production process (goods or services), e.g. GHG emissions, air/water/soil pollution, deforestation, etc. Hence, before asking ourselves how we can internalize costs in capitalism – a typical approach in dealing with environmental problems such as GHG emissions - we first need to realize that externalities are a precondition for capitalism to function. That does not mean that these externalities cannot be reduced at all. A very simple and effective way to at least partially **internalize social and environmental costs** is to set and enforce effective policy measures, for instance a limit on GHG emissions, or a minimum wage. These policy goals work to a certain degree. If minimum wages or emissions limits are set too high, the competitiveness of the private sector begins to falter in a capitalist environment. In short, there are limits as to how much the private sector can afford to internalize social and environmental in a capitalist economic framework.

The effects of the inherent drive to outcompete each other in the quest for profit is to aggregate **economic growth** (M. Binswanger 2009). This inherent logic to pursue profits – through the externalization of social and environmental costs - in a competitive global economy has led to a correlation between economic growth (that reflects profits) and **GHG emissions** (that reflect environmental externalities) at a global scale (Kallis 2017; Haberl et al. 2020) as Figure 9-8 and Figure 9-9 illustrate.

*Figure 9-8 World GDP over the last two millennia*



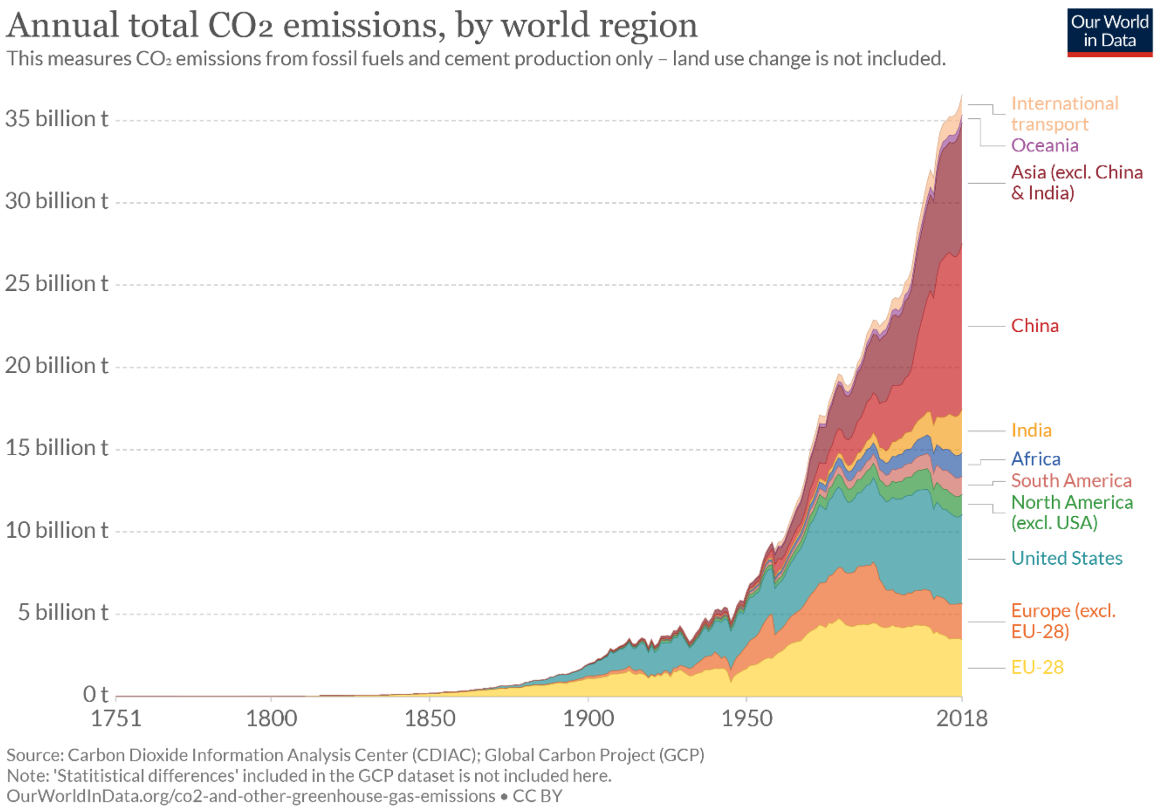




*Figure 9-9 Annual total CO2 emissions, by world region*

**Green Growth or Degrowth?**

Leaving aside social externalities of profit making for now, a meaningful solution to the escalating environmental crisis could entail an **absolute** – not relative – **decoupling** of the GHG emission footprint of produced goods and services from the growing economy, in a short period of time (Haberl et al.

2020). This solution is usually called "**green growth",** that is, the **dematerialization of economic growth**. Green growth suggests that we can continue growing the production of goods and services in a capitalist system while reducing environmental externalities of production. As discussed above, there are limits to this approach – due to the need to remain competitive and to generate profits, and due to the fact that even a service economy cannot be fully dematerialized (Kallis 2017).

An alternative approach to green growth as a solution to the environmental crisis is the absolute reduction of the quantity of produced and consumed goods and services in a given period of time (Haberl et al. 2020). This is usually called a degrowth economy, whereby degrowth entails the dematerialization of the economy through controlled shrinking of economic activities that require material inputs, such as fossil fuels, cement, metals and minerals, chemicals, rare earth elements, etc. Degrowth is impossible in capitalism as we know it, since capitalism is built on the pursuit of aggregate economic growth.

Regardless of whether one favors a green or a de-growth approach, an important argument against the greening of a growing economy lies in the risk of creating a new cycle of extractivist accumulation of minerals, metals and rare earth elements for a transition to 100% renewable energy and electric vehicles. A green but growing economy will be based on growing energy demands which would need to be met with unprecedented mining activities particularly in the global South. Under the present conditions, this extractivist cycle of capital accumulation will be based on the externalization of environmental costs (soil, water, air pollution) and social costs (poor labor and health standards, low wages).

The section above about the global GHG Budget to reach 1.5. degrees Celsius and the Switzerland's share and responsibility has illustrated that in a BAU scenario, the remaining carbon budget for Switzerland will be used up in the next few years, before 2030. How can the Swiss economy slow down this process and subsist on its budget until it is transformed into a net-zero emissions economy in 2030?

As Figure 9-10 shows, Swiss economic growth (expressed through the indicator GDP) has been substantial, while the Swiss CO2 emission footprint – expressed in consumption-based emissions – actually outstripped GDP growth. In other words, instead of decoupling economic growth from the GHG emission footprint ("green growth"), we see here a development that even outstrips recoupling. Consumption-based GHG emissions have grown faster than economic growth. In sum, we have seen neither green growth nor degrowth so far in Switzerland.

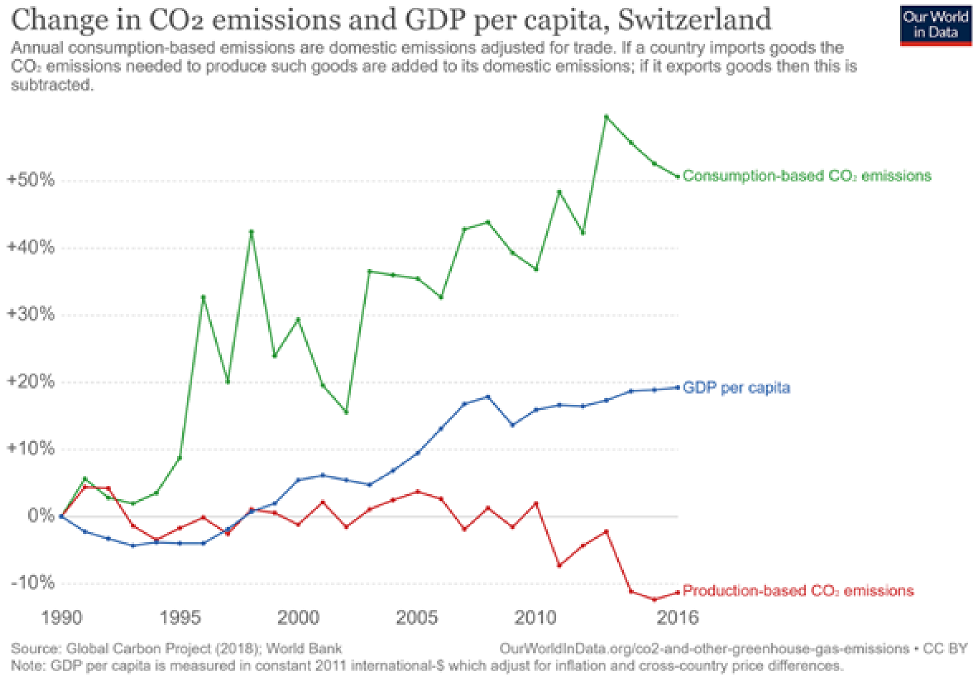



*Figure 9-10 Change in CO2 Emissions and GDP per capita, Switzerland*

**So, What Needs to be Done to Achieve Net 0 Emissions by 2030?**
Kallis (2017) contends that radical dematerialization - the goal of the CAP - is not compatible with economic growth. In a recent state-of-the-art review, Hickel and Kallis (2019) argue that the only way to remain within 1.5 degrees Celsius warming above pre-industrial levels globally is through controlled degrowth of the global economy. They also acknowledge that in some individual country cases it has been possible to reduce GHG emissions in absolute terms without a shrinking economy (green growth). However, this has not been the case for the Swiss economy if we follow the consumption-based principle which is more suitable for the Swiss economy given the large disparity between consumption and territorial emissions. Hence, Hickel and Kallis' conclusion also applies to Switzerland: In the little time that we have to achieve net 0 GHG emissions by 2030 in order to remain within 1.5 degrees Celsius, the Swiss material economy (as measured with the GDP metric) would have to shrink in absolute terms so that the remaining carbon budget is not used up before 2030.

The emphasis on time and economic (de)growth is crucial here, as emphasized by Hickel and Kallis (2020, 12): "...while absolute decoupling of GDP from emissions is possible and is already happening in some regions, it is unlikely to happen fast enough to respect the carbon budgets for 1.5°C and 2°C against a background of continued economic growth" and “emissions reductions in line with 1.5°C are not empirically feasible except in a de-growth scenario. “

Similarly, Parrique et al (2019, 3) conclude in a recent report that “not only is there no empirical evidence supporting the existence of a decoupling of economic growth from environmental pressures on anywhere near the scale needed to deal with environmental breakdown, but also, and perhaps more importantly, such decoupling appears unlikely to happen in the future.”

Finally, Haberl et al (2020, 2) have conducted the most recent and systematic review of the available scientific literature and conclude that “large rapid absolute reductions of resource use and GHG emissions cannot be achieved through observed decoupling rates, hence decoupling needs to be complemented by sufficiency-oriented strategies and strict enforcement of absolute reduction targets”.

**How Can Economic Activities Be Dematerialized?**
There are two principle ways to dematerialize economic activities: by relying on markets (that can be regulated by the state and influenced by consumer behavior) or by imposing bans on certain goods altogether (through new environmental standards or prohibitive taxation, e.g. the introduction of catalytic converters and lead-free petrol for automobiles in the 1970s, and the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987). These two approaches are not mutually exclusive and should be combined. The challenge is to find the right mix of policies that regulate, tax, ban, or incentivize.
While in mainstream economic theory markets offer the best way to govern economic activities towards environmental goals, in practice markets can only play a minor role in dematerializing economic activities given the little time we have and the huge challenge ahead to get to net 0 by 2030. Moreover, markets that are designed to reduce emissions through tradable permits (such as the ETS) perform poorly in practice. This poor performance is due to a lack of interest by the state to undermine the competitiveness and profits of firms whose business models are fossil-fuel based. As mentioned above, the main policy objective of government is to foster economic growth, not to stall it.

Thus, effective regulation of markets, environmental standard setting, taxation or bans all require a political economic structure that does not necessitate the pursuit of economic growth and is not dominated by private sector interests. Unless there are structural changes, shareholder-owned businesses will stand in the way of effective command and control interventions by the state, be it through market regulation or other instruments.
Another important challenge to effective dematerialization policies are often labor unions that will not allow the state to intervene in a way that jobs are at risk as long as healthcare, social welfare and

pensions are coupled with life-long and mass employment. In the current capitalist framework, labor needs and supports aggregate economic growth so that new jobs can be created when existent jobs are outsourced overseas or to the machines. Thus, in the capitalist economy capital and labor are both interested in economic growth and will fight efforts to dematerialize the economy if this means that certain goods and services have to go.

Ultimately, the state itself is not interested in intervening in a way that will cause businesses to run out of business or lose their competitiveness in the global market. This would lead to economic recession, growing unemployment rates and eventually an economic and/or debt crisis and collapse. Not only would the economic system be destabilized, rising unemployment and poverty rates would also destabilize the political system, inviting authoritarian populism, xenophobia, and even fascism. Thus, in the capitalist economy (regardless if it is Keynesian or neoliberal), capital, labor and the state are all interested in economic growth to ensure a stable economic and political system. This is the post-WWII compromise of liberal democracies (Schmelzer 2015). This compromise transformed political-distributional conflicts between capital and labor into an apolitical win-win consensus - more growth is better for everyone.

In conclusion, the main challenge ahead is to dematerialize the economy by decoupling economic activities from the present and future welfare of people so as to stop growing our material throughput and consume less goods (most of which we do not need for our well-being), all without leading to an economic collapse and political shift to the far-right. A set of regulations, including bans on certain goods, will be necessary to eliminate undesired economic activities at a large scale and quickly. Yet there are important political economic structures that would need to be overcome. Most importantly, an alternative is needed to offer people material well-being without the necessity to work in industries that fuel the climate crisis but fund state welfare and retirement programs through their productive activities. Only a labor that is liberated from the need to participate in the generation of perpetual economic growth can act as an agent of change towards a radical transformation of the economy to meet the 1.5 °C climate target.

# The Democracy Challenge

Any radical change or reform must thus be built on a broad social basis and popular support. The key question is how to raise this support by people who will have to be convinced to forego large parts of material consumption in exchange for other - less fossil fuel intensive - social references of good life and well-being. The transition towards a sustainable well-being-oriented economy demands from practically everyone in Switzerland to give up some of their consumption-oriented lifestyles. However, the challenge of radical decarbonization is in ensuring that the burden of the structural changes is evenly distributed. Economically wealthiest and most resilient residents will carry the biggest weight. Urban centers will have to move faster than rural areas.

This is easier said than done. The specter of revolt, resistance and authoritarianism looms large whenever radical societal changes are demanded. Social movements in France, Chile, Brazil and the political shift to the right across the world show the limits and consequences of ill-conceived economic and political reforms that predominantly target the working classes and the working poor.

The CAP must thus be built on more, not less, democracy. While capitalism has historically contributed to the climate crisis, democracy - if strengthened - can be an antidote to it. In short, we must “reclaim our democracies, and make them fit for purpose for the immediate and immense challenge we face” (Steinberger 2018).

An important challenge lies in overcoming the limits of a democratic framework that is based on elections and parliamentary representation. In such an arrangement, the influence of each individual is insignificant, whereas those who wield economic, social and cultural resources, have control over media and so on, are in a very strong position. Not only do they have far-reaching possibilities to

manipulate public opinion (i.e. damaging the credibility of climate scientists), with their economic power they can also blackmail societies by threatening to move jobs and capital out of the country. They often also have the means to exclude critical journalists, scientists and professionals from influential positions in media, government and administration, universities or armies. Finally, when societal conflicts escalate, state forces and agencies such as the intelligence agencies, police or military are mobilized to protect these very political and economic interests which stand in the way of radical and equitable decarbonization.
What we need for radical decarbonization is democracy beyond these limitations. The idea of a **transformational democracy** will be key to create the necessary support for the structural changes required. An important challenge will thus be to adopt the most adapted and effective scale for decision-making processes for different measures needed (see section Boosting Democracy).

# Monetary and Fiscal Considerations

**Carbon Pricing Insufficient**
In economics, the focus of climate policy has been almost exclusively on pricing mechanisms for a long time. Many actors in society and NGOs have been lured into this thinking to a certain extent, however, there is now widespread agreement that a net-zero carbon economy requires not just some microeconomics, but a new political economy (Aronoff et al. 2020) - massive investment, e.g. in public transport to enable us to avoid high carbon prices (Stiglitz 2019). This is even more important for the ambitious decarbonization the CAP wants to achieve. While the crucial role of fiscal policies is not frequently contested (even though there is strong disagreement about the type of fiscal policies), matters have been a bit more complicated regarding monetary policies. Most central banks have mandates that require them to guarantee price stability above all, sometimes coupled with targeting employment or financial stability. However, thanks to a shift in the conversation on climate change, the role of monetary policy and its coordination with fiscal policy is being scrutinized increasingly.

**What Fiscal Policy Measures are Required?**
Within the spectrum of people subscribing to the notion that pricing alone will not solve our carbon problem, we can broadly identify three approaches. One is arguing in favor of financing investment mainly through private finance and, should the public sector play a role, through partial use of carbon levies' revenues. This is the approach enshrined in the buildings program in Swiss climate policy. The second argues for a stronger role of more traditional tax policy instruments, namely personal income taxation, wealth taxation, capital or business taxation. A third approach emphasizes that the sheer extent of investment required makes large-scale borrowing necessary and argues for a comprehensive use of fiscal policy instruments, including coordination with monetary policy (see Pettifor 2019).

