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CO2 removal und Direct Air Capture

Parlamentarieranlass Neue Energie Luzern

12. September 2022

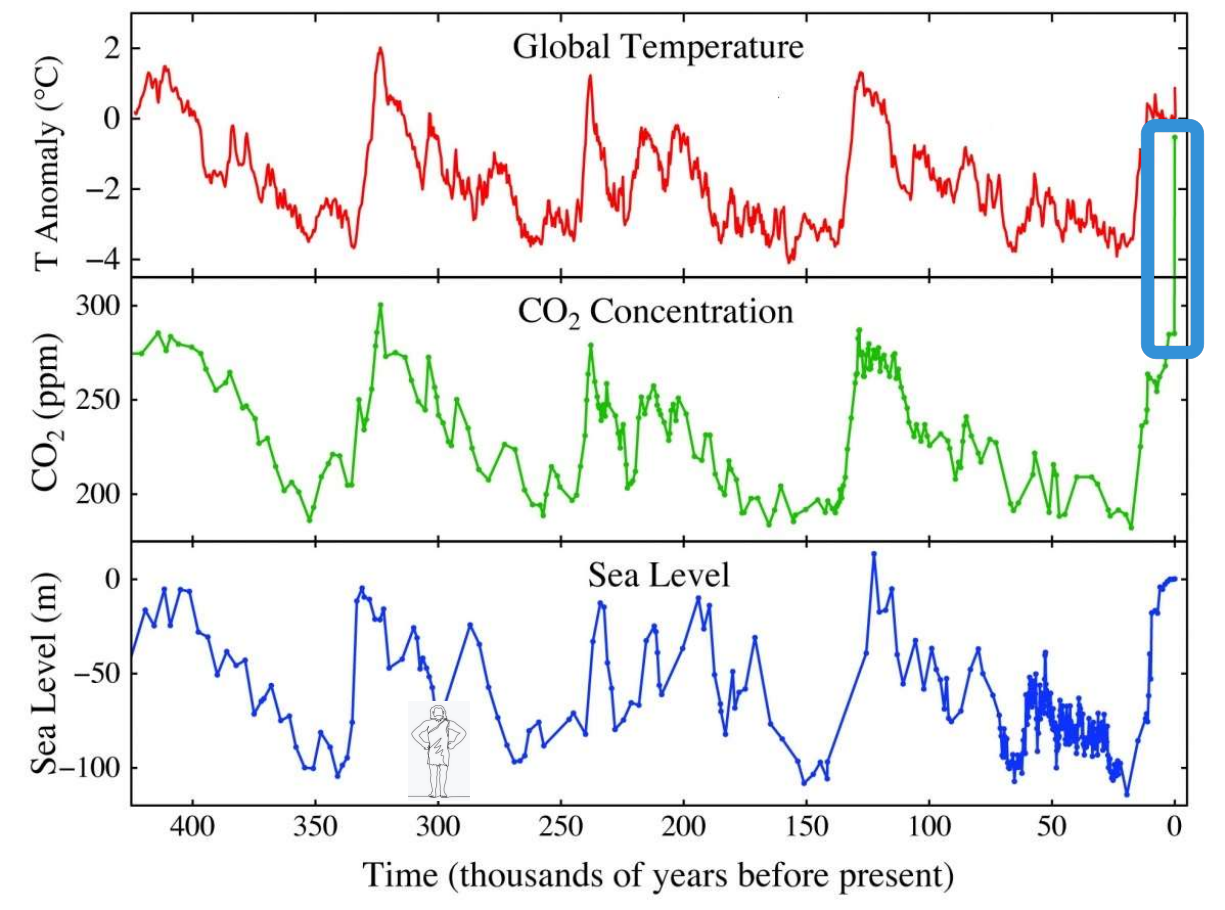
Where are we today?

Evolution since 1850 (pre-industrial times):

- Average atmospheric CO2 concentration: increase from 280 ppm to 420 ppm = **+140 ppm**
- Average temperature: increase of **+1.1°C**

… but the system Earth is not balanced!

