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Factsheet

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Negative emissions: the main approaches

If long-term climate targets are to be met, large quantities of CO_2 will need to be removed from the atmosphere and stored on a permanent or long-term basis ('negative emissions'). A number of negative emissions technologies currently exist, based on biological approaches such as wood utilisation or technological approaches such as direct air capture. However, these approaches either have not yet been tested in practice or are not ready for deployment on the scale that would be required to affect the climate. Action should be taken today to create conditions conductive to the development of negative emissions technologies.

According to the Intergovernmental Panel on Climate Change (IPCC), global warming can only be limited to 1.5 °C if global CO_2 emissions reach net zero by around the year 2050.[1] Any remaining CO_2 emissions will need to be balanced by permanently removing CO_2 from the atmosphere ('negative emissions'). According to current knowledge, the global development of CO_2 emissions will probably need to be net negative by the end of this century. This means that, by that time, the amount of CO_2 permanently removed from the atmosphere will have to exceed the amount of CO_2 emitted.

Based on these findings, the Federal Council decided on 28 August 2019 that Switzerland should reduce its greenhouse gas emissions to net zero by 2050. This target can and must be achieved primarily by moving away from fossil fuels (especially oil, gas, petrol and diesel). The remaining hard-to-avoid emissions, for example from agriculture, waste incineration or cement production, will need to be balanced by the use of natural and technological CO_2 sinks.

[1] Intergovernmental Panel on Climate Change (IPCC), 2018: *Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*.

Negative emissions as a response to excessively high CO_2 concentration

There are various measures that humans can take in response to global warming (see Figure 1):

i. The top priority should be to tackle the problem at source and prevent man-made greenhouse gas emissions from entering the atmosphere at all, for example by moving from fossil fuels to renewables for energy generation. In terms of consumption, we can make climate-friendly changes to the way we eat, get around and use space. In industry, for example at cement factories or municipal waste incineration plants, CO_2 can be captured directly at source and permanently stored in suitable locations (known as 'carbon capture and storage', or CCS).

ii. We can use negative emissions technologies (NETs) to remove CO_2 already in the atmosphere and permanently store it, thereby lowering the CO_2 concentration.

iii. Another option is 'solar radiation modification' (SRM), where more sunlight is reflected back out into space in order to counteract warming.

iv. Finally, we can adapt to the unavoidable impacts of global warming.