In our opinion, the first two approaches both have serious shortcomings: To increase public support for carbon pricing policies, per-capita redistribution can ensure that low- and middle-income households are made better off on average. However, as the carbon price is mainly levied on heating fuels in Switzerland, removing funds from the redistributive mechanisms and moving them into a "Climate Fund" or a similar instrument will disproportionately hurt poorer households. Financing green investment through these kinds of taxes is thus politically risky and may cause a public backlash similar to the "Gilets Jaunes" protests in France.
While traditional tax policies certainly need to play a role in the financing of a rapid decarbonization, the kind of taxes matters. Federal income taxes are significantly more progressive than their equivalents on the cantonal level. This may be beneficial in ensuring broad popular support. Furthermore, imposing wealth, capital or inheritance taxes at the federal level reduces climate policy freeriding by individual cantons. However, even if we were to raise taxes from all those sources, time pressure and the steep decarbonization path indicate that these measures may neither be sufficiently large, nor

happen early enough. It is key that we do not tighten public expenditures for climate mitigation because measures to generate tax revenues fall short.
Therefore, while our proposals include measures to tax the historically most carbon-intensive lifestyles (people with large incomes and large fortunes) through ordinary taxation, we do not make public investment and expenditure decisions conditional on these measures being implemented. In contrast, we argue that the overhaul of our energy, production and transport systems likely requires credit-financed investment. Many people frequently draw from the American experience during the New Deal area to describe the level of effort necessary. Under Franklin D. Roosevelt, government spending growth averaged 8% per year from 1933 to 1939 (Pettifor 2019). Even though Switzerland is currently running large budget surpluses, our ability to decarbonize may depend on either our willingness to run government budget deficits or to set up new institutions such as the public climate bank. This likely requires new forms of coordination between monetary and fiscal authorities.

**Monetary Policy and Climate Change**
The Swiss National Bank has been a laggard rather than a leader on fossil fuel divestment, while e.g. the Swedish Riksbank has already divested from fossil fuels. A new study by Bolton et al. (2020) shows how climate change could potentially cause serious shocks in the financial markets. Both physical shocks (because of climate damages) and transition shocks (because of abrupt policy changes to avert climate change) can be the cause. The shocks then are likely to transmit to the real economy and seriously constrain the ability of central banks to fulfill their mandate, even if this only consists of price stability (Bolton et al. 2020):

- Supply shocks could potentially lead to stagflation-type effects, where monetary authorities would lose their ability to conduct effective policy
- Since climate heating happens at a global scale, national authorities may not be able to appropriately react to imported supply shocks.
- It is not sure whether central banks would ever be able to hedge against coming fat-tail climate risks (so-called “green swans”)

The Swiss National Bank seems to be unaware about how its ability to conduct monetary policy would change under such circumstances. Possible scenarios could involve supply shocks in other countries (e.g. increases in food or commodity prices because of climate related droughts or hazards), financial shocks (a mortgage crisis because of a sudden decline in US coastal house prices) or any other climate related scenario. If the SNB’s awareness of the problem does not change, the law has to be adjusted to explicitly mandate the SNB to include these risks.
In terms of broader monetary policy maneuvering room, Switzerland is in a comfortable situation regarding its monetary policy. It is not on a de facto “gold standard” as the countries in the Eurozone, who are not supported by a lender of last resort and thus need to rely on globalized financial markets for capital (Pettifor 2019). This leaves the opportunity for significant monetary interventions in favor of climate change mitigation. While we acknowledge that all such interventions come with their own risks, some of them have been widely applied already.

# Existing Climate-Related Policy Measures and their Shortcoming

In Switzerland, there is already a CO2 law which comprises policies to curb carbon emissions. These include measures to price emissions (e.g. levy on heating fuels, emissions trading system, taxes on motor fuel which can also be considered CO2 taxes to some extent). Besides this strong focus on pricing, Swiss climate policy uses regulations (e.g. vehicle fuel standards) and subsidies for renewable energy construction financed by a levy on electric power) and the buildings program (financed by part of the CO2 levy on heating fuels).

In addition to the official government policy in the CO2 law, there are mainly four comprehensive decarbonization plans. However, like the official federal policy, none of these match the ambitions of the 2030 net zero target. They also stay firmly in the framework of the current policy. The four documents are the following:

- Climate Master Plan (Climate Alliance)
- Cool Down 2040 Strategy (Green Liberal Party)
- Climate Marshall Plan (Socialist Party)
- Climate Plan (Green Party)

This section will briefly outline the three of the four proposals (the Climate Plan by the Green Party has not been assessed as it has been published after the creation of this analysis) and point out significant shortcomings in their approaches in contrast to the structural approach we urge for in this chapter.

## Climate Master Plan (Climate Alliance)

The Climate alliance is an umbrella organization of Swiss environmental and development NGOs, churches and labor unions. The report (Climate Alliance Switzerland 2016a) is the most detailed decarbonization strategy and is concerned with the following research question: "How far can domestic greenhouse gas emissions be reduced by 2030, taking into account technical, ecological and economic aspects, and what (political) measures can be taken to create the framework for the necessary transformation?"
It concludes that the proposed measures could reduce territorial GHG emissions by 60% until 2030. It is striking that even the report itself recognizes that the measures were insufficient to reach the target of 2 °C global warming already in 2016, and the target has to be considered a complete failure from any global equity perspective. For global warming below 2 °C, a reduction of at least 60% in territorial emissions would be necessary until 2030, globally. From an «Equal Cumulative per Capita Emissions» perspective, net territorial emissions in Switzerland would have to be reduced to below zero before 2040. Under an equity principles method (Bretschger 2013), territorial emissions would have to be reduced by 75% until 2030.
The proposed measures are hesitant and remain in a green growth framework (see section Taking a Structural Approach to Analyze the Current Situation and Devise a Transformational Way Forward).
For road transport emissions e.g., the suggested reduction mainly stems from more efficient internal combustion engine cars and more electric vehicles. Broader measures such as an increase in vehicle occupancy rates, a shift in the modal split towards public transport or a reduction in passenger kilometers travelled through technological measures, home office etc. play no or only a minor role.

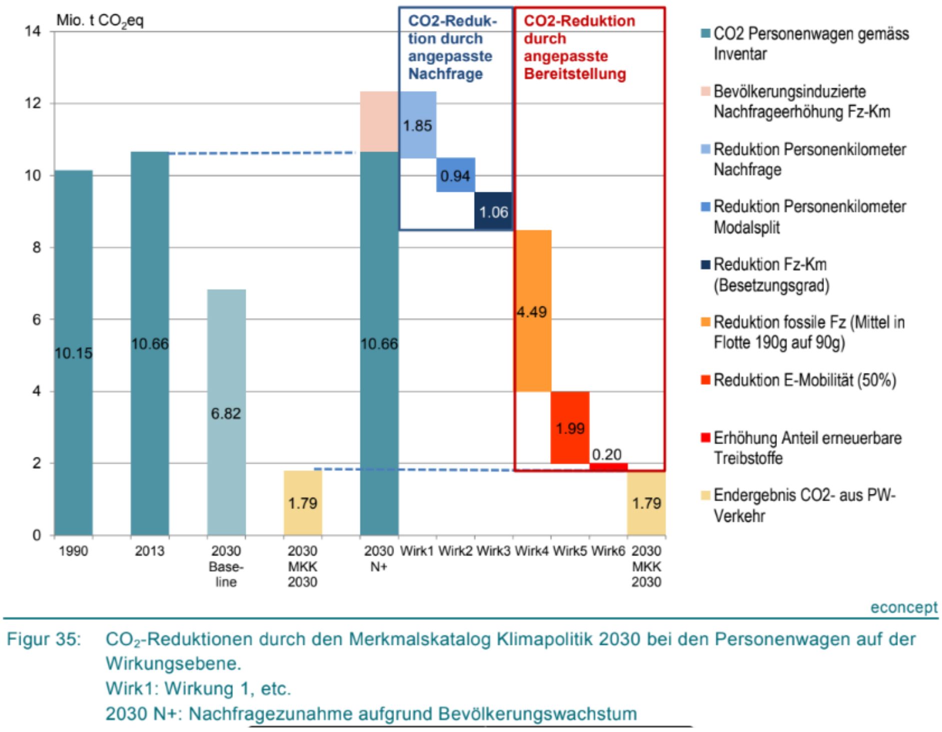



*Figure 9-11 CO2 reductions through the characteristics catalog Climate Policy 2030 for passenger cars on the impact level*

In the buildings sector, the document suggests tightening construction guidelines, increase the CO2 levy for heating fuels to CHF 240 and double the size of the buildings program from CHF 200 mio to CHF 400 mio. Renewable heating systems should become mandatory for new houses if it is economically viable. Depending on the energy efficiency category GEAK/CECB/CECE, homeowners need to construct a fund to make energy efficiency investments. The study further suggests efficiency contracting and efficiency funds to secure further financial means to make buildings more energy efficient. While the requirement for a building related energy investment fund is likely too slow to curb GHG emissions from heating at the required pace, mandating renewable housing systems bear the potential for social conflict if not supported by measures such as a climate bank.

In an additional report, (Climate Alliance Switzerland 2016b) also lays out measures to reduce imported emissions as well as the effect of Swiss investments on the climate. The report suggests to include grey emissions into efficiency standards, to introduce carbon levies on imported products with high emissions and do more research, but also talks hesitantly about the need to reduce material consumption (through “cultural change” toward sharing and unspecified changes in product liability and property rights, “circular economy”). A key point where the report hints at (without providing a detailed solution) is regulations in trade agreements. The measures regarding the financial sector include reduction targets for institutional investors, a CO2 levy on capital income from non-renewable resources on the swiss capital market. Furthermore, the law should be changed such that asset managers are not only mandated to grant security, profitability and liquidity, but also climate compatibility.

## Cool Down 2040 (Green Liberal Party)

The Green Liberal Party proposes a net zero target of domestic emissions by 2040. Its plan (Green Liberal Party Switzerland 2019) includes measures to price emissions (taxes and trading systems), regulatory changes and technical measures (smart grid, smart traffic control etc.). While the net zero target of 2040 deserves some appreciation for being the most ambitious one of the three targets, it still completely lacks the ambition required from a perspective of climate justice and global equity.

One important upside of the proposal is its inclusion of measures to promote rail, bike and pedestrian traffic as an alternative to road travel, as well as measures to reduce distances travelled by cars and lorries (f.ex. die Alpentransitbörse/ La bourse du transit alpin/ La borsa dei transiti alpine or mobility pricing). This would be an important step to reduce CO2 emissions and material consumption while increasing quality of life. The strategy thereby breaks out of a pure green growth logic, as it implicitly recognizes finite resources such as public space and infrastructure. The plan also includes measures to tackle the destructive role of financial markets, namely transparency about climate risks in financial products. Thereby, one of the most important blind spots of Swiss climate policy is brought into discussion. Furthermore, the shift to renewable construction materials such as wood, as well as stricter spatial planning rules clearly reflect parts of the structural approach to climate policy we are promoting.
The plan also wants to increase the share of carbon emissions covered by carbon prices. It lays out a detailed price trajectory for motor fuels (beginning at CHF 110, increasing by CHF 10 every year). In the beginning, GLP wants to use part of the revenue of the CO2 tax on fuels (up to 50%) instead of highly progressive federal income taxes to finance green investment. As a study by Filippini and Heimsch (2015) shows, fossil fuel price increases will affect Swiss people heterogeneously, depending on where they live. People in rural areas have less opportunities to change their behavior to avoid these taxes. Hence, they will be forced to pay a larger share of the green transition fund. In an Interview with SRF, former GLP president Martin Bäumle was once quoted saying that he opposes climate policies where "the very rich and the entrepreneurs will pay for the whole exercise again. The majority of the poorer people pay no federal tax at all. You should not mix environmental policy too much with social policy" (Washington 2019). In contrast, researchers such as Filippini warn of a referendum loss if rural people are ignored. He calls for a 100% dividend redistribution to the population, differentiated between urban and rural areas.

## Climate Marshall Plan (Socialist Party)

The Socialist Party's "Climate Marshall Plan" (Socialist Party Switzerland 2010) proposes net zero territorial greenhouse gas emissions by 2050 at the latest. This goal falls short of all climate justice requirements and is completely insufficient also in comparison to the climate strike target, net zero by 2030. Despite its insufficient consideration for global climate justice, the Socialist Party proposal emphasizes a just transition within Switzerland. It acknowledges the need for additional public investment expenditures and subsidies. In particular, the massive reinforcement of the buildings program should be financed by highly progressive federal income taxation and value added taxes through the federal budget. It also emphasizes the need for tenant protection and introduces an investment program of 300 Mio. p.a., where only landlords who guarantee stable rental prices for the following 10 years are eligible.
Overall, the plan remains firmly in a green growth framework. At the forefront is an investment offensive in solar energy infrastructure (CHF 480 million p.a.), charging infrastructure (CHF 100 million p.a.) and vehicle fleet electrification (CHF 200 million plus investments through climate bonds). The only policy where it breaks out from a green growth narrative is the hesitant attempt to reduce or at least freeze traffic: Car traffic is tackled by blocking the construction of new highways; to reduce air traffic, the "Marshall Plan" wants to introduce a moratorium to increases of airport capacity and mandate CO2 warnings on flight travel ads. To substitute flights, an expansion of rail connections to Europe is emphasized. It is notable that while an increase in low carbon public transport is mentioned, the plan does not suggest any changes in the overall composition of inland traffic towards more walking, biking and trains.

In stark contrast to the “cool down 2040” strategy, the weakness of the Climate Marshall Plan is its vagueness regarding CO2 levies. While a levy in the transport sector is mentioned several times, the authors refrain from being specific about the level of the levy. The only indication they give is that it “should be rolled out gradually” and “only be increased if targets are not met” While the suggested 100% equal per-capita redistribution of the revenues is more socially just than other uses, the Climate Marshall Plan does not propose any measure for the compensation of those hardest hit by the policy either.

# Learning from Corona

**The Role of Science in Times of Crisis**

Epidemiologists and virologists are the most important advisers to governments all over the world as the corona pandemic spreads. It almost seems as if science is finally listened to, being used to govern for the good of humanity. No doubt, the corona pandemic requires state-of-the-art scientific knowledge to be defeated. Some Asian countries have even shown that scientific knowledge coupled with high-tech digital technology can be enough to track and contain the spread of the virus with only little disruptions to economic and political life.

Can we draw an analogy from how science is harnessed for policy with regard to the climate crisis?

To an extent yes, but there are also important differences. Certainly, both are problems that affect all of humanity and both do not know borders. Just like epidemiology and virology are fundamental to understanding corona, climate science has been fundamental to understanding and anticipating the climate crisis. Climate models have consistently shown to produce accurate projections since the 1970s (Hausfather et al. 2020). However, unlike the case of the coronavirus, climate science coupled with state-of-the-art technology alone is not enough to guide the world to a sustainable future. Effective climate change mitigation requires first and foremost political economical changes, not just technological fixes. We also cannot simply let climate scientists and environmental engineers advise our governments and hope that the science-technology-policy trio will do the job.

**What Can we Learn from Corona?**

The necessary structural changes that are hinted at in the section 1.3 tend to be understood by many as utopian – not realistic – given the political realities, etc. In short, so-called “capitalist realism” - “the widespread sense that not only is capitalism the only viable political and economic system, but also that it is now impossible even to imagine a coherent alternative to it” (Fisher 2009, 2) - is in the way of radical climate action. This belief has been entirely overturned only in the matter of days across the Global North in the wake of the nascent Corona pandemic. Entire nation states have suspended social, economic, and political “business-as-usual” to contain the spread of the virus (Brand and Högelsberger 2020). Everything is suddenly possible what was always believed to be impossible, from the suspension of capitalist markets, to the nationalization of entire industries (e.g. Spanish private hospitals), to the transition to a planned economy to ensure the supply of critical goods, to de facto unconditional basic income payments. Corona has already taught us that when deemed socially necessary, state and society can change everything in the matter of days. The list of things we allegedly cannot have but actually can is endless and keeps growing day by day. Even more important is that the pandemic has also shown how GHG emissions can be reduced effectively in a matter of weeks by - temporarily for now - retiring entire infrastructures, production lines, and consumption practices. These reductions show that another world is possible, where GHG emissions are reduced without the reliance on markets or emission offsetting.

When the pandemic is over, the world will face several possible futures (Mair 2020). We could go back to pre-Corona capitalist business-as-usual, or we could stay within a post-capitalist economy which will likely have significant positive effects on climate mitigation and a functioning social system that was ensured through a reconfigured state-society relationship that embraced principles of solidarity and decoupled social well-being from capitalist markets and logics, all in order to contain the pandemic.

However, it is to be expected that Corona will usher in an unprecedented global economic recession with massive amounts of public debt, unemployment, and worthless pension funds.

Rather than “wasting another crisis” (Aronoff et al. 2020), or missing a “historic opportunity”, as IEA head Fatih Birol described it , this future post-Corona moment could be harnessed to maintain a post-capitalist society and economy that keeps a functioning social system, resets all economic debt, further strengthens the hopefully well-established care economy, builds on a solid base of publicly funded green jobs (Aronoff et al. 2020) (see Policy 9.1 & 9.2) and does not return to capitalist markets so as to keep GHG emissions in check (Brand and Högelsberger 2020).
Moreover, a post-corona era may require recurring periods of social distancing and repeated rounds of controlled contraction of economic activities to keep the virus in check. This situation offers a possibility to bring together policies of climate mitigation and policies of pandemic mitigation. Social scientist Tilman Santarius and ecological economist Steffen Lange (2020) formulated it as follows: In terms of economic policy, the pandemic requires a move beyond neoclassical and Keynesian thinking in order to cope with the socioeconomic consequences of the crisis. If political measures to restrict social contacts become necessary over a longer period of time, a transformation of the existing economy, which is dependent on economic cycles and growth, to a sustainable and crisis-resistant economy, a resilient economy, must be initiated.

# Green Investment in Good Jobs

The rapid decarbonization of Switzerland will involve a radical transformation of the economic system, at an unprecedented scale and speed. The policies presented in the CAP, if implemented as a block, will promote a change in production methods (toward carbon efficiency), a shift in consumption patterns (from carbon intensive to low-carbon products and services), and a decrease of overall material consumption (hence also less production of goods). Some economic sectors will shrink or disappear, while others will grow, and possibly the overall economic activity will decrease (measured as GDP).
In the long term, job losses in polluting sectors will be replaced by new jobs with shorter working times and lower carbon footprints. However, in the short term, the balance between job losses and job creation might be negative, new jobs might be located in different regions and require different training compared to the current fossil carbon-based economy. If left uncontrolled, these temporary imbalances can have deep social consequences such as an increase in unemployment, poverty, and social unrest. This needs to be avoided, and the state has the responsibility to guarantee the means to have a decent life to everybody.