Let's have a look into the past!
Last 400'000 years



Adapted from James Hansen, Makiko Sato, 2013

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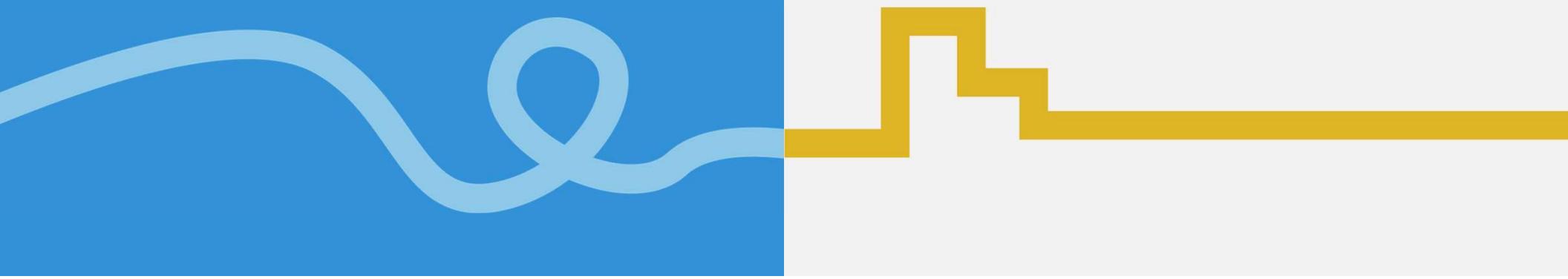
Looking ahead: what must be done?

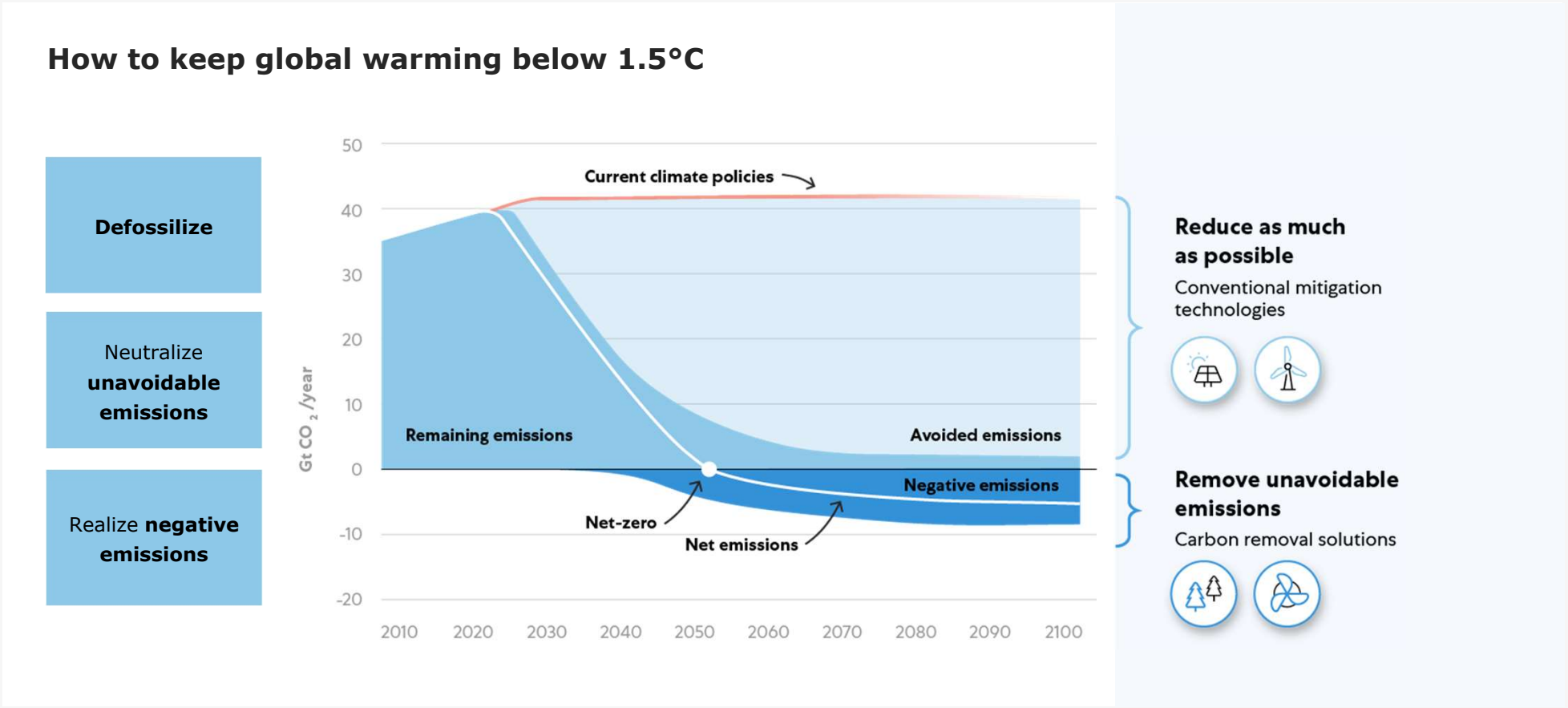


The Paris Agreement (2015)

