Carbon removal, net zero, and implications for Switzerland

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EXECUTIVE SUMMARY

This E4S white paper provides an overview of carbon removal in the context of climate action towards net zero, covering the main points policy-makers and organizational leaders should keep in mind.

We will make the case for carbon removal, which in this paper includes carbon capture, utilization and storage (CCUS) and negative emission technologies (NET), as an important but small part of climate action in the 2-3 critical decades we have to stabilize our climate and stop biodiversity loss.

This insight is key for properly designing and governing carbon removal, as a complement to deep emission reductions based on sufficiency, efficiency, and clean energy. We will argue that CCUS and NET are important contributions to broader climate action, with potential limited to several percent of current emissions. This is not a contradiction: no single approach will solve the climate crisis.

After decades of climate inaction and ever-increasing emissions, despite increasingly urgent and precise warnings by the IPCC, several successful international agreements (Kyoto, Paris), unprecedented mobilization of the civil society around the world, and more frequent extreme weather events (flooding, drought, fires, temperature extremes) - the time to act is running out, if we want to keep warming within 1.5°C above pre-industrial times. We have less than a decade to globally halve emissions, and less than 30 years to reach -90%. We may need costly, difficult to implement measures like carbon removal, which we could have easily avoided with timely reductions.

To stay within 1.5°C warming, IPCC's AR6, published in August 2021, defines the remaining carbon budget we can safely emit at 300-400 Gt CO_2. The 300 Gt limit will be reached around 2027-2028, unless we massively reduce our emissions almost immediately. This extremely short window limits the role of technologies still in R&D, and the time to deploy existing ones - suggesting an emphasis on policy, behavior, and economic measures.

In this context, carbon removal, both CCUS (carbon capture before it reaches the atmosphere) and NET (negative emissions, removing carbon from the air and storing it at climate-relevant time scales) will have an important role to play. Today, carbon removal beyond the fast natural carbon cycle (i.e. photosynthesis and storage in living biomass and soils) is experimental and small-scale. Worldwide, it is highly unlikely to scale beyond 5-10% of current emissions (i.e. 3-6 Gt CO_2e), at least in the 2-3 critical decades to come, during which we must stabilize the climate (IPCC AR6 WG3 will include a new estimate). Yet it can still provide significant climate benefits such as reaching net zero if combined with deep decarbonization.

Climate warming affects humans directly and indirectly, by degrading ecosystem services on which we depend for survival, such as food, medicine, pollination, or nutrient cycling. Protecting ecosystem services is one of the main reasons for climate action. Many biological carbon removal measures, if properly implemented, can offer significant biodiversity co-benefits, even at relatively small scales.

What carbon removal cannot provide is a stable climate with business as usual, without deep cuts

in emissions.

Since 1972, CCS has been used commercially, mostly to enhance oil recovery from depleted oil fields (details in the section "CCS+EOR"); today it removes 0.1% of current emissions. The so far committed expansion plans will not significantly change this ratio. Given the investment and deployment cycle, carbon removal is unlikely to play more than a marginal role before the 2030s.

It is essential to keep in mind the purpose of carbon removal: help reach net zero by removing the residual emissions, after sufficiently deep decarbonization. Additionally, it should provide real biodiversity co-benefits, and avoid any negative ecosystem impacts. This is not how CCUS has developed historically (to extract more oil from depleted fields) or is viewed by big players today: to extend the fossil era, prolong the lifetime of stranded assets like coal power plants, open new markets for oil companies (solvents), or simply benefit from available "green" subsidies. Stabilizing the climate is missing from the goals of almost all main players.

Unless this purpose (and the actions it leads to) changes, carbon removal will not meaningfully contribute to climate action, even distracting from real action, while transferring wealth from taxpayers to corporations.

Carbon removal is costly and requires funding to be deployed at a meaningful scale. Funding can be based on a carbon tax plus removal subsidy of several hundred dollars per ton CO_2 or through some form of a carbon removal mandate, directly or via a cleanup fund. One such proposal for Switzerland, the Swiss Climate Cleanup Fund, is developed in the E4S working paper "Climate Cleanup Fund - getting to Swiss Net Zero".

In practice, carbon removal will only work within a framework of international cooperation, except perhaps for small-scale projects with significant local ecosystem benefits. If positioned as a complementary measure to reach net zero based on deep decarbonization across all sectors, the moral hazard can be limited - carbon removal will not be seen as a possible substitute for significant emission cuts. With such international cooperation and proper positioning, carbon removal can play a limited but very important role in our task of stabilizing the climate.

For Switzerland, given its density, fragile ecosystems, faster warming already reaching 2°C, limited available biomass, and relatively high emissions from cement and waste incineration, we stress the importance of nature-based climate action with biodiversity co-benefits, especially wetland restoration, biochar and soil carbon projects. Additionally, CCS with local geological storage should be developed for cement plants and incinerators, as well as limited BECCS. The realistic potential in Switzerland is around 5 Mt per year, corresponding to the last 10% of territorial emissions, reaching net zero together with deep decarbonization. Carefully designed and monitored, carbon removal measures could also strengthen the resilience of fragile ecosystems.

The importance of carbon removal goes well beyond the last 5-10% of current emissions, by implicitly defining goals for sufficiency, efficiency, and renewable energy, and setting an "objective" carbon price. The realistically achievable carbon removal potential determines how deep and how fast we must reduce emissions to stay within the remaining 1.5°C budget. Carbon removal also sets an objective, "technical" as opposed to "political" price for emitting CO_2, creating a strong signal to accelerate climate action. Nature-based carbon removal also offers rapid and significant biodiversity benefits, if designed and monitored for this goal. Metaphorically, the "tail" of carbon removal could be wagging into action the "dog" of deep decarbonization.