## Policy 9.1: Public Program for Green Jobs (ProGJ)

### Description

A Public Program for Green Jobs (ProGJ) will be created to cushion the social consequences of the Corona crisis and the transition to a GHG-neutral economy. In the course of decarbonization, jobs will inevitably be lost in emitting sectors, as these will have to shrink or even disappear completely.
The ProGJ should proactively take care of employees in the affected sectors and provide them with an alternative in a sustainable area in advance. For this purpose, it can work together with the Regional Employment Centers (RAV) and must take care of the creation of additional jobs in sustainable areas.

**Example 1:** The ProGJ, will create a program to advise and support all building owners who want to retrofit their house/flat, install solar panels, replace heating systems or implement other renovations that will decrease the energetic demand of their buildings. This program will assist building owners in finding credit with the climate bank (see chapter Buildings and Spatial Development), information about the different possible technical solutions, and bureaucratic paperwork. This service will be provided free of charge, or at a low price. This program will create jobs and offer training in an important economic sector that will likely develop in the future, at the same time it will accelerate the improvement in building efficiency, and the deployment of renewable energy sources, thus contributing to achieve carbon neutrality.

**Example 2:** The ProGJ will create repairing centers spread throughout the country. These centers will provide a public repairing service where electrical appliances, furniture, clothes etc. can be repaired at an affordable price. Goods that break within the manufacturer's warranty can be repaired in these centers free of charge (manufacturers will be charged by the centers for the repair). Additionally, these repairing centers could offer free use of tools, training in several activities, and could become community centers where one can get help with various issues. These centers will have multiple functions, they will provide good jobs and professional training, and through their activity they will increase the lifetime of objects, thus reducing their material footprint. One possible example of how these repair centers could be organized is developed in Policy 9.2.

**Example 3**: The ProGJ will create a fleet of low-emission or electric public taxis that will provide public transport in rural areas where the population density is too low for the conventional public transport system. This will create job opportunities in marginal areas, improve the capacity of public transport, and will decrease the dependency from cars.

**Example 4:** The ProGJ, in coordination with the Federal office for the Environment will create a program to improve the biodiversity and the environmental quality in Switzerland (OECD 2017). The ProGJ alone will not be able to reverse the trend in biodiversity loss and environmental degradation, additional policies will be necessary. However, the ProGJ will provide the workforce for the protection, restoration and monitoring of biodiversity and environmental quality. There are countless projects that could be implemented under such a program, and they could include the management of natural areas that are also used for recreation. Especially in the urban context these green areas will also play a role in the adaptation to higher Summer temperatures. When extending green areas in urban contexts, such extension should not lead to gentrified environments (see chapter Buildings and Spatial Development).

**Example 5**: The ProGJ, in coordination with agencies working in the caring economy (child care, care of elderly, health care) will support an expanding care economy (see Policy 9.3) by facilitating the training of people who would like to work in the care economy, and help them find a job there. Women and men who chose to take care of their children or parents at home will be able to claim their compensation from the ProGJ who will be authorized by the state to treat reproductive care as a normal part of the care economy.

## Financing

With the implementation of the ProGJ the public sector will take a larger role in the overall economy of Switzerland, and it will provide enhanced services to the population. Therefore, the ProGJ will be financed by the core budget of the state, it is possible that in the first phase the costs of the ProGJ will be substantial, resulting in a government deficit. However, currently government spending is regulated by the debt brake (FFA 2020). The debt brake essentially says that over an economic cycle, expenditures cannot exceed revenues, in this way public debt cannot rise (in the long term). Switzerland's public debt brake poses a substantial limitation to achieve full funding of the ProGJ, and of the CAP's policy proposals in general. Therefore, we propose that public investments in mitigation and adaptation spending for climate change are exempted from the public debt brake's general expenditure rule. Mitigation measures towards carbon neutrality shall not include any climate offsetting or otherwise compensating schemes (e.g. outsourcing as described above).

## Impact

The impact of the ProGJ on the GHG emissions will be indirect. By creating jobs in economic sectors with low GHG footprint, the ProGJ will contribute to achieve a rapid transition to a GHG neutral economy.

## Social Compatibility

The main goal of the ProGJ is to ensure that the socio-economic transition envisioned by the CAP will be just, equitable, and politically legitimate. The ProGJ should enable all people to find a job in a green sector and keep the unemployment rate low.

## Questions and Uncertainties

There are many possible structures and tasks that could be adopted by the ProGJ. One important aspect will be to achieve a good coordination between the federal, cantonal and local activities of the ProGJ. It will also be important to monitor the activities and impact of the ProGJ to adapt its interventions quickly to the changes in the economy.

# Policy 9.2: Nationwide Network of Climate Workshops

## Description

Climate workshops provide equipment for loan, offer repair services and organize further training and courses. They cover areas such as textile, wood and metal processing, IT and telecommunications consulting and support. In this way, a new economy is created in the local area with the lowest possible transport volumes and optimized use of equipment and expertise. Climate workshops are a focal point in the development of a sustainable and climate-friendly everyday culture in the handling of goods and materials. As the technologies of digital printing become more widespread, the range of possible applications is growing. For example, spare parts can be produced locally. Manufacturers of goods must accordingly be obliged to publish appropriate instructions for all wearing parts of their products.

Climate workshops are part of public services and should be set up in all districts and villages. They must be integrated as much as possible into the respective local communities, for example through cooperation with neighborhood or village associations, with schools, technical colleges and universities, with scout organizations etc. Many of their individual services (e.g. repair services) may come at some small costs (but without serving any profit interests). Nevertheless, it is clear that they need financial support from the public sector.

## Impact

Climate workshops support households, municipalities, neighborhoods, special purpose associations, clubs, SMEs, etc. in ecological adaptation processes and in sustainable everyday life and habitat design. The efforts of people and various organizations are given a collective framework to support them and improve their efficiency. Climate workshops strengthen the relevant skills and ensure their rapid dissemination. At the same time, climate workshops are a focus project for new, sustainable forms of economic activity, e.g. the broad use of additive manufacturing (3-D printing) to promote the sustainable use of goods, machines and installations.

They can also act as a catalyst for a practice-based, sustainable reorientation of schools and other educational institutions by working closely with them.

## Funding

It is estimated that 3000 Climate workshops will be required in Switzerland in a full implementation (for comparison: there are about 10'000 kindergartens and primary schools in Switzerland). If one estimates 7 jobs per workshop, this results in about 20,000 full-time jobs, which requires about CHF 2 billion per year. If the same amount is used for rooms, materials, machines, etc., the total cost is CHF 4 billion. With an estimated income from services of CHF 1 billion, this leaves CHF 3 billion annually, which must be provided by the public sector.
This funding requirement is to be financed primarily by a climate tax on financial assets (see Policy 9.9).

## Compatibility with Social Objectives

Climate workshops redesign everyday life and consumer behavior into a jointly borne task, during which many new forms of quality of life rapidly emerge. The creation of around 20,000 new jobs makes it possible to give many people a new professional perspective. At the same time, craft qualifications are supported and upgraded. For example, new career prospects can be opened up for employees in car repair shops. There are around 5200 car workshops in Switzerland, of which around 4000 garages with 39,000 employees are organized in the Swiss Association of Motor Trades and Crafts (AGVS).

## Questions and Uncertainties

The establishment of a sufficient number of climate workshops requires the efforts of a wide range of actors to be brought together. Those include existing institutions such as repair cafés, professional associations and trade unions, neighborhood associations, educational institutions, trade associations, local authorities, etc. If this succeeds, it will be possible to advance a new way of how everyday life is organized in the sense of a solidarity-based way of life. It is important that the experience gained during the construction process is continuously evaluated and that there is the political will to overcome obstacles and difficulties.

# Social Economy

## Introduction

The climate emergency demands for “rapid, far-reaching and unprecedented changes in all aspects of society” (IPCC 2018). Accepting the scientific consensus also means to accept that small, individual changes will just not make it, but a structural redefinition of our economic system is inevitable if we truly want to limit climate change. We therefore need to envision a new economic model based on the reassurance that our labor is able to generate communal welfare without the necessity of ever-expanding material throughput. At the core of any climate policy adhering to a just transition must lie a plan to redistribute the wealth and fruits of societal production and reproduction equitably: a social economy.

This involves a shift of economic reason away from profit creation towards social welfare and community wealth. This also means changing the way we rationalize economic growth, instead of focusing on GDP a Genuine Progress Indicator needs to account for sustainable human and environmental wellbeing (The Green New Deal for Europe 2019, see more in policy 9.6). A comprehensive change in production and consumption schemes must be centered on green jobs providing a better living and caring for community goods. At the same time, shifting production away from carbon intensive to low-carbon jobs achieves more than just CO2 reductions - care and education provide necessary means for community development, allow for stronger societal bonds and must be thought more broadly. Community care involves jobs in sports, play, culture, ecosystem repair, kindergartens and public leisure, to name just a few. Providing a job guarantee and collectivizing reproductive work can contribute to close gender imbalances and is effectively enhancing quality of life. At the same time this incentivizes more sustainable living habits as it opens up quality time through a general reduction in overall working hours with full wage compensation.

**A Green Transition is a Just Transition.**

Decarbonizing our economy means moving from profit-oriented towards communal welfare- oriented modes of production. Our goal is to build an economy which prioritizes not material growth as the sole denominator for societal development, but for an economy in which the wellbeing of people and our environment is pivotal in the question of how we organize our societies. The past decades have been predominantly focused on a radical privatization of public services, including healthcare, education, housing and pensions. However, having the climate crises in mind we will have to relearn public participation throughout our economic organization. This means to enhance workers’ rights not only in the way labor is accounted for, but also in what ways we are using our collective ability to work and what we are producing. A just transition does not only mean to provide green jobs, it also means to provide meaningful jobs.

# Policy 9.3: Working Time Reduction (WTR)

## Description

We aim for WTR in a post-growth economy, which allows us to reduce working hours while redistributing the work more evenly on the workforce, thus giving people jobs who may have lost a job during the transition to a decarbonized economy.

The number of full-time weekly working hours is gradually reduced from 41 hours (FSO 2020b) to e.g. 30 hours per week in the next 2 years, and to 24 hours per week until 2030. The working week is reduced to four working days (the standard week lasts from Monday to Thursday) immediately.

Working time reduction is a crucial measure to redistribute the productivity gains of the economy to the workers by compensating (fully or partially) less working time with higher wages, and to ensure that all workers have a secure working place in a post-growth economy (Kallis 2017)(Kallis 2017). Historically working time reduction has been a central demand of the labor movement and poses several impactful positive effects on the ecological, care-economical and the social realm.

An important policy goal of the WTR should be to set free time to enable people, households and communities to pursue non-paid (not commodified and potentially low carbon) activities and to regain autonomy over their immediate environment and community life. Hence WTR must actively ensure that the increasing leisure time is not used for more (and potentially high carbon) consumption (Kallis 2017; Gorz 1991). This will be achieved through the GHG pricing and the respective border adjustment (see Policy 1.2 and Policy 1.3).

**Types of Working Time Reduction**

A reduction in the hours a person works through their life can be achieved in several different ways. Not all measures are equally effective in terms of gender and social equality as well as ecology. Several of the presented measures can be combined. A shorter working week could be combined with a shorter workday. Often the amount of labor is measured in working hours per week or year. A WTR measure could also consist of a reduction in the total working hours per worker during a week, year or a whole life, which would make the current labor policies more flexible. A shorter working week has been a demand for a long time from different interest groups. A shorter working week could result in a three-day weekend for the whole population or workers could choose, on which days they work. Some of an enterprise's workers could work from Monday to Thursday and the others from Tuesday to Friday.

A different approach would be to reduce the length of the workday. The standard eight-hour workday would be reduced to a shorter workday. There have been experiments in Swedish companies introducing a six-hour workday (De Spiegelaere and Piasna 2017).

Another measure could delay the entrance of the labor market by extending the period spent in education. Alternatively, the retirement age could be lowered. This reduces the overall working years of a person.

A lowering of the retirement age would counter the current trend increasing the retirement age (Finnish Centre for Pensions 2107). Workers could also have the possibility to take sabbaticals with the guarantee to return to their workplace after the sabbatical.

## Financing

The WTR is financed through the tax on large assets which is in effect a redistribution of the productivity gains back to the workers (see Policy 9.9).

## Impact

The positive impact of shorter working hours is the use of less energy and therefore carbon emissions. When workers do work for a shorter time period the output of the whole economic system can be substantially reduced. According to Nässén and Larsson (2015) a reduction of working hours to 21 hours would **reduce carbon emissions by 41%**. However, Nässén and Larsson (2015) do assume a parallel reduction of income which shall not be assumed since this goes contrary to the principle of climate justice. Its social compatibility will be further discussed in the respective section. On the other hand, more working hours translates into more consumption and studies report on a direct link between (very) long working hours and carbon-intensive consumption. The reverse is not necessarily true but depends on what happens with the freed leisure time (Dengler and Strunk 2018).

Working time reduction can have other positive effects. Continuing productivity gains will reduce wages to a lesser extent than working hours. Hence, people will work less with a partial compensation of wages. In other words, people will have more leisure time and can do all the things they normally do not have time for. Their purchasing power will also decrease, although to a lesser extent. Since the goal is not to spend more free time to consume more, a small reduction in purchasing power can be justified (with exception in low paid jobs where workers cannot afford any wage cut).

Some parts of the additional leisure time may be used for less carbon-intensive ways of commuting. Furthermore, carbon emissions of commuting will be reduced by 20% since workers only have to commute on four days per week.

### Social Compatibility

A reduction of income with the same ratio through all income levels would be antisocial. Not all people contribute equally to the overall carbon emissions (Chitnis et al. 2014). The shortening of working hours poses a unique chance to create a more just society. While the average income needs to drop to ensure mitigation of carbon emissions, it can be done in a way that leaves a larger part of the cake to the working class. It is possible to extend the income of the working class, while reducing carbon emissions. This would require a redistribution of wealth from the wealthy, big-polluters to the lower-income classes of society. It is essentially a shift from capital to labor (Kallis et al. 2013) - a shortening of surplus labor. There exists a wide range of options to redistribute wealth: A maximum and a minimum wage should be introduced and the tax on large assets (Policy 9.9). These measures would reduce carbon emissions and fight income inequality at the same time.

WTR should avoid creating a "dual society" (Gorz 1991) of highly productive professional workers (whose high productivity can be translated into reduced working time with equal pay, e.g. people working in the banking and finance sector) and low-skilled low-pay jobs in the service industry (e.g. the care or gastronomy sectors). Rather, WTR should be designed to reduce the proliferation of low pay precarious service jobs by decreasing the demand for such jobs. A WTR policy will increase the effective wages in the care and service jobs sector (since less working hours will be at least partly compensated with higher wages). Moreover, the market for some service jobs will increase (care jobs) while for others it will decrease. Most of those exist because working people do not have enough leisure time to organize their lives in their free time (Gorz 1991).

### Questions and Uncertainties

The choice of the right amount of WTR in hours per week cannot be calculated with technical precision. We cannot know how productivity will develop in a world with WTR. Any decision about the right amount of WTR is at least initially a political decision, not a technical one (Gorz 1991).

# Policy 9.4: Strengthening the Care Economy

### Description

The care economy is a relatively low-carbon economy and should replace some of the other (carbon-intensive) sectors in the economy as an important job and wage-earning market.

The care economy (caring for children at home and in day-nurseries/Kindergartens/Schools, caring for elderly at home or in retirement homes, caring for sick people in hospitals) will be expanded and low-paid jobs or unpaid reproductive work at home will be paid good wages. Those who will want to work in the care economy will be given a job guarantee.

Childcare will be recognized as a full-time job, entitling each parent up to 12 months' pay of a Swiss average salary by the state or, if they choose to work otherwise, free child care in a day-nursery. The state will thus pay in total up to 24 months of childcare. Single parents are entitled to 24 months of childcare.
Mothers and fathers can choose if they want to take care of their children and be paid by the state, or rely on free childcare and work in a job (paid by the employer). The time spent to reintegrate into the job market after giving birth (or for fathers after taking care of children at home) is compensated by the state at the amount of at least half the average Swiss salary, potentially more (it should not be less than the effective minimum wage and/or standard of living in Switzerland).

### Financing

Higher wages in the care economy, more jobs in the care economy, and full recognition of reproductive care will incur costs on society through taxes on consumption of goods and services which will become more expensive. On the other hand, care services (day-nurseries, kindergartens, elderly care, health care) will become cheaper or free, compensating partly for higher costs of living.

### Impact

Strengthening the care economy will have socially positive impacts by contributing to gender equality (Dengler and Strunk 2018), and environmentally positive impacts by contributing to less societal consumption of high-carbon goods and services (degrowth of carbon intensive goods and services) and to more consumption of care services (growth of low-carbon economic activities).

Socially and environmentally, paying higher wages and expanding the job market for care of children, elderly and sick will provide a strong labor market of low-carbon jobs that are needed to compensate for job reductions in the high-carbon labor markets that will shrink due to the CAP. Upgrading of jobs in the care economy and expanding it will contribute to less societal consumption of high-carbon goods and services as these will be taxed to finance the upgrade of jobs in the care economy.

A full recognition of reproductive care as part of normal economic activities will further reduce gender imbalances in present and future income. All sexes can be caretakers at home, entitled to full pay or compensation. In terms of climate mitigation, it will also contribute to less consumption overall since such a recognition will be financed through societal consumptive activities. This will help reduce the GHG footprint.

### Social Compatibility

We expect only positive social effects.