The Paris Agreement is a **legally binding international treaty on climate change**. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016.

"The Paris Agreement sets out a global framework to avoid dangerous climate change by limiting global warming to well **below 2°C and pursuing efforts to limit it to 1.5°C.**"

How to spend our remaining CO2 budget?

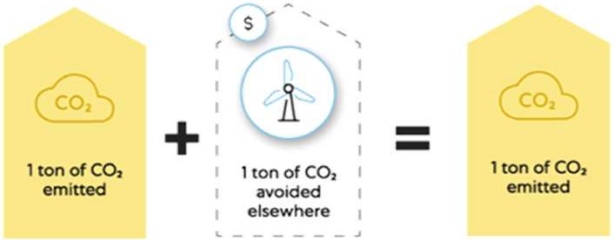


Source: Adapted from IPCC (2022) & United Nations Environment Programme (2021)

Are carbon emissions actually removed?

Carbon offset

I purchase offset credits to neutralize my emissons.
The current level of emissions **is maintained.**

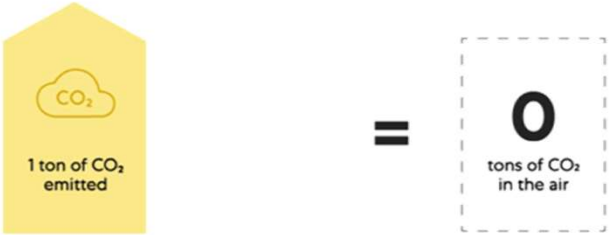


My corporate carbon emissions — Carbon neutral

✕ Not net-zero goal compatible
✕ Your emitted CO_2 remains in the air

Carbon removal

I purchase removal credits to remove my emissions.
The current level of emissions **is reduced to zero.**



My corporate carbon emissions — Net-zero carbon

✓ Additionality guaranteed
✓ Your emitted CO_2 is removed again from the air

	Area required to remove 8 Gt CO_2 per year	Water required to remove 8 Gt CO_2 per year	Expected cost at large scale	Impact on environment*
Afforestation Large-scale tree plantations to increase carbon storage in biomass and soil.	 **6'400'000 km²** Europe = 10'500'000 km²	 **740 km³** Yearly global freshwater withdrawal 2010 = 4'000 km³	**5–50 USD/t CO_2**	**Biodiversity** **Albedo** **Food Security**
BECCS Bioenergy in combination with Carbon Capture and Storage.	 **2'500'000 km²**	 **480 km³**	**100–200 USD/t CO_2**	**Biodiversity** **Albedo** **Food security**
Enhanced weathering Distribution of crushed silicate rocks on soil surfaces to absorb and bind CO_2 chemically.	 **220'000 km²**	 **3 km³**	**50–200 USD/t CO_2**	**River/ocean chemistry**
Direct air capture Direct capture of CO_2 from ambient air through engineered chemical reactions.	 **15'800km²****	 **8 km³** Potentially zero	**< 200 USD/t CO_2**	**Minor**