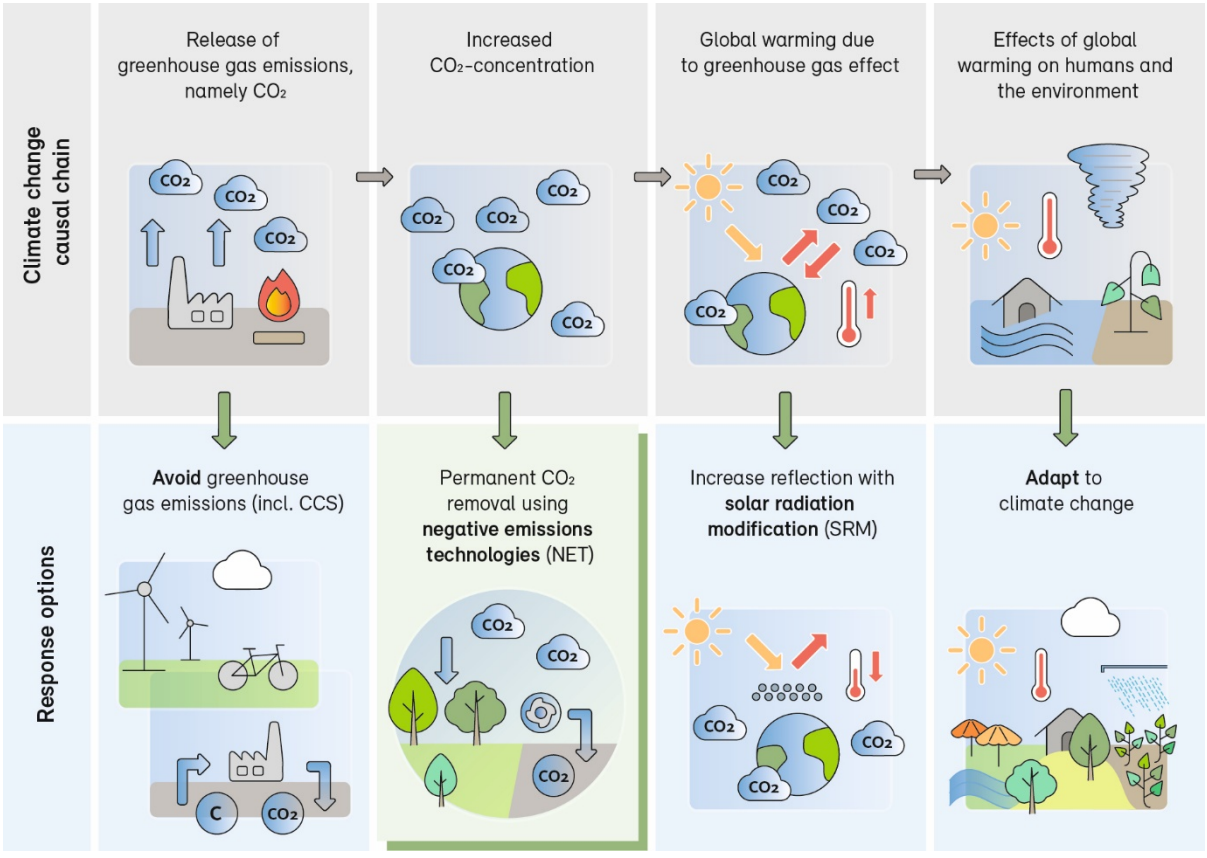

Figure 1: *Humans can respond in various ways along the climate change causal chain. Source: FOEN illustration based on Jan C. Minx et. al., 2018.*[2]

[2] Jan C. Minx et. al., 2018: *Negative emissions – Part 1: Research landscape and synthesis*. Environmental Research Letters 13, 063001. Available at https://doi.org/10.1088/1748-9326/aabf9b.

NETs and SRM are fundamentally different concepts: whereas NETs directly address the increased CO_2 concentration in the atmosphere, which causes the warming effect, SRM acts on the balance between solar radiation reaching the earth and heat radiated back from the earth, which is altered by the CO_2 concentration. In other words, SRM only tackles the warming (i.e. the symptom). Moreover, SRM may pose major risks to people and the environment, which have not yet been adequately researched. For these reasons, SRM was not factored into any of the IPCC's possible net CO_2 emissions pathways for limiting global warming to 1.5 °C. Switzerland is not actively pursuing SRM as part of its national climate policy either. It is, however, working internationally to further advance discussions about SRM and NET knowledge and international governance.

Negative emissions approaches exist – but many questions remain unanswered

We know of a number of NETs that can use biological or technological approaches to remove CO_2 from the atmosphere and store it on a more or less permanent basis. Essentially, CO_2 can be captured in biomass (through photosynthesis) or by chemical means (using air filters or mineral sequestration). The CO_2 (or, with some techniques, just the carbon (C)) is then stored in biomass on the earth's surface (e.g. in wood), in the soil, in the geological substrate, in minerals or in the seabed (see Figure 2). For these techniques to generate negative emissions to a degree that affects the climate, the CO_2 must be stored for a long time, i.e. for several decades or preferably for centuries. CO_2 stored in forest biomass or in humus in the soil is more liable to end up back in the air than CO_2 sequestered deep underground or in minerals, due for example to exceptional events (such as forest fires) or intensive soil tillage.

At present, many fundamental questions relating to the implementation of NETs – such as cost, environmental impact, permanence and conflicting objectives – have not been sufficiently explored at national or international level. Furthermore, all the techniques discussed either have not yet been tested in practice or are not ready for deployment on the scale that would be required to affect the climate. Consequently, it is not possible at this stage to make reliable assertions about the realisable potential of NETs in Switzerland. In order to plug these knowledge gaps, research and development on NETs needs to be urgently stepped up.

The path to further developing NETs by 2050

As well as 'traditional' climate policy, NET development affects other public policy areas including agricultural and forest policy, energy policy, waste, legal regulation of the subsurface, (CO_2) transport infrastructure, research funding and technology transfer. Within the Federal Administration, it will be examined how discussions and action to create the conditions required for NETs could be coordinated by the Federal Office for the Environment (FOEN). This includes developing a NET roadmap setting out how the necessary negative emissions can be built up by 2050 in line with the Federal Council's long-term climate strategy. In this context, the potential that could be realised sustainably and the involvement of relevant stakeholders, from research and industry for example, should be assessed in more detail.