# Policy 9.5: Foundations and Cooperatives Replace Corporations

### Description

The legal form of corporations and stock-companies depends on economic growth and on the externalization of environmental costs (Binswanger 2019). Corporations and especially listed stock-corporations are not only forced to generate revenue to satisfy their shareholders with dividend payments, but the basic interest of shareholders is growing share value, hence shareholders will push for economic growth. Typically, salary structures and management bonuses are linked to the share value and create further incentives to grow, whatever the societal costs may be. If shares of a company are traded on the stock exchange, there is constant pressure to maximize shareholder value. If management chooses to pursue other goals and forego some profit opportunities, they risk lowering the value of the shares. In this case, there is an incentive for investors to buy this company at a low price, change the management and maximize shareholder value again. This will increase the stock price again and the investors can sell the shares at a higher price and make a handsome profit (H.-C. Binswanger 2009).

Therefore, foundations and cooperatives should become much more widespread legal forms for new and existing companies. These legal forms are less under pressure to grow.

Legally, it is rather easy to become a cooperative. In general, cooperatives have easy access to debt capital. Unfortunately, the cooperative form is not well present in business research and in business news. The conditions, pros and cons of foundations and cooperatives have to become more widely discussed.
In order to foster foundations and cooperatives, and the conversion from stock and other corporations the following measures need to be taken: Establish an office of free legal advice in each language part of Switzerland for new foundations and cooperatives and conversions. Provide support for courses to establish business consulting and support the establishment of a national association that represents the interests in the public and political arenas. There are cooperative sectors such as renewable energy that need some financial and organizational support to professionalize.

Switzerland is a country with a long and deeply rooted tradition of cooperatives. This is a medium-term system change measure. Nevertheless, new frameworks and incentives should start immediately.

## Financing

This could be done at low costs, and money that is spent on conventional business research, business development and location promotion could be redirected, hence the measure could be financially neutral.

## Impact

As this is only one factor that makes our actual economy dependent on growth, we cannot expect wonders and it would be very difficult to quantify the impact.
This system change measure is consistent with the increase in social and non-profit enterprises and with the aim of younger people to engage in their daily work and not work in very hierarchical and top-down corporations.

## Social Compatibility

This is supposed to affect society at large. All the pros and cons of a post-growth society apply.

## Questions and Uncertainties

Within the industry sector we propose three measures that trigger among others sufficiency: the moratorium for new buildings and infrastructure, the CO2-levy and this measure to slow down the inherent growth aspiration of corporations.
However, it is hard to predict how these measures initiate a system change into a more sustainable way our system works.

# Policy 9.6: Replacement of GDP by Sustainable Development Index (SDI)

## Description

Switzerland is playing a major role in the development and establishment of the Sustainable Development Index (SDI), as proposed by Jason Hickel (Hickel 2020). The SDI is based on five indicators (education, life expectancy, income, CO2 emissions, material footprint) to combine the strength of the Human Development Index with a focus on ecological sustainability, yielding an indicator of strong socio-ecological sustainability that measures nations' ecological efficiency in delivering human development. To this end, Switzerland is setting up an internationally oriented foundation and financing it with CHF 5 million annually. It invites all those institutions, organizations and public bodies to join in these efforts, provided that they are committed to the priority of the SDI over purely economic goals and measurement methods. The aim is to establish the new indicator as an internationally authoritative measure of quality of life and prosperity.

## Effects

The gross domestic product (GDP) is a purely monetary quantity that is completely blind to ecological and social conditions. It encourages a dogmatic fixation on monetary economic growth. In addition, GDP ignores inactivity and its conditions as well as voluntary work, thus promoting the marginalization of the care economy. GDP also has a considerable tax impact. By definition, a recession occurs when GDP falls in two subsequent quarters. It is taken for granted that this is bad and should be prevented by all means.
By replacing GDP with an SDI-based indicator, we can finally start assessing the state of the economy in a more appropriate way, which should give tailwind to everyone interested in positive environmental change in the realization of the SDI-compatible economy.

The very fact that Switzerland is committed to the development of such a standard encourages debate and creates a global reference point for movements, NGOs and progressive politics.

## Funding

Five million francs per year from the confederation's general financial resources.

## Compatibility with Social Objectives

Since the SDI also includes many social objectives, a social orientation of politics and economy is promoted.

# Boosting Democracy

## Introduction

What we need is not so much a concept of how democracy ideally would work (something we possibly will never be sure about). Right now, it is more about how to democratically launch successful transformational processes of economic, infrastructural and social systems. We therefore call such a democracy transformational. A transformational democracy can be conceived as a society that learns quickly.

We have to realize that the current political institutions will not do the work on their own. They are far too dependent on the driving forces and power structures of capitalism. This transformation of democracy must occur in every part of life, needs to come from a grassroots level and be inspired by decentral organization and democratic experimentation. of social movements.

Transformational democracy must strengthen the following six development trajectories:

1. A key element is the democratic engagement of people in social movements, NGOs, at their working place, in their neighborhoods or professional milieus. This engagement must be encouraged, and it must be promising by being effective, fruitful, and by granting strong personal experience. Today, such an engagement is often very limited in its outcome, and often highly frustrating. This must dramatically change. We need to put power to the people. This means also that engaged people get offered both time and material support for their engagement
2. Economic decision-making must be democratized. This can be achieved on a great variety of levels: goods and services should only be permitted if they harm the environment as little as possible; goods and services should be should no longer be used for the maximization of profit; societies need strong economic actors who are not bound to profit-making; private enterprises must be socialized; any information of public interest must be publicly accessible; work and especially care-work must be upgraded and revaluated, and so on.
3. Collaboration must replace competition as the driving force of development. We must perceive our social and economic activities as part of commons. For instance, patents should therefore generally be open source.
4. Transformational Democracy must be capable of speeding up both decision-making and implementation of everything capable to reduce carbon emissions.
5. The transformation processes need a clear orientation: We want to assure basic conditions for a good life to everyone on this planet - in a sustainable economic and social framework.
6. Finally, the exorbitant amounts of financial wealth accumulated in neoliberal capitalism create a tremendous space of speculation on financial markets – a speculation constantly threatening economic and social stability. Furthermore, these assets were built on unsustainable and extractive capitalism. Redistributing these assets “back” into society is not just a question of justice, but an indispensable task for assuring the material bases for democracy.

The following paragraphs describe concrete policies for strengthening democracy and making it a transformational one.

# Policy 9.7: Financing the Initial Phase of a World Climate Forum

On a worldwide level, movements and forms of a transformational democracy are as needed as on local or regional levels. The globalization-critical movement had developed the form of the World Social Forums WSF. However, to avoid any splitting these Forums worked under the self-limitation of not taking decisions and calling for action. This limitation must be surmounted, even if there could be disagreements and even splits. But the emergency of global warming demands for global policies and global action.
A World Climate Forum must have a new start and should not be tracked by the still existing WSF It needs a fresh start, triggered by climate movements and movements for climate justice all over the world.
If a sufficiently representative group is formed that wishes to initiate a World Climate Forum, the confederation will contribute CHF 10 mio to the costs of the initial three-year phase. This applies regardless of the countries where the preparatory work and implementation take place.
This demand can also be addressed to other state bodies (like cities or cantons).

## Financing

The costs may be CHF 10 mio per year, financed by the federation.

## Impact

Global movements and global forms of transformational democracy are absolutely crucial for a successful climate policy. We can deal with the climate crisis only on a global level. A powerful World Climate Forum could become a decisive means of organizing and empowering such global movements.

## Social Compatibility

We see no problems.

# Policy 9.8: New Concept of Ownership

A new concept of ownership should be established, according to which 1) private property of social relevance may only be used to the extent that it does not cause any damage to the general public, in particular with regard to environmental protection and climate warming, and 2) private property of social relevance must be made available to the general public if this is necessary from a superordinate perspective (e.g. because of urgent ecological and social concerns) (e.g. house roofs that must be made usable for solar energy use).

# Policy 9.9: Climate-Protection Tax on Large Assets and the Establishment of Capital Controls

## Description

As mentioned above, redistributing quite an important part of the fortunes accumulated within the last decades in the hands of a very small minority of ultra-rich people is not just a question of justice, but an indispensable task for assuring the material bases for a powerful democracy and an effective climate policy. One concrete measure to do so is a tax on large financial assets.

The confederation levies a climate asset tax of 20% on all asset shares above one million francs per household. This does not include owner-occupied property and tangible assets that are in daily use. Half of the revenue from this tax is to be used in the countries of the Global South for climate protection projects, e.g. sustainable energy supply, and prevent damage attributable to climate change. The other half will be used for climate policy measures in Switzerland.

In order to prevent the tax from being evaded, the time for the collection of the relevant assets is set in such a way that no deduction of assets abroad is possible and a capital movement control is introduced to prevent the subsequent deduction of taxable assets. Banking secrecy must also be completely lifted with respect to the tax authorities in Switzerland.

## Financing

The demanded taxes provide the federation with the necessary financial resources to be able to pursue an effective climate policy both within the country and on a global level. Financial burdens, on the other hand, are very limited and minimal in comparison to the revenue (new federal staff required in the tax area).

## Impact

The tax provides a socially responsible fundraising for climate policy, especially for the balancing of resources in favor of the Global South.

## Social Compatibility

A climate asset tax is a central component of climate justice. It taps social wealth where it has been increasingly concentrated in recent decades. It takes into account the fact that both global warming and the growing inequality in wealth distribution have increased massively over the same period. The tax also increases the acceptance of many other measures such as incentive levies urging the population to change everyday habits and consumption patterns, and partially resigning from especially harmful consumption (like flying, driving SUVs or eating a steak every day).

## Questions and Uncertainties

It is necessary to examine which form of collection is appropriate to ensure that the tax is levied in such a way as to maximize the yield of the tax without creating negative side effects. Two possible variants are:

- A one-off levy. In order to prevent taxpayers from having to sell all of their securities in large quantities during the same period, which could cause their prices to fall significantly, a transfer of securities is negotiated with the tax authorities. All assets must be disclosed to the authorities and a bundle of securities must be transferred to the confederation with the same level of risk as the total assets.

- An annual tax of, for example, 2% of the assets for 10 years. In this variant, it is particularly important to use capital controls to prevent taxable capital shares being created outside the country.

# Policy 9.10: Abolition of Lump-Sum Taxation

## Description

Switzerland is well placed to meet the challenges presented by the rapid decarbonization of the economy. Thanks to the large GDP, Switzerland can afford to have the 13th highest per-capita government spending among OECD countries (OECD 2020), maintaining a low tax pressure on citizens and businesses operating in the country (FDFA 2020). However, the financial virtuosity of Switzerland is partly based on its status as a tax haven. In particular Switzerland used to offer advantageous terms to foreign corporations, and because of that Switzerland was placed on the grey list of the European Union. This changed with the tax reform, the approved in May 2019 (FDF 2020a), that resulted in the removal of Switzerland from the EU's grey list (European Commission 2020). However, Switzerland continues to have a reduced taxation regime for foreign wealthy individuals. In 2018, 4557 people profited from the lump-sum taxation and paid a total of 821 million CHF. While some cantons abolished this tax, so far the Federal Council rejected the abolition of expenditure-based taxation for economic reasons (FDF 2020b). We therefore propose the abolition of the lump-sum taxation on the federal level.

## Financing

Assuming the worst-case scenario in which all beneficiaries of the lump-sum taxation will move their fiscal residence abroad, the abolishment of the sum-lump tax will result in ~CHF 800 mio of missing revenues each year.

## Impact

This policy will not have a direct impact on GHG emissions but has important consequences for regarding the aspect of climate justice. The money collected by this measure will be used to fund climate friendly projects and mitigation measures.

## Social Compatibility

Historically, the Swiss fiscal regime contributed to international tax avoidance, and to increased profits for foreign corporations and wealthy individuals with fiscal residence in the country. Switzerland benefited from additional fiscal revenues that are not available to other countries, these resources would be extremely valuable to finance environmental and social public investments in other countries. The abolition of tax havens and international tax avoidance is an important goal to ensure climate justice.

## Questions and Uncertainties

Individuals benefiting from lump-sum taxation might move their fiscal residence to other fiscal havens, however this is not a reason not to implement this policy.

# Policy 9.11: Climate Delegate of the Federal Council and Monitoring the Progress in Climate Protection Policies

## Description

The institution of a climate policy delegate of the Federal Council is created. The delegate will coordinate the climate policy projects of the confederation, cantons and municipalities, maintain a lively exchange with NGOs and climate movements, create a monitoring process and draw up an annual report. The delegate must have a strong and independent position, comparable to the position of the Swiss National Bank. This person of course needs a strong and competent staff and open insight in all data of any importance to GHG-reduction and climate justice.
Each year, the delegate convenes a conference to discuss progress in climate policy. Invited to the conference are representatives from politics, authorities and associations as well as from the Climate Councils. The conference discusses measures to keep Switzerland on track with regard to climate targets. The outcome might be appropriate recommendations.

## Financing

Usual federal budget.

## Impact

The implementation of a climate policy as outlined in the Climate Action Plan must be conceived as an ongoing process which needs monitoring and measures to ensure its implementation.
First of all, it is necessary to establish a whole set of measurements, of a Climate Action Plan. This must be done through political processes in combination with a broad mobilization of the population as described above (for instance in the form of climate councils).

Second, we need firm action to assure the necessary progress of actions. A climate delegate must coordinate and focalize this process.

## Questions and Uncertainties

The delegate is unlikely to have much effect on its own. However, in combination with a strong climate movement and corresponding pressure on policymakers, such an institution can make a significant contribution to ensuring that this pressure is systematically translated into an appropriately effective climate policy.

# Policy 9.12: Democratic Rights for all Residents of Switzerland

## Description

Switzerland is introducing all democratic rights for non-Swiss citizens who have been resident in Switzerland for at least five years. The major challenges posed by climate change are increasingly affecting everyone. It is therefore all the more urgent that all those affected be given full democratic participation rights.

### Impact

At the end of 2019, 2,111,412 people with foreign passports were living in Switzerland. 1,376,575 of them had a C settlement permit entitling them to unlimited residence in Switzerland and 713,911 people had a B residence permit valid for 5 years (EU/EFTA countries) or one year (all other countries). Residence permits are usually renewed. For both categories, it can be assumed that these people are living in Switzerland for a longer period or permanently. People with a foreign passport and a long-term or permanent permit account for around 24.5% of the total resident population. The importance of extending democratic rights to this part of the population is correspondingly high, especially in such a great political transition as the one that will be needed in Switzerland to reach net 0 GHG emissions by 2030.

## Policy 9.13: Democratic Rights for Everyone Aged 14 and Over

### Description

Switzerland introduces the right to vote and stand for election for all people who have reached the age of 14.

### Impact

Global warming particularly affects the younger generations. It is therefore more than justified to grant this generation full democratic rights, as the Canton of Glarus has done since 2007. The proportion of 14 to17-year-olds in the resident population is just over 80,000. Around 320,000 people would therefore benefit from such an extension of democratic rights (in combination with voting and election rights for non-Swiss).

# 10 International Collaboration and Climate Finance



# Vision

Switzerland accepts its global climate responsibility; Swiss [climate et al.] policy and action is based on science and Switzerland's [total / historic] climate impact. This implies the inclusion of consumption based GHG emissions, the investments and direct business operations in fossil fuel extraction projects, deforestation operations and other environmentally destructive projects.

This means that

1. Swiss climate policy is oriented at the consumption-based ecological and climate footprint that includes all GHG emissions being caused directly or through consumption of imported goods and services by Swiss residents or [organizations].
2. To achieve the science-based emission reduction necessary to avoid overshooting of 1.5 °C, Switzerland aims at reducing its footprint by 13% per year both domestically and abroad; the latter means through adequate additional measures over and above domestic measures, without aiming to add the ITMO to the domestic emission goal.
3. To support the poorest and most affected societies in the Global South, based on the polluter-pays principle and in line with the Paris Agreement, Switzerland contributes at least CHF1 billion per year to international climate finance. For this, Switzerland mobilizes new [public &

private] financial means, in addition to fulfilling its obligation to provide 0.7% of GDP to development assistance.

4. [Loss & Damage Vision] With its climate footprint, Switzerland contributes more appropriately to the support of L&D affected people in developing countries.
5. In multilateral bodies and in the global climate debate, Switzerland is committed to the consistent and timely implementation of the Paris Agreement. The Federal Council is working in particular to ensure that the rules and criteria for mobilizing and crediting international support and climate financing are interpreted in the spirit of the 1992 Framework Convention on Climate Change. This means first and foremost taking the precautionary, polluter-pays and other relevant Rio principles as a basis and promoting effective policies to support those most affected by the climate crisis.

# Current situation

Anyone who takes climate responsibility seriously knows that our climate footprint also includes GHG emissions caused by the consumption of imported goods and international flights outside our national borders. In the sense of polluter-pays justice, it is a matter of assuming responsibility for the consequences of one's own emissions for third parties: If, of all people, the poorest in the world, who themselves have contributed least to climate change, are hit hardest by its effects, those who are mainly responsible for them must make a financial contribution. Climate justice therefore also means that the consequential costs of the climate change caused by our consumer behavior must be adequately borne.

In accordance with the territorial principle underlying the UNFCCC Kyoto Protocol, however, the targets in the existing CO2 law only refer to emissions from transport, housing, agriculture, waste and industry within Switzerland's borders. Swiss climate policy thus excludes additional emissions of over 1,150 million tons of CO2eq per year caused by persons or companies' resident in Switzerland outside the country's borders. This includes emissions generated abroad during the production of goods and services destined for Switzerland. According to the residence principle, the Swiss Federal Statistical Office estimates these foreign emissions of Switzerland to be 76.1 million tons CO2eq in 2015, which is almost two thirds of Switzerland's total consumer-related footprint of 116.2 million tons CO2eq per year.
This figure does not include emissions caused by the Swiss financial center's facilities and investments. According to the Swiss Climate Alliance, these emissions are several times higher than the domestic GHG emissions. The question is: Who bears the (climate) responsibility for this?