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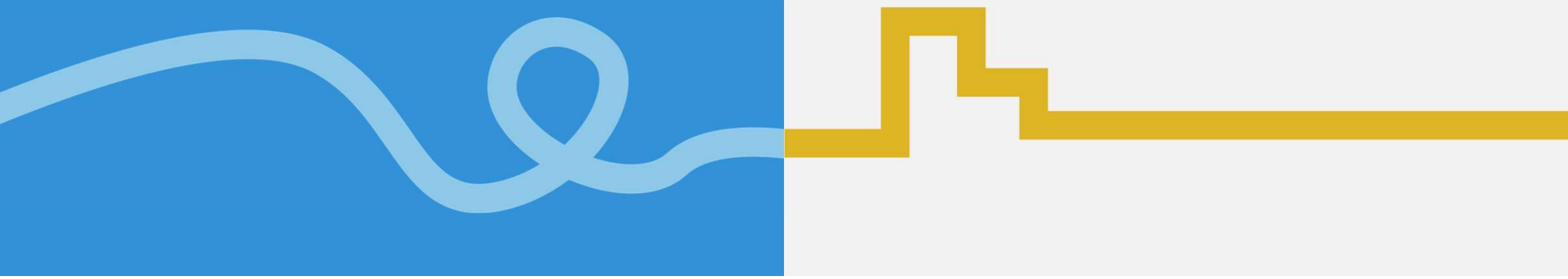