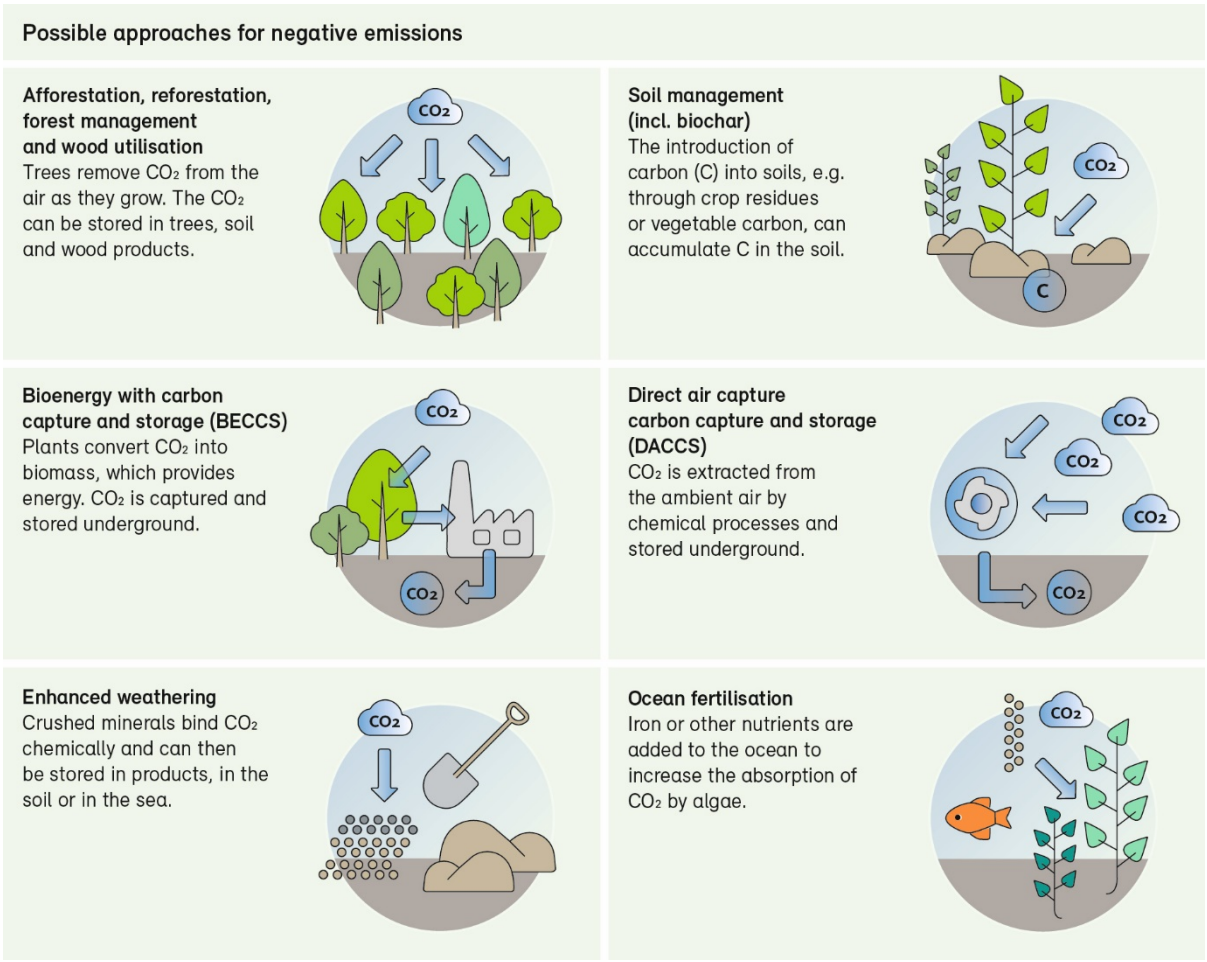

Figure 2: *There are various approaches for removing CO_2 from the atmosphere. Source: FOEN illustration based on content from the Mercator Research Institute on Global Commons and Climate Change (MCC).*

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- FOEN webpage: 2050 climate target
  https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/climate-target2050.html
- FOEN webpage: Negative emissions technologies
  https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/climate-target2050/negative-emissionstechnologien.html