The consideration of global responsibility plays no role in Switzerland's current view and policy. This must change: Switzerland must take its influence on the global climate crisis seriously, and assume its responsibility with regard to emissions triggered worldwide by its consumption and behavior and the resulting effects.
The Federal Council also wants to claim additional foreign certificates amounting to 10.8 million tons of CO2eq per year as domestic reductions. Measured in terms of domestic emissions, domestic and foreign reductions are to be reported together as a total reduction of -50%. Measured in terms of Switzerland's total footprint, however, total emissions are only 2.2% lower than in 1990.

## Climate justice

Climate justice means choosing a political approach to man-made climate change that meets ethical criteria, not only with regard to future generations, but also in the historical-geographical context: some are responsible or profit, others feel the consequences or have to pay for them. It is therefore not acceptable to consider the dramatic consequences of global warming as a purely technical environmental problem. That would be unfair.
Climate justice as a concept includes not only the generational (justice) question - "you are leaving us a world at the abyss, you have created a problem that we must solve" - but also global distribution and equality issues.
In its origins, the term "climate justice" goes back to the drafting of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, when the reduction of greenhouse gas emissions was negotiated for the first time. It was shaped by human rights and equality considerations and the demand that every inhabitant of the earth should be entitled to the same limited "emissions budget". Because the wealthy countries of the Global North had built their prosperity in the 20th century on the burning of cheap fossil fuels, it is a priori unfair to deny the Global South the same now. In the 1997 Kyoto Protocol, for example, the countries of the Global North were required to reduce their emissions; countries of the Global South should be allowed to continue using fossil fuels for the time being.

In the face of progressive climate change, the demand for global equal treatment must be reinterpreted from a right to a duty: Everyone must make an equal effort to reduce their climate footprint. This means that large emitters such as Switzerland must contribute much more to the global reduction of man-made greenhouse gases than the countries of the Global South who are responsible per capita for far fewer emissions. As a principle, this view was already anchored in the 1992 Framework Convention in the approach of "common but differentiated responsibilities". In plain language, this means that if the global community wants to eliminate greenhouse gas emissions quickly, the wealthy industrialized countries - and increasingly also the emerging economies - must not only reduce their own, far too large CO2 footprint, but also support developing countries in their efforts to develop with as few greenhouse gas emissions as possible.
However, climate justice as a normative concept needs to be thought of further today, beyond the question of reducing greenhouse gas emissions: Basically, it is about the unequal distribution of cause and effect of the climate crisis. The ongoing climate crisis manifests itself in very different ways in different parts of the world. And the means of containing climate change or guarding against its negative effects are distributed very differently.
Put simply, climate justice culminates in the imperative that every person, every country, but also every corporation assumes responsibility for the climate; to participate responsibly and responsibly in the joint solution of the global climate problem according to the respective means and responsibilities.

# Climate Finance

Tasks for poor countries used to focus primarily on the social and economic dimensions. Developing countries need to increasingly protect their population and invest in infrastructure to prepare for, and cope with, the impacts of climate change. Yet these countries in particular have hardly contributed to the climate crisis. However, in the Paris Agreement of 2015 - together with wealthy and bigger $CO_2$-emitting states such as Switzerland – they also committed themselves to reducing emissions.

In the Paris Agreement, the industrialized countries reaffirmed their commitment to jointly provide international climate financing of USD 100 billion per year - from public and private sources - for mitigation and adaptation measures in developing countries from 2020. The agreement does not prescribe how high the individual country contributions should be but calls on the industrialized countries to make a fair contribution based on the principles of the Framework Convention on Climate Change (responsibility and economic performance).

Contrary to international development cooperation, international climate financing is not aimed at combating poverty nor promoting prosperity but is intended to support developing countries in preventing and coping with climate change. For that, new and additional public funds are needed. Using the already limited resources of official development assistance (ODA) for this purpose – or merely claiming them a second time as international climate finance, as is sometimes the case today – is cynical and counterproductive.

In terms of climate financing, global climate justice means that the obligation of the industrialized countries under the Paris Climate Convention to jointly provide USD 100 billion per year for climate protection and adaptation measures in developing countries must be scaled down to Switzerland on the basis of global climate responsibility.

To date, Swiss spending on international climate protection amounts to around CHF 300 million per year. This sum consists primarily of credited "climate-relevant activities" of regular development projects. Just under CHF 100 mio is paid annually to the multilateral climate financing instruments provided for this purpose. These contributions are financed from the framework credits of international cooperation – accordingly less money is available for existing development projects. The proportion of mobilized private funds is low.

For the period after 2020, the Federal Council (2011) assumes in its report on international climate financing of 10 May 2017 that "Switzerland's fair share of the common financing target of the industrialized countries [from 2020] should amount to USD 450 to 600 mio per year.

Alliance Sud and the more than 80 organizations of the Swiss Climate Alliance, on the other hand, state that a fair share of Swiss climate financing contributions must be at least CHF 1 bn per year (Jürg Staudenmann 2013), in line with the criteria of the Framework Convention on Climate Change: This is because both global climate responsibility and Swiss economic output are around 1 percent compared to all industrialized countries.

While it is true that development and climate measures in developing countries can complement each other in a certain way, Switzerland must not finance this "climate billion" at the expense of existing development cooperation. This is all the truer as the funds for development cooperation still fall well short of the long-promised 0.7% of gross national income (GNI). Switzerland must fulfill its international (financing) obligations in both areas on its own and on an equal footing.

Nevertheless, the Federal Council's 2017 report proposes "to achieve the Swiss share [...] public funds from existing sources and a significant proportion of mobilized private funds. [...] The public funds for Switzerland's international climate financing should continue to be financed primarily from the framework credits for international cooperation and, as before, from the framework credit Global Environment. The Federal Council wants to "examine to what extent Switzerland's international cooperation should make greater use of instruments to mobilize private funds or whether new partnership models with the private sector are possible that would favor the mobilization of private funds." The report leaves open the question of how Switzerland intends to mobilize such financial resources within the framework of its climate financing commitment from 2020.

However, climate financing must not be at the expense of development cooperation. Supporting the poorest and most vulnerable populations in the Global South in the fight against climate change is not the same as fighting poverty or reducing inequality. The reduction of greenhouse gases (mitigation) and protection against the effects of progressive climate change (adaptation) can complement development cooperation, but never replace it. It is therefore cynical when Switzerland and other countries want to sell the same franc to developing countries twice; once as official development assistance and a second time as climate financing.

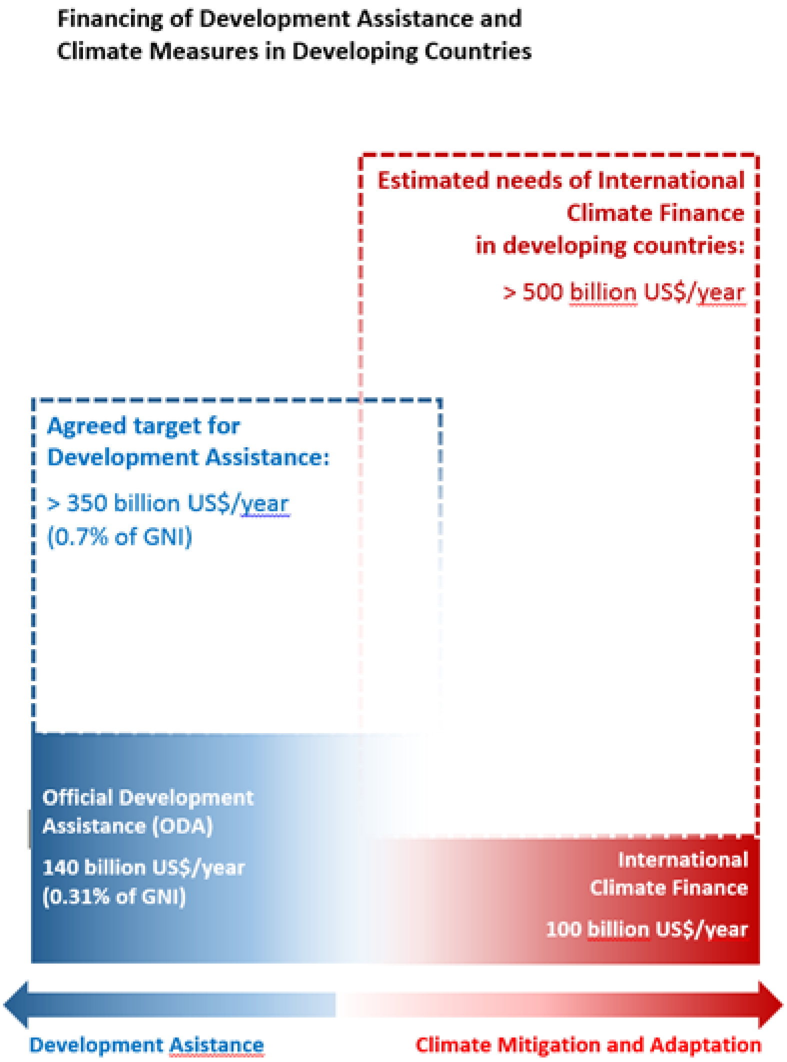



*Figure 10-1 International Climate Finance needs to be mobilized in addition to already existing development assistance (ODA) (Alliance Sud 2019, 16).*

# Policy 10.1: Switzerland contributes CHF 1 bn in climate finance each year

## Description

**Collection of Funds**
The mobilized funds are pooled and prepared for payments or transfers (treasury, fund, program, foundation, etc.).

**Finance Programs**
The available funds are transferred to institutions, funds or programs to finance measures in the target countries (e.g. Green Climate Fund, direct investments in countries through bilateral [SDC/SECO/FOEN] or multilateral [World Bank or similar] development cooperation, etc.).

**Use of Funds**
The funds are invested in various projects, regions and sectors (e.g. in particularly poor developing countries or in island states, for mitigation or adaptation, etc.)

## Financing

The Alliance Sud position paper "Climate justice and international climate financing from a development policy perspective" (Alliance Sud 2019) explores the link between climate and development tasks and proposes concrete solutions as to how CHF 1 bn can be mobilized annually in addition to development cooperation to support climate measures in developing countries in a way that is fair to the polluter.
Money is mobilized or generated through taxes, sanctions, levies, voluntary contributions, etc.

# ITMOs and “Compensation” Abroad

The facts are clear: In its special autumn 2018 report, the International Panel on Climate Change (IPCC) stated that if global warming of more than 1.5 °C is to be avoided, then at most we can put only 420 billion tons of CO2eq into the atmosphere. If this "residual budget" is exhausted, then every additional ton of CO2eq emitted must again be extracted from the atmosphere. In purely mathematical terms this would require a 5% annual reduction in emissions compared to today. In this way, global greenhouse gas emissions could be halved by 2030 and reduced to net zero by 2040.

In August 2019, Switzerland joined the countries aiming to reduce their greenhouse gas emissions to net zero. The Federal Council left open the measures through which Switzerland has to become climate neutral, in particular how it plans to offset irreducible emissions for example from agriculture. Instead, it continues to opt for CO2 offsets abroad. If the Parliament continues to support this approach, Switzerland is heading for a series of major self-inflicted problems.

International law still offers no clarity how cross-border compensation projects are to be regulated after the entry into force of the Paris Agreement in 2021. Article 6 of the Agreement does indeed envisage the possibility for contracting states to exchange or trade certificates among themselves representing their effective emission reductions. The details regarding the manner in which the so-called Internationally Transferred Mitigation Outcomes (ITMO) are to come about and properly calculated are the subject of the last chapter of the Paris rulebook, which is still pending approval.

**"Negative emissions" and afforestation**

There is still the possibility to use "negative emissions" to offset greenhouse emissions where there has been no reduction, in other words, capturing and removing excess greenhouse gases (especially CO2 from the atmosphere and returning it to the soil or biomass for long-term storage. Very high-tech methods are already being tested for this purpose, though their practicability, economic efficiency and scalability are yet to be clarified. A more forward-looking solution, on the other hand, would seem to be the production of plant coal as a by-product of energy production from wood or biomass waste. Plant coal can in fact be absorbed into agricultural land over the decades, with proven positive effects. At the heart of the debate are the "green" approaches to CO2 storage in the biomass or the soil. This ranges from (re)forestation of cleared land to the build-up of CO2 in the form of humus in agricultural soils. Reforestation is extolled largely uncritically as a key approach to solving the climate crisis. While even the experts themselves disagree as to the true absorption potential of newly replanted forests, some developmental objections should also be considered. The question arises, from a moral standpoint, as to the justification of rich countries with far above-average per capita carbon footprints for targeting developing countries as alternative locations for climate measures that they themselves have neglected to take. It cannot be that we are unwilling to seriously reconsider our lifestyle, while simultaneously demanding that the emissions it generates are economized far away from home. And there are still the complex issues surrounding the question of where exactly this massive reforestation is to take place. The displacement of people, very often indigenous people, for afforestation projects must be strongly condemned as it reinforces imperial practices. For further discussions on negative emissions see the corresponding chapter.

**Measures Abroad are Needed - in addition, not instead of Domestic Measures**
To avoid misunderstanding, there is no objection whatsoever to the conduct of effective climate projects outside of Switzerland in keeping with the principles of good international cooperation. On the contrary, the Paris Agreement expressly calls for support to developing countries in combating the climate crisis. But besides emission reduction, this also entails measures to adapt to climate change, which began a long time ago.
This is precisely the rationale of international climate funding, in which Switzerland must participate to the tune of at least one billion francs annually. Instead of supposedly "offsetting" the climate protection measures that we ourselves have failed to take, there should be additional international climate funding projects designed to benefit the local people directly.

It appears as an aberration to spend millions outside our national borders to purchase cheap reduction certificates. Instead, these funds should be available to protect the people in the Global South from progressive climate change through disinterested, effective reduction measures. This does not of course release us from the duty of simultaneously reducing our own carbon footprint.

The net effect of relying on negative emissions and purely mathematical "climate neutrality" is inevitably to postpone climate measures here at home. Not only is the outsourcing strategy unsafe, it is also morally dubious and economically short-sighted. But more than anything else, it cements a selfish climate policy that fails to challenge our lifestyle and its disastrous impacts on people in the Global South who are already suffering.

# Policy 10.2: No Externalization of GHG Emissions

## Description

According to the Federal Council and Parliament, only three-fifths of the desired halving of Switzerland's domestic emissions by 2030 will actually take place here at home. Switzerland, like a handful of other rich countries, wishes to "offset" the remainder by purchasing ITMOs. Switzerland is therefore a leading advocate for the early conclusion of the arrangements on offsets under Article 6 of the Paris Agreement.

## Impact

It seems appealing at first glance to offset emissions abroad, for it is cheaper, at least for now. A second look however raises the question of why increasing amounts should be spent each year to buy foreign emission reduction certificates whose additionality is questionable and cannot be guaranteed, instead of those millions being used locally to convert domestic structures to emission-free technologies and practices. It is simple logic that the strategy of outsourcing is destined to fail over the short or long term. Because all countries must reduce their emissions to net zero, foreign emission certificates will quickly become scarce. At the same time, demand will rise, and hence prices will increase accordingly. After the low-hanging fruit have been picked, there will soon be no more countries prepared to cheaply sell off the increasingly hard-won progress they have made towards climate neutrality. Switzerland will thus no longer be able to avoid having to eliminate its own emissions, and this irrespective of whether we have already paid for reductions abroad, that largely exist on paper only and contribute in actuality to less reductions than is officially declared and certified, if any at all.

## Questions and Uncertainties

In order to ensure that offsets reflect credible emission reductions, the following key conditions would need to be met:

- Additionality, i.e. the activity generating the offset cannot be business as usual
- Conservative baseline: the aggregation of all country baselines that determine the volume of offsets needs to be consistent with a 1.5 °C mitigation pathway
- International oversight of offset creation needs to be assured. Non-controlled voluntary markets shall not be able to generate offsets.

However, currently none of these conditions are met and it is beyond the power of the Swiss state to decide upon these issues solely. Offsetting emissions is therefore no option at the moment.

# Climate Diplomacy and Collaboration

## Policy 10.3: New Interpretation of International Trade Agreements

### Description

Switzerland declares that the respect for human rights and international agreements on climate protection clearly take precedence over the provisions of other international treaties, particularly trade agreements. In case of doubt, it suspends the application of provisions in trade agreements if they make it impossible to achieve the climate agreements and/or are contrary to human rights, and it refrains from demanding compliance with such provisions from other countries and therefore from resorting to arbitration. This applies, for example, to investor-state dispute settlement agreements that grant non-governmental arbitration tribunals the power to decide on national laws to protect the climate and achieve climate justice.

### Impact

With this policy, Switzerland is providing the international impetus for this. As the location of many UN bodies and as an international trading power, Switzerland can use this policy to quickly and effectively set international policy in motion.
Each concrete case would then have its specific impact. Example: Subsidies for solar power installations produced within Switzerland could be important to build up competences and capacities within Switzerland. Such subsidies could be interpreted as a violation to WTO-rules asking for equality of treatment. Other example: Switzerland bans certain products for their inbuilt obsolescence. If these products are only imported, this could again be interpreted as a violation of equality of treatment.

### Financing

If there are any financing effects, they depend on each concrete case.

### Social Compatibility

Again, effects depend on each concrete case. Should for instance a border tax adjustment be brought to an arbitration tribunal, effects would be completely different from a case concerning product-based rules.

### Questions and Uncertainties

The policy can create conflicts with other countries or with the institutions linked to trade agreements. But if we seriously want to reduce GHG-emissions, such conflicts cannot be avoided. Instead, movements, NGOs and public entities must offensively make clear that human rights and climate protection agreements must be given priority over trade agreements. They must fight together on an international level for such a policy change.

# Policy 10.4: Prioritizing Human Rights, Peacekeeping, Climate Protection and Climate Justice in International Law

## Description

Within the UN framework, Switzerland proposes the creation of a clear order of priorities. In this context, agreements on international law, human rights, peacekeeping, climate protection and justice should be given priority over all other international treaties, particularly trade agreements. Thus, provisions in international agreements that contradict these priority agreements are suspended. Violations of the priority law should also be sanctionable.
Switzerland is setting up a coordination office in order to win over as many partners as possible at all levels for such a project and is making available an annual sum of CHF 5 million for this purpose. Partners should not only be states, but also NGOs, social movements, municipalities and so on.