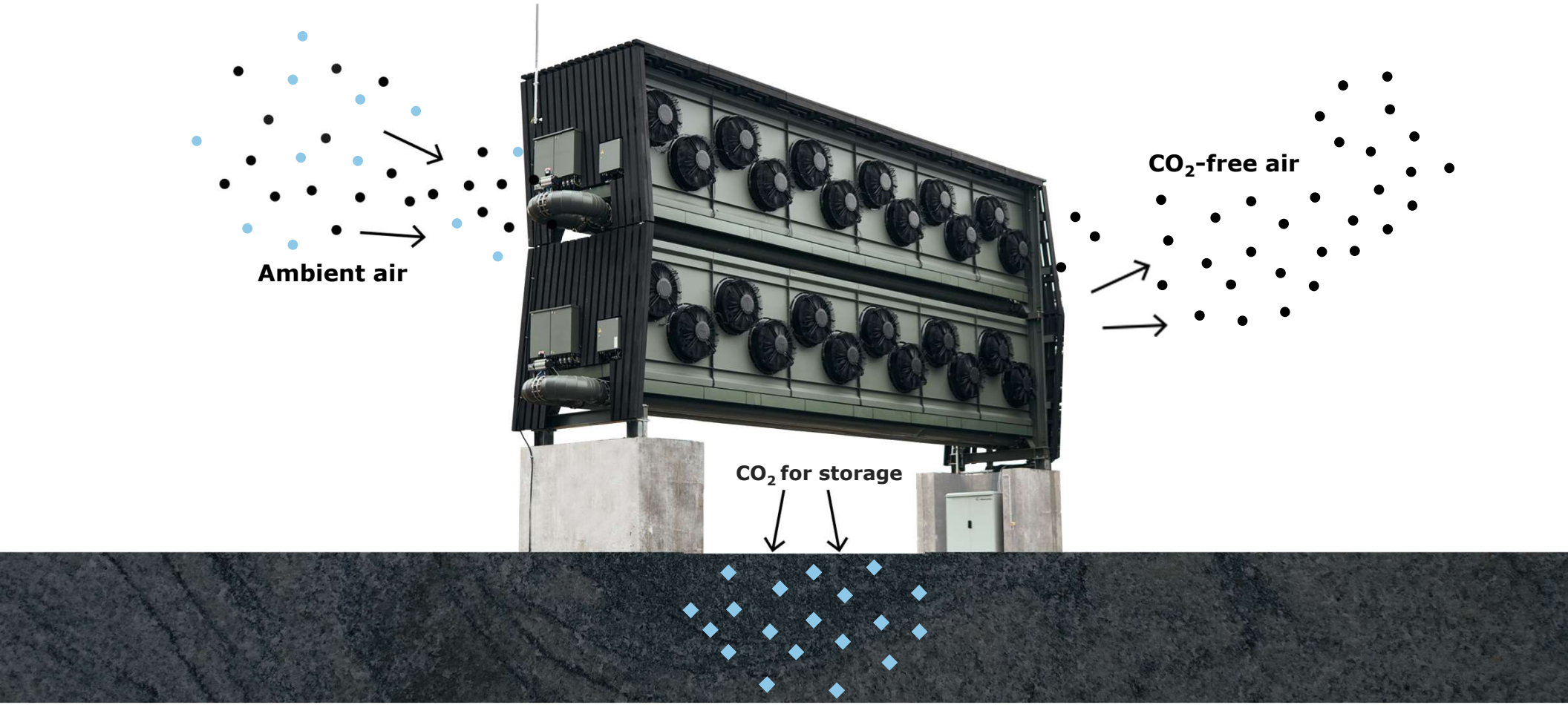
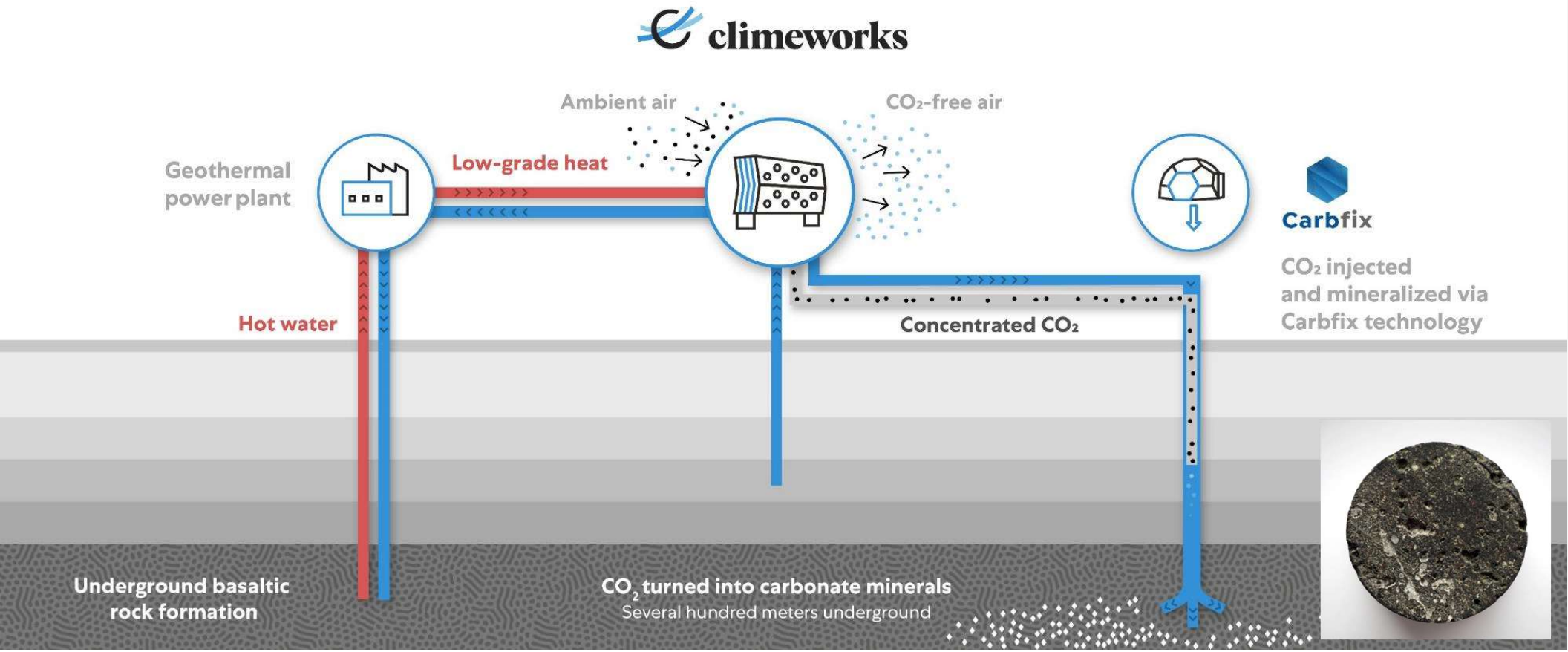
Climeworks‘ Direct Air Capture