## Impact

This policy can focus on the will of the international community to make decisive progress in climate protection, justice in the media and human rights and to create clarity about the order of priorities in international treaties.
A resolute initiative by Switzerland for a global constitutional law alone will bring movement to global politics and make it possible to bring new alliances into play.

## Financing

Five million francs per year from the confederation's general financial resources.

## Social Compatibility

The combination of human rights and climate policy promotes the orientation towards global climate justice and social compatibility of climate policy.

# Policy 10.5: The Fossil Fuel Non-Proliferation Treaty (FF-NPT)

## Description

The idea behind the FF-NPT is simple: Its goal is to phase out fossil fuels through a legally binding treaty. As outlined by Newell and Simms (2020) the FF-NPT would contain three pillars: non-proliferation, disarmament and the promotion of peaceful use of technology. ‘Non-proliferation’ refers to the prevention of exploitation of new fossil fuel resources. ‘Disarmament’ means the coordinated, managed and accelerated decline of existing fossil fuel infrastructure. For the third pillar Newell and Simms (2020, 1047) suggest to massively expand “existing initiatives to provide poorer countries with access to low carbon and non-fossil-fuel clean energy and transport, and the technology needed for its development." To finance these projects, they propose to reuse former fossil fuel subsidies.

The FF-NPT is based on the existing example of the Non-Proliferation Treaty of nuclear weapons which was negotiated in the middle of the Cold War. The big difference to the Paris Agreement is it being legally binding with member states having the tool to impose economic sanctions on a party violating the treaty.

The role of Switzerland would be to bring this up in international climate negotiations and to take up a leading role in the negotiations, however, the UN needs to be the neutral party organizing the negotiation rounds. In a first step, the state of Switzerland gets in contact with the steering committee behind the FF-NPT and further explores how such a treaty can be implemented.

## Financing

The authors propose for financing the third pillar that "[f]unds could be redirected from fossil fuel subsidies which make up the equivalent of 6.5% of global GDP, as well as generated through a global carbon tax and potentially held in [a] Global Transition Fund" (Newell and Simms 2020, 1047).

## Impact

In the long-term the treaty will lead to the phase out of all fossil fuels on a global scale.

## Social Compatibility

The central aspect of the second and third pillar are to ensure a just transition of the phase out of fossil fuels which includes a massive expansion of renewable energy sources in particular in the Global South.

## Questions and Uncertainties

It is quite unlikely that a NPT for fossil fuels can be brokered as easily as the one for a nuclear NPT because of the much greater importance of fossil fuels in the economic system.

# 11 Education



# Vision

There is a broad, fact-based debate on specific solutions to the climate crisis. The public discussions do not focus on scenarios of possible consequences of global warming, but on how we want to live in a carbon-neutral world. Schools, media, politicians and NGOs make sure that reliable information is spread in an appropriate frequency and provide platforms for debates and peer-learning. Thus, citizens have an overview about the problems we have to tackle and what solutions exist, which is the basis for a constructive democratic process. They also provide action-related knowledge and relevant competences to avoid unnecessary greenhouse gas emissions voluntarily and therefore allow the legislator to focus on the complex problems.
Every person that goes through our education system is enabled to contribute to a CO2-neutral Switzerland as a citizen, as employee and as a part of the sovereign. There is a praxis-oriented climate education as a fixed part of all curricula and levels. These lessons focus on climate-relevant competences and climate education as a cross-sectional issue.

# Current Situation

## Public Knowledge and Behavior

The most important impulses for action are the knowledge about climate change causes, adequate and relevant competences and the right mindset. People must have the appropriate skills to actively and appropriately contribute to the societal task of reducing emissions. Lastly, they must have developed the right attitude and mindset to actually apply their knowledge and skills.

People must realize how climate change impacts their life, such as risks to people, places, traditions, or even values such as 'fairness' and 'justice' (Wang and Kim 2018), fellow human beings and the whole posterity. Additionally, they need to know how to reduce greenhouse gas emissions to keep global warming below 1.5° degrees and minimize the climate crisis.
This is currently not the case. Despite numerous good initiatives and many actors, most people in Switzerland lack the knowledge, the competences and the attitude to make it possible to avert a severe climate crisis. Our policies will change this with quite a number of approaches.

A short history of knowledge level: Between the 1990s and 2010 the factual knowledge about the climate crisis increased from a relatively minor level. In the following years (until the COP 21 in Paris) it stagnated. The action-related knowledge started on a higher standard, but does not follow such a clear trend.
In the 1990s big companies started to deny the existence of global warming despite better knowledge. At the end of the decade, they started to accept the scientific consensus themselves, but to support climate change deniers financially.

## Current Means of Information

### Government

Currently, the government does not have major information campaigns for the broad public. The climate program of FOEN focuses on professional education. Until 2021 the climate program of FOEN is being revised and there are plans to expand the target group to the public. The CO2 talks that are offered in the French-speaking regions of Switzerland, in which the participants, under the supervision of a trained leader, look for an individual reduction in the greenhouse gas footprint while maintaining a high quality of life, are very successful. The courses are fully booked and are currently expanded to the German-speaking part.
Still the government euphemisms the role of Switzerland. For example, by talking about the inland emissions and ignoring the carbon footprint and the investments in fossil fuels.

### Schools

The urgency in the practice of this topic is missing at all levels. Crisis awareness is lacking.
Behavioral research in the area of sustainability is not receiving enough attention. Education and research are strongly focused on the problem, but little on what the society needs to change to solve it, e.g. on climate relevant competences and behavior.

In recent years, curricula based on the ‘Lehrplan 21’ (Curriculum 21) have been developed for primary schools and secondary level I in the German-speaking cantons of Switzerland. Education for sustainable development (Bildung für Nachhaltige Entwicklung, Education en vue d’un Développement Durable, educazione allo Sviluppo Sostenibile, short ESD) is an integral part of this ‘Lehrplan 21’. Beside other subjects, it also includes climate education. But it strongly depends on the teacher how intense the climate crisis is taught. Furthermore, ESD is not a subject itself. It is much more a multidisciplinary approach. On the one hand, this can be an advantage in understanding complex issues. On the other hand, there is also the danger of getting lost between other topics. The implementation is in the teachers’ responsibility, sometimes also several teachers, and many of them lack adequate training (Schweizerische Konferenz der kantonalen Erziehungsdirektoren 2020). The ‘Plan d'études romand’ is the counterpart in French-speaking cantons to ‘Lehrplan 21’, where ESD is also included.

The corresponding framework for secondary schools II is the so-called ‘Rahmenlehrplan’ (Plans d’études cadres, Programmi quadro d’insegnamento). Currently, the ‘Rahmenlehrplan’ for high schools is being revised and will be implemented in 2023.

## Media

There are big differences between media companies when it comes to articles about the climate crisis. The media attention for the climate crisis is on a high level since Paris. (Brüggemann et al. 2018; Forschungsinstitut Öffentlichkeit und Gesellschaft 2017). But a more frequent reporting on climate change does not necessarily increase the public understanding of the topic. Brüggemann et al. (2018) criticizes that extreme weather scenarios are sometimes described as a direct consequence of global warming. Media tend to ignore uncertainties and to present scenarios as definite facts. Often the principle of balanced reporting leads to the result that high quality scientific information can be thwarted by nonqualified actors, mainly politicians (Michaels 2019).

# Policy Measures

## Policy 11.1: Climate Change Education as Core Element of the Education System at all Levels

### Description

Climate Change Education has to get a focal point at all school levels. In compulsory schooling the ESD has to be improved and enlarged. Additionally, climate change education must be included in the 'Rahmenlehrplan' (outline curriculum) as a core element of high school education. The 'Rahmenlehrplan' will shortly be revised nationally by the Swiss Conference of Cantonal Ministers of Education (EDK) (Schweizerische Konferenz der kantonalen Erziehungsdirektoren 2020). The climate change education should be oriented towards the UNESCO learning goals in order to guarantee that not only knowledge but also competence is imparted (Federal Department of Foreign Affairs 2020).

ESD will most likely be included in the 'Rahmenlehrplan'. However, it is crucial that sustainability is understood in the strong perspective and that the focus lies on competence development and not only knowledge transfer. The revision of the 'Rahmenlehrplan' will be finished in autumn 2022. Cantons will start redefining their regional or local curricula parallel to the EDK process. The new 'Rahmenlehrplan' will be implemented in schools in 2023. It is very important that experts on climate change and sustainable development are involved and can have influence in the essential processes of the development of the new 'Rahmenlehrplan'.

### Impact

This measure ensures that climate change education must be a focal point at all school levels. In this way, all students will acquire the competence to understand sustainability in a strong perspective and can make decisions according to this knowledge.

### Questions and Uncertainties

- Is there a chance to get climate change education as a separate theme/topic into the 'Rahmenlehrplan' or will it be included in ESD?
- how to get influence in the process? It will be important to find out whether sustainability will be a theme (in geography or economy) or a cross-curricular dimension. If it will be cross-curricular, it is important to ensure all subject teachers understand what climate change education / ESD is about.

# Policy 11.2: National Advanced Training Program on Climate Change Education for all Teachers

## Description

A compulsory national continuing education program on climate change education for teachers will be introduced. This program is aimed particularly at teachers already teaching, and not only at teachers in training. These further training courses are coordinated nationally but are implemented locally at the schools with smaller teams of teachers. The content of these training courses should be based on the UNESCO goals of the climate change education program and guarantee that the teachers understand the topic and are able to pass on their knowledge to their students using suitable teaching methods.

## Impact

All teachers themselves have the competence to understand the climate crisis and to act on this knowledge. They can successfully pass this competence on to their students using suitable teaching methods. In this way, the steps laid down in the curriculum (Policy 11.1) can actually be implemented.

# Policy 11.3: National Climate Action Week

## Description

The proposed ‘National Climate Action Week’ is intended to be an event taking place throughout Switzerland at schools and universities. During this experience-oriented week, all participating pupils and students deal with topics related to climatic and ecological changes. The Climate Action Week is intended to reach children and adolescents of all school levels regardless of their family background. The content can depend on school level and ranges from basic to background knowledge about the topic of climate change and its connection to personal and general energy and resource consumption. Topics can be taken from local or actual issues. In this way, the Climate Action Week addresses the gaps in knowledge formulated in the status quo and thus contributes to a comprehensive knowledge base and development of climate relevant competences, so that society as a whole can achieve responsible use of the environment.

In the current education system, the National Climate Action Week needs to be provided to the schools by the federal government and cantons via the conference of cantonal ministers of education. The already established and widespread structure of project-weeks can be used easily when appropriate material is available. This facilitates the preparation and implementation of the National Climate Action Week for teachers with the optional support of governmental and non-governmental climate protection organizations.

A proposed first step is the creation of a well-arranged platform with the availability or accessibility of the already existing environmental education material. Then, this is communicated in the cantonal and national education networks. This platform could configure education21 as an existing and functioning organization that distributes and funds environmental education nationwide.

A further step is to launch a compulsory and simultaneous National Climate Action Week for all school types. This increases the national attention for the project and thereby helps developing a general change in our society towards sustainable thinking and acting as well as towards competence- and value-oriented learning.
Several climate protection organizations already offer elements of whole day or week programs. The focus of Climate Action Weeks will be to build up and promote climate-relevant competences among pupils and students. It can include art or theatre methods and represent new types of cultural environmental education. It is not a question of reinventing the wheel, but of using existing innovative extra-curricular environmental education. It should be offered in a transdisciplinary and interdisciplinary manner and be accessible to everyone. The integration in the formal educational structure should be seen as multiple empowerments of the pupils as well as the teachers, school administrators and other educational actors towards a prioritization of climate-relevant issues.

## Financing

The instrument of a project-week is already established in most schools around the country with specific financing practices. It should be possible for every school either to organize a self-directed Climate Action Week or to benefit from the expertise of governmental and non-governmental climate protection organizations - both with low costs. The financing of project-weeks with experts has to be provided by the State, the cantons and the schools, possibly supported by power supply and waste management companies.

## Impact

The National Climate Action Week has an indirect impact on the climate and covers questions on climate change and energy supply as well as resource consumption on a personal, family and social level. The participants carry their findings home to their friends and families, in private and in public. They spread their beliefs, knowledge, skills and visions in socially relevant structures as well as in the media. Thereby, the National Climate Action Week contributes to a broad awareness process. It also supports teachers to implement competence-based learning towards participation and a sense of responsibility for yourself, the community and the environment.

# Policy 11.4: Education on a Local Level

## Description

The government should initiate local climate education projects open to the public. The aim is to reach people outside of the education system. The people should be able to understand their part in the solution and willing to take action. These local projects should be planned together with experts.
There are already existing platforms which can be used to initiate education projects like local commissions or NGOs. Numerous organizations are already specialized in climate education. Their services can be used for these projects and the State should support these structures. Also, “Climate Assemblies” could be used as a platform to inform people about these kinds of projects and to share the theoretical base useful to the projects.
The Swiss government can relay this to cantons, municipalities and cities on the basis of best practice. As it is not too difficult to adjust the programs, this policy should be implemented in 2021.

## Financing

The existing projects only function owing to a lot of volunteer work and therefore usually cannot exploit their full potential, as a survey by the ‘Energieforschung Zürich’ in 2018 showed (Moser et al. 2018). It would be desirable to have sufficient partial financing from the federal government with the

participation of the municipalities and cities. Similar models already exist in other areas (spatial development, energy (Energie Schweiz 2020) or migration).
The promotion of assemblies does not cost a lot, but it would be advantageous to help organizing the events by financing publications and advertising for mobilization.

## Impact

Education on the climate crisis will be integrated into established structures (youth centers/community centers). It gives the topic additional importance and enables participatory education. In addition, knowledge and skills can be imparted on a more personal level and together with familiar people.

The measures of Assemblies as well in the Public-Private Partnership as in the institutional way give a huge flow of Information; the climate subject comes in the first row and in the center of the political discussion, not only as an incidental theme. Because of the binding character of the institution, it will be of interest for the media too.
Local projects show opportunities for action by making impactful projects and initiatives in their own region visible and pointing out climate-friendly ways of consumption. Networking among the projects and initiatives is also encouraged. People, who would like to get involved are activated, for example, through a future conference. In the next step, project groups tackle concrete challenges.

## Social Compatibility

Acting together has an integrating effect. Additional social groups within society can be empowered to work for the common good. This addresses the increasing social segregation. The question of how poorly integrated minorities could be reached through such projects deserves special attention. Specially funded projects with scientific support would be conceivable here. Climate Assemblies and local projects in general should be available and open for everyone.

## Questions and Uncertainties

It is uncertain who (if anyone) can impose compulsory programs/recommendations on community and youth centers.

# Policy 11.5: Government Information Campaign

## Description

With an information campaign, the government and governmental organizations like FOEN, MeteoSwiss, National Centre for Climate Studies etc. are informing the population about the climate crisis, the need for action and stimulate corresponding behavior, skills and mindsets. The solution outlined is intended to be no less effective than the Climate Action Plan and aims to reduce Swiss net greenhouse gas emissions to zero by 2030.

The campaign is intended to make people understand that we need change if we want to maintain our quality of life in the future. It is intended to show the population in a positive way what the necessary changes mean for them and what enrichments they offer to the individual citizen. In addition to general facts, the ability to act should also be conveyed. In its implementation, the confederation is guided by the findings of educational research.

This measure is to be implemented primarily nationally but also on a cantonal level and locally. The campaign is to be launched immediately, as education is the basis for many other changes and enables a rapid reduction of unnecessary emissions.

### Financing

It is assumed that the information campaign can be financed from the existing federal campaign budget.

### Impact

The authors expect the information campaign to have an awakening effect. The information campaign would underline the importance of the problem and improve the level of knowledge and willingness to act in similar ways as the COVID-19 info campaign of the Federal Office of Public Health did. This would enable a well-founded social debate on how to solve the climate crisis. It would also encourage people to take the initiative and look for solutions in their own environment. It would reach a large number of people, thus creating a social dynamic. Measures that would be issued by the federal government would now meet with understanding rather than resistance.

## Policy 11.6: Journalism Reflecting the Reality of Problems

### Description

Media can help avert a climate catastrophe through creating scientifically substantiated content that reflects the reality of problems. The treatment of the topic should not be reactively orientated towards sensational single events, but should be constructively involved in the political process through a debate on solutions for the crisis. As the fourth power, the media must not limit itself to exposing grievances and naming problems, but should furthermore encourage a social debate in a solution-oriented way to actually improve life. The urgency of the situation must be duly considered. Media should label opinions and scientific facts/estimates accordingly. This policy should be implemented beginning today. Press Council has the controlling function and is responsible for ensuring that the Code of Conduct for Journalists is observed. This code contains the ethical principles for professional journalistic writing. In addition to this code of journalism, there is also the government mandate for SRG/SSR to provide balanced reporting. Furthermore, an independent institution should install a monitoring with a periodical reporting on how the media follow the ethical code.

### Impact

As the fourth power, the media have a great influence in our society. Especially in the area of education, the media have a great responsibility. Many people who are no longer part of the education system are largely educated by the media. If they trust in the responsibility of the media in relation to the climate crisis, it will be much easier to impart knowledge to the general population outside of educational institutions.

# Policy 11.7: Counsellor for Environmental Awareness

## Description

With this policy we introduce the role of a counsellor in every Swiss firm. Depending on the size of the company, this role would be taken up by one or more people, who are responsible for the organization of educative training on climate change, stimulating an ongoing discussion on the topic, and to foster the awareness about sustainable behavior.
As the following two policies talk about education in the industry and are in relation to the Industry and Buildings and spatial planning section of this document, the work of the counsellor as well as the environmental training (see policy 11.8) should be based on policies of the chapter Industry and Service Sector as well as policies of the chapter Buildings and Spatial Development. This means that the counsellor should be aware of the measures provided by these policies and should be involved in these projects. They should especially work with those contents that are nearest to the work practice of the employees and can be easily applied by the employees.