Direct Air Capture



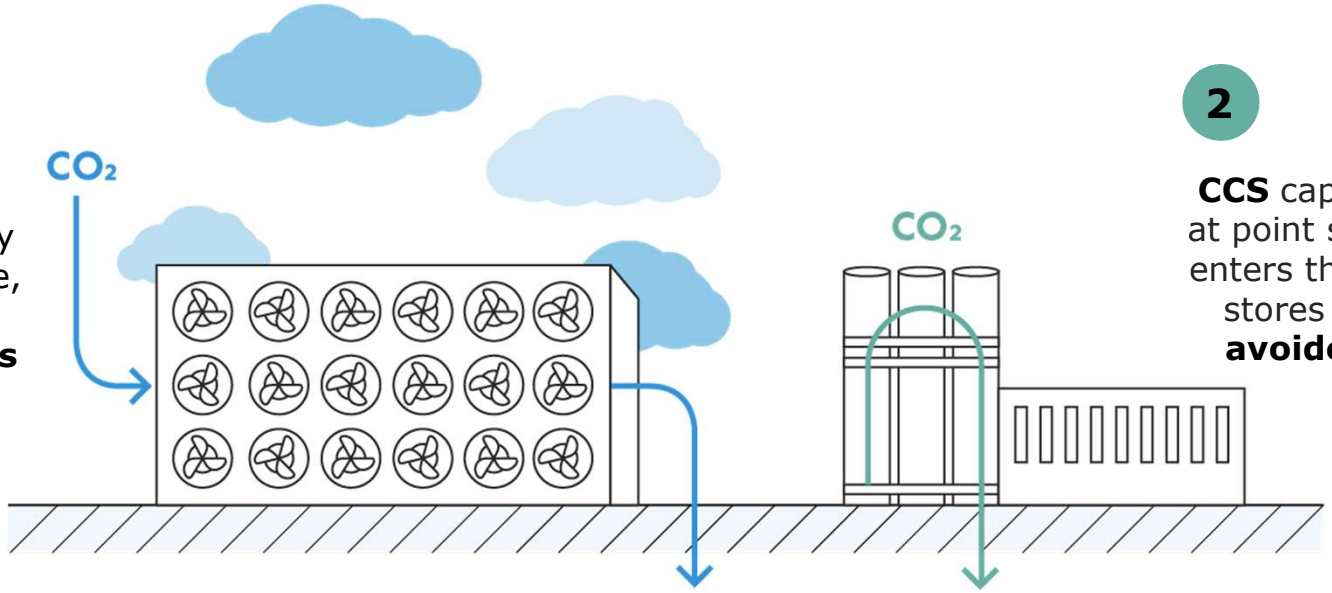
Mineralization: a safe and permanent storage



Direct air capture and storage (DAC+S) vs. carbon capture and storage (CCS)

1

CDR via **DAC+S** removes CO_2 directly from the atmosphere, resulting in **negative emissions**