In the best case, the counsellor is someone who already works at the company and is interested in taking action for the climate. If the company is not able to find people to take up this role or if none of their current employees has the capacity to do so, the company should employ someone external to take up the role of counsellor. However, the counsellor has to be familiar with company' products, its processes, and, if possible, its employees. They would need to be given access to all the necessary information about the company and their working method to carry out the task of a counsellor.

The counsellor is responsible for the constant maintenance of climate awareness in the company. First of all, they are responsible for the organization of the environmental training for the employees (see policy 11.8). The counsellor has to make sure that these training sessions are held.

The goal is that all the employees are permanently reminded of the contents of the training they participated in. Sustainable behavior in the workplace as well as in their personal life should be frequently discussed and renewed bringing up new ideas and inputs. This can be achieved with the organization of small discussions or gatherings, the holding of further training with renewed contents or any other ideas and initiatives the counsellor or the employees themselves come up with.

The counsellor should make sure that both the discussion about the ecological behavior of the company as well as about the private behavior of the individual employees is kept alive. The employees should be informed about the actions their company takes to improve their ecological footprint. They should be encouraged to contribute ideas about how resource management and the company's processes can be improved and they should be informed about the company's goals in this area.

A platform should be created for the exchange of the counsellors. It should help the counsellors to connect with each other and discuss the content and form of their consulting. It should allow them to generate new inputs and ideas, and help them with the solution of occurring problems. This platform should exist online, but there should also be the possibility to meet in person.

## Financing

As the counsellor is employed by the company, it is primarily the company who pays for them. If the company is struggling to come up with the necessary funds, there could be government subsidies for those companies (particularly smaller companies).

## Impact

Thanks to the counsellor, the awareness of the climate crisis is to be increased, constantly brought to mind and discussed with others. Employees will be educated and hopefully their behavior will become more sustainable. They will find a space to bring in their own opinions and ideas. Through the discussion of their own company's sustainability, they will become aware of the ecological impact of the company they work for. In the best case, they will act on that awareness and push their employer to act in a more sustainable way.

## Social Compatibility

Here it is also debatable if this policy is necessary for every form and size of a company, or if the compulsory training (see Policy: environmental training) is already sufficient. However, the role of the counsellor can of course always be adapted for the individual company, in means of the hours of work they invest or the measures they take.
For further discussions, see questions and uncertainties of the policy environmental training.

## Questions and Uncertainties

A big question that poses itself is if there can be found a motivated person in every company, and of course as the task of the counsellor will be interpreted individually, it is hard to say if it will be received well by all the employees.

# Policy 11.8: Environmental Training for all Employees and Apprentices

## Description

Environmental training for all the employees and apprentices should be held. It is organized by the counsellor and held by an expert or different group of experts. The training should be based and connected to the employee's field of work. Part of the training should be tailored for different professions and different kinds of employees.

Therefore, the training should be structured in three modules.

- **The first module: basic facts, background of the climate crisis** should provide the employees information on the basics and facts about the climate crisis.
- **The second module: private behavior change** should give an overview of the behavior changes that individuals can make in their everyday personal life, highlighting for example the big negative impact some products have on the environment and suggesting alternatives.
- **The third module: impact of the professional life** should raise awareness on the environmental impact of the company, what it can do to improve the situation, and what the employees can do while carrying out their specific tasks to contribute.

Although those contents should be known to everyone, the lectures should still be adapted to different audiences and consider their educational background and their existing awareness about climate issues.

The training could contain topics including:

- **Science**: Scientific data on climate change and forecasts
- **Mobility**: Information about emissions and pollution caused by the main means of transport.

- **Clothing**: Information of the ecological impact of the fashion industry (especially fast fashion).
- **Food**: information about the environmental impact of some products, as well as solutions to this problem.
- **Investments**: Information about investments of the financial community, especially in fossil fuels.
- **Getting active:** The counsellor should provide the participants with a list of useful links and organizations they can join if they wish to get more active.

The way of educating the employees should not only be giving them tips and lots of information but also giving them the chance to think for themselves and to come up with their own ideas and solutions. Through that, their motivation to actually use the tips and to act on them will increase. For example, it should be asked in the lectures: What can you do to reduce your daily waste at work? Or: How can you save more energy at home? etc. The training should be structured in a way that stimulates discussion and interaction.

## Financing

Expected costs: An average employee costs a company about CHF 400 a day, a two-hour training (which means the absence from work) with about eight people would quickly cost about CHF 1000 for a company. The shortfall in production is not figured in. As there are no direct profits for a company and to make this policy more attractive to the business world, a governmental cover of costs would be recommended. As one probably understood, the financing of this policy is problematic. However, as expressed in the section 'Questions and Uncertainties', the authors of this chapter believe this policy was to be kept in the chapter because it could be an interesting hint.

## Impact

The goal of this training would be to raise the employee's awareness of their own influence on the climate and motivate them to change their behavior and take action. On the one hand it should raise their general awareness about climate change, its importance and the distress it causes. On the other hand, it should provide practical tips on how to specifically change things at the workplace and in their field of work.

## Social Compatibility

Positive side effects are obviously the changing of behavior and the increase in climate consciousness of all the employees. However, there could of course always be certain people who react reluctantly and won't be motivated to change anything. It cannot be taken for granted that employees will enthusiastically participate in such a project, change their personal behavior, and commit to helping their company in becoming more sustainable.

This is why it is important to structure the training in such a way that people get the chance to come up with their own ideas and are not just lectured about what to do. The participants should not have the impression that this training is useless and imposed from the State, but rather see it as an occasion to get involved in the matter of climate change and realize they can contribute themselves to the cause.

## Questions and Uncertainties

The question that imposes itself is, naturally, if people will actually take action after receiving the necessary information. The authors of this chapter only provide education, tips and something to think about, we cannot force people to act differently afterwards. This is why we implement practically-based information which is easy and coherent to apply.

Another question is whether to make these policies compulsory or not. Of course, such a policy could be more attractive for a company if it was not implemented by every other company and, at the same time, could be looked at as a strengthening of the image and reputation, as well as becoming a more attractive employer. A label or certificate could be created to increase the companies' motivation. It would surely be more welcomed by the economy rather than compulsory regulations. Furthermore, it might be received more enthusiastically by the employers as well as the employees if it is based on a voluntary action. However, the authors believe that because of the urgency of the climate crisis these policies should be implemented fast and by every company, not only the ones that are already on an environment friendly path. The authors all reached the consensus that these policies should be looked at as strong recommendations. Whether they are more efficient if made compulsory or on a voluntary-competitive base remains to be discussed.

# Policy 11.9: Carbon Conversations

## Description

The Carbon Conversations project brings people together to explore climate change and the impact of their personal lives. People within their municipalities meet up and discuss their feelings and practices related to climate change in small groups. The project originated in the UK from researcher Rosemary Randall and has gained international attention. Knowing about climate change is important and education about the drivers of climate change has been covered in other policies in the CAP. Equally important is to discuss and share one's thoughts and emotions regarding climate change. The evaluation of such initiated projects has shown that participants have changed their behavior after a few sessions. Being able to share feelings of fear, anger, guilt or others related to climate change and realizing that others have the same feelings establishes a common ground and helps participants to take action towards a more sustainable lifestyle. The project is implemented in each municipality, including one session per month, and everyone is welcome to participate. The first sessions are guided with a facilitator and are subsequently self-managed. Each meeting lasts 2 hours. Participants are encouraged to share their thoughts on how climate change relates to their personal lives and what kinds of actions they take or want to take and where they are struggling.

## Financing

The costs are relatively low, as a community building can be used to facilitate the meetings. There are administrative costs in the beginning to implement the project, to inform the public about it and to cover costs for the facilitation.

## Impact

Talking about emotions connected to climate change allows participants to acknowledge their fears, uncertainties, frustrations and other feelings. As initiated projects have shown, people tend to take action after such discussions. Participants realize that most people share the same feelings and can help each other and find ideas for a mutual change. This leads to an open, flat hierarchy and collaborative approach to take action against climate change. The project will be monitored through continuous evaluations to measure its impact on the participants.

## Social Compatibility

Local communities get empowered to establish a sense of connectedness and belonging. Further, it strengthens a shared learning experience and the motivation to collaborate. The act of listening to other opinions and understanding each other is valued highly. Local initiatives may emerge out of the conversations. Therefore, the project sets the roots for taking action against climate change on multiple levels.

## Questions and Uncertainties

As the project is implemented by the municipalities, the content may differ in different places. Participation is voluntary, therefore, the whole population may not be reached. Nevertheless, the authors count on the public interest of willing to share feelings and practices in regard to climate change.

# 12 Adaptation



# Vision

We need to adapt to the changing climate. We have to do it as mitigation measures are not sufficiently effective to contain global warming to acceptable levels. Adaptation needs to be re-thought in the process and integrated in the climate action plan. Especially because adaptation will define the level of impact and risks we will sense in Switzerland and elsewhere.

Within the climate change adaptation research community there is a growing tendency to discuss adaptation using the language of transformation, reflecting a sense that the current status quo will not secure a sustainable future, especially in light of the lack of sufficient progress to mitigate the causes of anthropogenic climate change (Barrott et al. 2015).
The concept of transformative adaptation offers hope that as a society we are capable of 'big change' in a world that increasingly demands reinvention and innovation in response to a myriad of interconnected pressures, thresholds and boundaries. However, these terms may also threaten our sense of stability; a steady change from business as usual may be far more palatable than change which may require us to question what we value and the way we live (Barrott et al. 2015).

The interconnections between players in any given system are complex, and poorly designed attempts. Changes can have negative unintended consequences or introduce new failures or inequalities. This means to inquire into a system of interest, to understand the history of that system (e.g. around sources of control, legitimacy and knowledge) and challenge the assumptions that underpin existing structures and ways of doing things. Reproducing 'solutions' without assessing what holds the current system in place may result in simply reinforcing existing failures and inequalities. By developing a more detailed sense of the system as it currently exists, we can design interventions and feedback mechanisms that enable us to learn how ideas for system improvements are put into practice (Barrott et al. 2015). Our Vision is that Adaptation measures enable us to build resilience, while seeing the bigger picture and interconnections of future problems. This can only be reached if people living in Switzerland know about future scenarios and the government, the cantons and organizations work together to protect working areas, vulnerable places and vulnerable people.

# Current Situation

Adaptation is a complex and multi-dimensional process which involves many actors and is often very local. On one hand we are concerned by a common belief that Switzerland is in the privileged situation of not having to adapt to climate change to protect itself from storm surges, floods, droughts, heat waves and forest fires like in other countries. On the other hand, the entire Swiss population felt the strong storms and the changing climate in February 2020 and in recent summers of extreme heat.

There are some larger risks where even experts are not sure yet how the outcome of these risks will be. A study released by the Federal Department of the Environment, Transport, Energy and Communications examined the risks to the country's infrastructure as a result of the climate crisis. An increase in the number of heatwaves, rockfalls and landslides will cause more damage to rails and roads (FOEN 2019c).
Rising temperatures will require investments in the reconstruction of roads that can withstand heat. Damage caused by low temperatures will decrease. In the rail sector, extreme temperatures and storms will require a reduction in train speed, which could result in expensive delays. Higher temperatures, irregular rainfall and drier summers are already reducing the output of nuclear and hydroelectric power plants. The authors of the report above estimate that by 2050, the energy sector will lose hundreds of millions of CHF in revenue. Damage to roads and railways caused by global heating, and the consequences for hydro- and nuclear power plants, can cost up to CHF 1 billion per year (FOEN 2019c). However, the authors acknowledged that there are considerable gaps in knowledge and that these forecasts must be treated with caution.
Mountain regions will probably face large problems with water management in agriculture and winter tourism. Multi water reservoirs for artificial snowmaking, agriculture and hydroelectric power plants could not be filled anymore by melting snow.
Climate change is a reality to which Switzerland, like other countries, must adjust. Even with success in reducing global greenhouse gas emissions, the climate will continue to change over the coming decades. Therefore, it will be necessary to adjust to new conditions and deepen research on unclarities with regards to certain risks!
With this in mind, the Federal Council has developed a strategy and an action plan in order to adapt to climate change. The aim is that authorities, businesses and the public take up this challenge together. 2019 a pilot program started with a total of 50 projects running in all parts of Switzerland, under the overall responsibility of the Federal Office for the Environment. In six sectors there are several promising projects.

# Increase in Heat Stress

Current climate scenarios are not only based on an increase in average temperatures. Maximum temperatures will increase even more dramatically, in particular during summer in urban areas. High temperatures and more frequent heat events have far-reaching consequences for humans, ecosystems and the environment. Critical situations occur in particular during more intense heat waves, as these place a strain on the population and can be life-threatening for elderly and sick people, people in need of care, and also small children and pregnant women. Hence, there is a need to develop strategies to face those problems.

### Serrières on the Way to New Freshness

Because of its topography and altitude, the area around Neuchâtel can already be considered to be a heat island, a problem typical for cities. This is also valid for the industrial quarter of Serrières which now receives additional attention thanks to this project. The project is trying to locally implement the strategy of the Federal Council for adaptation to climate change. We chose to present this project, because beside concrete measures, they try to include the local population. The aim of the project is to put especially vulnerable people, i.e. children and old people, in the center, as they will be the main group who will suffer because of increasing heat periods. With attractive measures, this project also tries to encourage people to influence public space. Testing new living forms should strengthen social bounds and the support between neighborhood residents, meaning that they are better prepared for extreme weather phenomena. The industry quartier of Serrières should become a research and application area for testing different solutions to limit heat storage through alternative surface covering and more grassing. Furthermore the project wants to include the research and integration of passive air-conditioning options through architecture, pergolas, shading, sprinkling etc. and natural cooling methods as “free cooling” through the river Serrière (NCCS 2019).

# Increase in Summer Drought

With an increase in temperatures, water reservoirs that are currently bound as snow and glacial ice are disappearing. At the same time, longer rain-free periods can be expected. This development is contrasted by a sharp increase in water demand on hot days. Although our country has large reservoirs, water can become scarce in local regions in summer. These changes have an impact on ecosystems and all water users and competitive situations can arise. This mainly concerns agriculture, which is dependent on a sufficient supply of water.

## Water Management: Watering in Mountain Regions

In Val de Bagnes there is still enough water. In times where there is no rainfall, meltwater can cover the requirements. But this situation is expected to change. The aim of this project is to estimate requirements and the availability of water for different users until the year of 2100. We chose to present this project because it focuses on “large risks” in mountain regions and tries to research benefits and risks of multipurpose water storage, i.e. for artificial snowmaking, drinking water, agriculture etc. in mountain regions. The project can contribute to making the necessary changes in the supply network for this area (NCCS 2019).

# Increase in Flood Risk, Decrease in Slope Stability and more Landslides

Climate change causes more frequent and more severe floods in Switzerland. Moreover, in the Alps, melting glaciers and thawing permafrost compromise the stability of the ground. This results in more landslides, rockfalls, rockslides and debris flows. In medium and low altitudes, heavy rainfall and retreating snowlines increase the danger of erosion and flow slides. This among other things endangers settlements, transport routes, infrastructure and agricultural land.

## Natural Hazards: Dangers Resulting from Thawing Rock Faces

Permafrost soils do not only stabilize the ground but also a lot of rock faces on steep mountain slopes. Especially in the canton of Wallis where people tend to live close to steep mountain slopes, rock rushes and landslides pose a potential danger. We chose to present this project because it illustrates how vulnerable many mountain regions in Switzerland are and how urgent the need for adaptation is. The aim of this project is to create a risk map which can be used for risk management and danger prevention. In order to this the rock faces will be assigned in risk categories depending on their damage potential (settlements, touristic infrastructure, traffic lines etc.) Another aim of the project is to show possible economic and environmental chances from future developments (NCCS 2019).

# Changes to Habitats, Species Composition, and the Landscape

The changes in temperature and rainfall affects the habitats of animal and plant species. This results in local changes in species composition. These changes are likely to have a negative impact on ecosystem services (e.g. soil fertility, protection from erosion, carbon storage), at least in the beginning. Positive effects are only to be expected in the long term, if at all. The changes mainly concern forestry and agriculture, where they create new conditions for cultivation and production.

## Protected Areas in Times of Climate Change

Protected areas restrict the land use of specific areas, thus enabling threatened species to survive in the intensively used landscape. But protected areas for nature and landscape will change as well as a consequence of climate change. The abundance of species and their habitats will change. The question will come up if today's protected areas will still contribute to preserving biological diversity from specific species. A project in the canton of Graubünden tries to research if and how biodiversity can be maintained in a changing climate. We chose this project because there is not much research in the field, even on the international level. Generally, big parks are a good solution because different habitats remain connected. But for the comparatively small protected areas in Switzerland there are no known concepts yet that consider climate change (NCCS 2019).

# Spreading Invasive Species and Diseases

Climate change promotes the spread of invasive species. These can cause extensive damage in agriculture and forestry. Furthermore, the health of humans and animals can also be endangered by the arrival and spread of new pathogens and disease vectors.

## Spreading from Forest Pests

The number and distribution of pest organisms on forest trees are rising in Switzerland. On one hand new species are arriving and on the other hand indigenous species are getting more aggressive. There are several reasons for that: the barrier effect of the alps is decreasing. Global trade and the mobility of people is still increasing, bringing more species into Switzerland. Furthermore, many trees will get more susceptible to pests because of a changing climate and the direct influences of human activity.
This project aims to research more deeply when climatic thresholds will be crossed for specific species and where dispersion areas for forest pests are. Through better prognosis, future risks could be recognized earlier, and treatment options could be created. We chose to present this project because forestry is an important sector in adaptation (erosion control, protection forests, natural cooling) but as well in mitigation (negative emissions). So it's important to get informed about how forests can change in the future and what trees should be chosen to ensure the well-being of forest ecosystems (NCCS 2019).

# Raising Awareness, Information and Coordination

The people affected need to be informed about the consequences of climate change in order to adapt in a targeted way. Many municipalities, regions and cantons are only starting to develop possible solutions and create networks. The necessary knowledge is often dispersed and does not specifically target the groups concerned. Adaptation to climate change will only succeed if all players collaborate across technical and organizational borders.

## Raising Awareness: Exchange Between Cantons and Municipalities

This project aims to consider a concept for larger exchange and coordination between cantons and municipalities which are involved in the pilot program of the federal council. This should promote knowledge transfer and exchange of experiences between the cantons. We chose to present this project because it tries to enable cantons to announce their adaptation strategy on a local level and include local actors in the process (NCCS 2019).

# Policy Measures

Swiss climate adaptation policy must account for individuals and sectors most disadvantaged by climate change. In addition to the project of the Federal Office for the Environment we focus our policies on certain vulnerable groups and regions that will suffer earlier from climate change and have limited adaptive capacities. It is the aim that people, who are negatively impacted by the changes first, do not have to bear adaptation costs themselves.

## Policy 12.1: Focus on Prevention, Build Resilience and Invest in the Health System

### Description

The overall health effects of a changing climate are likely to be overwhelmingly negative. Pollution does not only affect the climate but also social and environmental determinants of health – clean air and drinking water, sufficient food and secure shelter. The impact of climate change on health is various and ranges from extreme heat, natural disasters over changes in rainfall patterns and infection patterns to mental health issues because of extreme weather events such as anxiety or depression.

Extreme heat waves can cause heat stress and heat strokes. High temperatures raise levels of ozone which exacerbates cardiovascular and respiratory disease. Aeroallergen levels of e.g. pollen are higher in extreme heat, which can trigger asthma (WHO 2018). Already today household air pollution causes 790 000 premature deaths in continental Europe, corresponding to more than 9000 premature deaths in Switzerland (Lelieveld et al. 2018).
Natural disasters mainly force people living in the global south to move houses. However, in mountain regions in Switzerland it is also possible that extreme weather events such as strong storms or fires cause physical injury. Floods contaminate freshwater supplies, heighten the risk of water-borne diseases, and create breeding grounds for disease-carrying insects such as mosquitoes. Floods also cause drownings and physical injuries, damage homes and disrupt the supply of medical and health services (IPCC 2018). With a warming climate it is more likely that tiger mosquitos will increasingly settle down in Ticino, which would consequently lead to more vector-borne diseases (FOPH 2018).

The whole population will be affected by climate change, but some communities are more vulnerable than others. People living in bigger cities or mountain regions are particularly vulnerable. Children are among the most vulnerable to the resulting health risks because they will be exposed longer to the health consequences. Parallel to the corona crisis the health effects are also expected to be more severe for elderly people and people with pre-existing medical conditions (WHO 2018). Furthermore, little research exists with regard to the short- and long-term impacts of climate change on mental health disorders (e.g. depression and anxiety), and the associated financial costs. Climate change affects mental health in a variety of direct, indirect, and overarching pathways—disproportionately affecting those most marginalized (Hayes et al. 2018).
The lack of awareness in society is alarming with regards to the health risks caused by climate change. The population needs to know what issues are likely to come up and who is most endangered. Some may be able to withstand heat better than others, but health is a state of physical and mental well-being, rather than the mere absence of illness. To maintain this well-being a holistic approach to health care will become more important than ever in a changing climate. This entails informing the population about climate related health risks, focusing on prevention, deepening research on how to build

resilience to climate change and policies that secure a sustainable work environment for health-workers and qualitative caregivers.
The adaptation strategy should focus both on primary prevention i.e. reduction of exposure to infection and upcoming disease as well as on secondary prevention i.e. health care with regards to infectious diseases.
Many policies such as building resilient infrastructure for extreme weather events, creating enough green cooling places in cities, monitoring vector-borne diseases are vital to protect a population affected by increasing health risks. One example for resilient infrastructure is the use of gray-water for watering green spaces such as parks. This ensures they do not dry out and lose their cooling effect even in times when water is scarce (ISOE 2020). Future changes in the local climate must always be incorporated into the planning of cities and their infrastructure. Additionally, following the example of Serrières, it is essential to include the local population in the process.

Furthermore, there are synergies between climate change mitigation and adaptation. By building clean energy systems and promoting safe public transportation and active movement – such as cycling or walking as alternatives to using private motorized vehicles – carbon emissions and the burden of household air pollution would be reduced. These alternatives to private motorized vehicles would encourage physical exercise and thus significantly benefit public health. These synergies are win-win situations. However, warning the population about times it is not advisable to do physical exercise outdoors, e.g. during a heat wave, is essential to a holistic adaptation policy.

We demand the enhancement of epidemiological surveillance targeted at specific territories. This is necessary because of the expected expansion of endemic infections and their subsequent emergence in new areas. This would be guided by information from climatic scenarios downscaled to specific regions and their implications in relation to disease cycles.

Meteorological services are highly relevant for the development of early warning systems to protect the population from the impacts of extreme weather events. These systems would guide interventions to increase the resilience of communities affected by disasters and reduce their exposure to infection.

A general approach to adaptation that can have health benefits is the enhancement of social capital. This involves the organization of a network of resources and the strengthening of social linkages that can help to reduce vulnerability and increase community resilience. Assessments have pointed to the advantages of social capital for adaptation (Ebi and Semenza 2008) but the barriers for its development have not been fully assessed (Huang et al. 2011). Research has shown that belonging to a social network can have a protective effect against heat-related illness (Naughton et al. 2002) and population groups that are excluded from access to resources and decision making, i.e. groups with low levels of social capital, in the adaptation process are in turn more vulnerable communities (Cutter and Boruff, n.d.) A concrete example for the building of social capital is the project in Serrièrre from the BAFU. Something like this could prove to be especially significant for senior citizens. It’s our aim that there will be more research on how to build resilience to climate change.

Maintaining a strong health care sector, i.e. avoiding excessive austerity measures, is essential to combating negative health effects from climate change. Care jobs have the potential to be green jobs. Caretaking as it is practiced for example in hospitals or retirement houses requires fewer resources and CO2 emissions tend to be lower compared to sectors involved in the production or distribution of goods. A green job refers to any occupation that is part of the sustainability workforce: a job that contributes to preserving or enhancing the well-being, culture, and governance of both current and future generations, as well as regenerating the natural resources and ecosystems upon which they rely. These green job occupations stand in contrast to work in industries that result in the degradation of ecological systems and the social, cultural, and political institutions that support them. Additionally, it's important to have more funding for research concerning the relationship of climate change and mental health in order to address these issues properly in the future.

The policies should be put in place as soon as possible to prevent as much damage to the health of the population as possible. Following the Covid19 crisis on one hand, there might be a strong movement from health workers demanding more funding, on the other hand more awareness for the importance of health staff among the population. Thus, it would be a good time to prepare the health system for future climate change related challenges.

## Impact

All these policies would have a long-term positive impact for public health and living conditions in Switzerland.

## Social Compatibility

The population would be informed better by the monitoring systems and would be provided tools to build resilience for themselves and their communities.

## Questions and Uncertainties

- How much will this transformation cost in the end? And how much will it cost if we miss to do this transformation?
- What concrete measures other than the enhancement of social capital can build resilience to climate caused health issues?

# Policy 12.2: Sustainable Alternatives for Tourism

Demanding that subsidies go towards ski resorts developing sustainable long-term alternatives for tourism without artificial snowmaking and mass tourism.

## Description

In the Alps the glaciers provide the clearest evidence of the changes brought because of global warming. In recent decades many Alpine glaciers have shrunk to half their earlier size (Bundesamt für Umwelt (2019). The consequences are rock falls, landslides and more mudslides. Global warming is further accentuated by what is referred to as the feedback effect: like a mirror, glaciers reflect solar energy. If the surface area of the mirror is reduced, the amount of reflection also decreases, and the sun heats up the planet even more. There are other reasons why the Alps are particularly impacted by climate change: the warming effect is more pronounced over land masses than over water. This phenomenon is particularly observable in the northern hemisphere, the location of most of the Earth's landmass – including the Alps.
The Alps are not just a victim, but also a contributing factor to climate change. Alpine regions consume around 10% more energy per capita than the European average (CIPRA 2012). Since most of the buildings in the Alps are in need of renovation, one of the keys to mitigating climate change lies in the construction industry and proper renovation (CIPRA 2012).

Tourism and transport are two other problematic areas for the climate in the Alps. Accounting for over 93% of traffic, motorized road traffic bears a key responsibility for greenhouse gas emissions caused in the Alps. The motor car is used for 84% of holiday travels to the Alps. This is an area where there is

an urgent need for innovative ideas and solutions; after all, the Alps are one of the most important holiday region in Europe, and many livelihoods depend on the tourism industry (CIPRA 2012).
Since 1864 the temperature in Switzerland has already risen by 1,8 degrees, roughly twice as much as the global average (Akademien der Wissenschaften Schweiz 2016). The CH2018 report comes to similar numbers. In conclusion there are already some, but in the future many more ski regions will be unable to continue offering their current version of winter tourism without artificial snowmaking.
Snowmaking machines consume very high amounts of water and energy, thus have high financial costs and also impact alpine ecosystems by i.a. changing the chemical composition of the soil (Casagrande et al. 2019). They do not solve the problem, but only delay the effects of climate change. The water required for snowmaking could be used for agriculture, households or hydroelectric power plants instead. Competition over water has already begun to emerge in some mountain areas of Switzerland and will certainly increase in the future. Not only is artificial snowmaking environmentally unsustainable, it will not be economically sustainable as secure snow regions decrease and thus costs of snowmaking increase.

A possibility would be to invest in year-round activities that are not dependent on snow such as mountain biking or hiking trails. As public concern for environmental protection increases, programs that care for nature, plant trees, protect biodiversity or holiday camps where participants can help in sustainable alpine agriculture might become more attractive. The goal of any policy should be to include everyone disadvantaged by climate change, to be creative and innovative and encourage ski regions to prepare for the future. Therefore, it is necessary that subsidies that go to ski resorts aim at developing sustainable and long-term alternatives for tourism without artificial snowmaking.

In addition, no further subsidies will be given to short-term business models in ski regions that fail to take environmental sustainability into account. Money, which is provided, should primarily be used to help ski regions diversify their offerings towards whole year solutions to make them more resilient to temperature rises. This can be achieved through measurements, which really evaluate the social and environmental impact of a project.

## Financing

No additional money is needed. It just has to be used more effectively and under stronger measurements. The Federal Parliament pledged to give CHF 30 million (SECO, 2012) for the years 2020-2023 to Innotour.

## Impact

This policy would save many ski regions from future financial difficulties due to a decrease in snowfall and water scarcity issues due to a subsequent increase in snowmaking. Additionally, it would facilitate the transition towards sustainable tourism in the Swiss alps. Furthermore, it would protect alpine ecosystems from the various negative impacts of artificial snowmaking infrastructure and reduce energy consumption.

## Social Compatibility

For working people in the sector of winter-tourism the ProGJ (see chapter Economic and political structure) needs to find suitable alternatives.

# Policy 12.3: Legal Framework to Support Climate Refugees

## Description

Climate change already has a significant effect on migration and this effect is expected to dramatically increase in the future. The impacts of climate change are numerous. Limited natural resources, such as drinking water, are likely to become even scarcer in many parts of the world. Crops and livestock struggle to survive in the most affected areas. Places where conditions become too hot and dry, or too cold and wet, threaten livelihoods and exacerbate food insecurity (UNHCR n.d.). Due to multiple factors such as thermal expansion and melting ice sheets, the sea level is expected to rise substantially and displace millions living in coastal areas (Bamber et al. 2019). Furthermore, Stanford researchers suggest that intensifying climate change will increase the risk of armed conflict (Mach et al. 2019).

Despite efforts to adapt to the changing environment, individuals around the world are being displaced by the effects of climate change and thus forced to relocate in order to survive. New displacement patterns and competition over depleted natural resources can spark conflict between communities or compound pre-existing vulnerabilities (UNHCR n.d.).
According to the UNHCR report, people who are displaced across borders in the context of climate change and disasters may in some circumstances be in need of international protection. The refugee law therefore has an important role to play in this area. UNHCR is providing protection and assistance for many people displaced by the effects of climate change and disasters, among other drivers, and is working to increase their resilience. Legal advice, guidance and the development of norms to support the enhanced protection of the rights of people displaced in the context of climate change related disasters is therefore needed.
Policymakers have to elaborate the definition "people displaced in the context of disasters and climate change" in the future because it will have severe consequences on which people get help and which do not. To give an idea, this definition could include all people who were forced to leave their homes because of direct natural disasters or economic consequences because of climate change that made it impossible to stay. Furthermore, the definition could also include all refugees who are displaced already and cannot protect themself from natural disasters, heat waves, air pollution, fires etc.

## Financing

There is no big need for additional financing.

## Impact

This policy would have a direct impact on all people considered a person displaced in the context of disasters and climate change. They would be protected and supported by Switzerland with legal advice, guidance and the development of norms.

## Social Compatibility

Since there would be more people in Switzerland it could offer a positive chance for diversity and immigrants could bring their knowledge to Switzerland. However, society reacting with hostility towards new people is thinkable too, as happened in 2016 with the refugee movement from Syria. On the other hand, Switzerland's low birthrate is expected to further decrease, like in many industrial countries (FSO n.d.) People displaced in the context of disasters and climate change could help make up for laborers in sectors where there might be lack of personal.

## Questions and Uncertainties

- What exactly constitutes "persons displaced in the context of disasters and climate change"? Climate change is one of many intersecting factors that have an impact on migration. We acknowledge the complexity and multicausality of migration and highlight the need for more research in this area.
- Furthermore, targeting assistance to "persons displaced in the context of disasters and climate change" would ignore those who were displaced by natural disasters that were not climate change related – such as earthquakes in Haiti or Sichuan – as well as those who were left behind. It would also ignore the needs of many other displaced peoples who flee state collapse, such as in Afghanistan and Iraq, but are not covered by the refugee convention. How should Switzerland address this unequal treatment?
- Furthermore, research should also focus on reducing the environmental impact of refugee settlements and ensuring sustainable responses to displacement.

# Glossary

| Abbreviation | Explanation |
|---|---|
| **ASF** | Animal sourced food |
| **BAU** | Business-As-Usual |
| **BECCS** | Bioenergy carbon capture and storage |
| **BIS** | Bank of International Settlements |
| **CAP** | Climate Action Plan |
| **CCS** | Carbon Capture and Storage |
| **CCU** | Carbon capture and usage |
| **CDR** | Carbon dioxide removal |
| **CO2eq** | $CO_2$-Equivalent |
| **COP** | UN Climate Change Conference |
| **DACCS** | Direct air carbon capture and storage |
| **DETEC** | Federal Department of the Environment, Transport, Energy and Communications |
| **ECB** | European Central Bank |
| **EDK** | Swiss Conference of Cantonal Ministers of Education |
| **ESD** | Education for Sustainable Development |
| **ESG** | ecological, social and governance |
| **ESPEC** | Environment, Spatial Planning and Energy Committees |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FDF** | The Federal Department of Finance |
| **FDFA** | Federal Department of Foreign Affairs |
| **FFA** | Federal Finance Administration |
| **FF-NPT** | Fossil Fuel Non-Proliferation Treaty |
| **FINMA** | Swiss Financial Market Supervisory Authority |
| **FOAG** | Federal Office for Agriculture |
| **FOC** | Federal Office of Culture |
| **FOCP** | Federal Office for Civil Protection |
| **FOEN** | Federal Office of the Environment |
| **FOPH** | Federal Office of Public Health |
| **FSD** | Education for sustainable Development |
| **FSO** | Federal Statistical Office |
| **FSVO** | Federal Food Safety and Veterinary Office |
| **GDP** | Gross Domestic Product |
| **GEAK/CECB/CECE** | Gebäudeenergieausweis der Kantone/ Certificat énergétique cantonal des bâtiments/ Certificato Energetico Cantonale degli Edifici |
| **GHG** | Greenhouse gas |
| **IAM** | Integrated assessment models |

| | |
|---|---|
| **ITMO** | Internationally Transferred Mitigation Outcomes |
| **LULUCF** | Land use, land-use change and forestry |
| **LULUCF** | Land use, land use change and forestry |
| **NAI** | Non-amortizable investment |
| **NDCs** | Nationally Determined Contributions |
| **NETs** | Negative emission technologies (technologies used for CDR) |
| **NGFS** | Network for Greening the Financial System |
| **NGO** | Non-Governmental Organization |
| **ODA** | Official development assistance |
| **OECD** | Organisation for Economic Co-operation and Development |
| **ÖLN/PER** | Ökologischer Leistungsnachweis/ Prestations écologiques requises/ Prova che le esigenze ecologiche sono rispettate |
| **ProGJ** | Public Program for Green Jobs |
| **RE** | Renewable energy |
| **SDGs** | Sustainable Development Goals |
| **SDI** | Sustainable Development Index |
| **SFA** | Synthetic fertilizer application |
| **SFOE** | Swiss Federal Office of Energy |
| **SIF** | State Secretariat for International Finance |
| **SNB** | Swiss National Bank |
| **SRG/SSR** | Swiss Broadcasting Corporation |
| **UNEP FI** | United Nations Environment Programme Finance Initiative |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **UNFCCC** | United Nations Framework Convention on Climate Change |
| **UNHCR** | UN Refugee Agency |
| **UVPV/OEIE/OEIA** | Verordnung über die Umweltverträglichkeitsprüfung/ Ordonnance relative à l'étude de l'impact sur l'environnement/ Ordinanza concernente l'esame dell'impatto sull'ambiente |
| **VBSA** | Verband der Betreiber Schweizer Abfallverwertungsanlagen/ Association suisse des exploitants d'instellations de traitement des déchets |
| **VHKA/DIFC/CISR** | Verbrauchsabhängige Heiz- und Warmwasserkostenabrechnung/ Décompte individuel des frais de chauffage et d'eau / Conteggio individuale delle spese di riscaldamento e di acqua calda |
| **WTO** | World Trade Organization |
| **WTR** | Working Time Reduction |

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