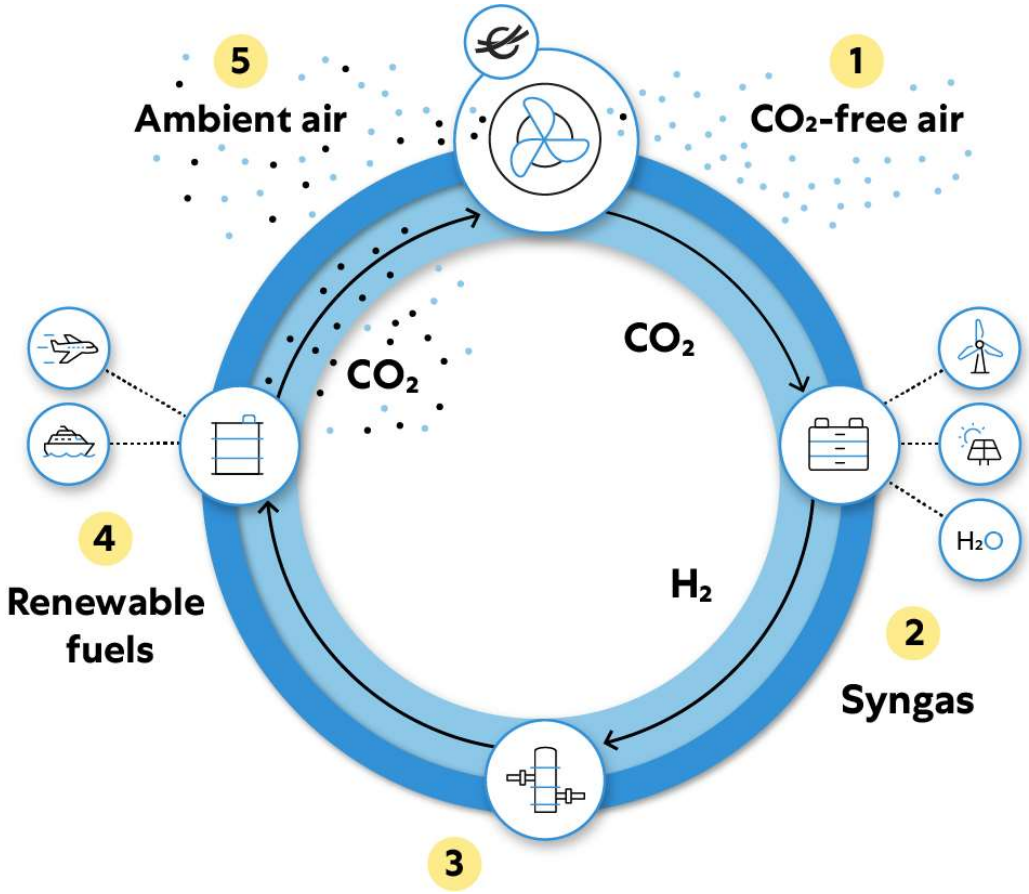


2

CCS captures fossil CO_2 at point sources before it enters the atmosphere & stores it, resulting in **avoided emissions**

Renewable synthetic fuels made from air

1. Climeworks captures pure CO_2 from air
2. Syngas produced from CO_2 and water using 100% renewable energy
3. Fully circular fuels generated from syngas
4. Refined to final product
5. Utilization of fully circular fuels releases CO_2 back into the atmosphere



Orca, our living proof

- The world’s **largest** DAC+S facility
- Started operation in September **2021 in Iceland**
- Nominal capacity of **4'000 tons of CO_2** per year
- Powered 100% by **geothermal energy**
- CO_2 permanently stored underground through **mineralization** (via Carbfix)

200+
Climeworkers
dedicated to reverse climate change

$ 810 million
raised

> 100’000
hours operational experience

< 10%
life cycle emissions
renewable energy powered

Climeworks plans continuous capture capacity increase

Iceland
Hellisheiði

Orca
4’000 tons
per year

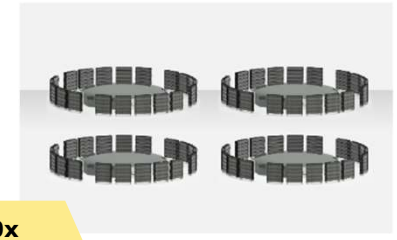
~10x scale-up

Iceland
Hellisheiði

Mammoth
36’000 tons
per year

~10x scale-up

Global



> 400’000 tons
per year

Global

Multi-mega ton range

2021
Enable scale-up

2024
Volume production

Capacity available*
(2027)

2027
Global roll-out

2030
Global roll-out

* Serves as an example and is subject to changes.

Together, we can win the race

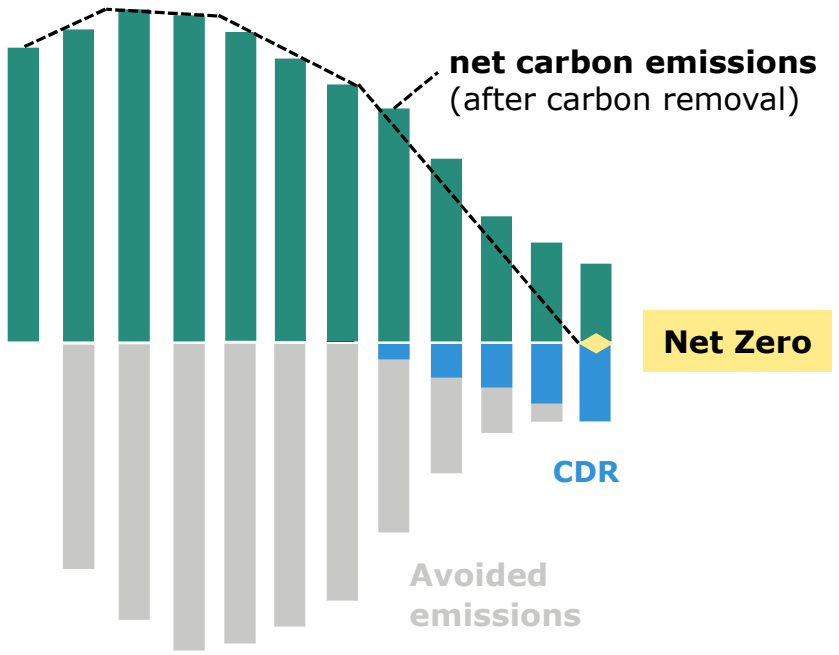
What can companies do?

1. Reduce **emissions** as much as possible

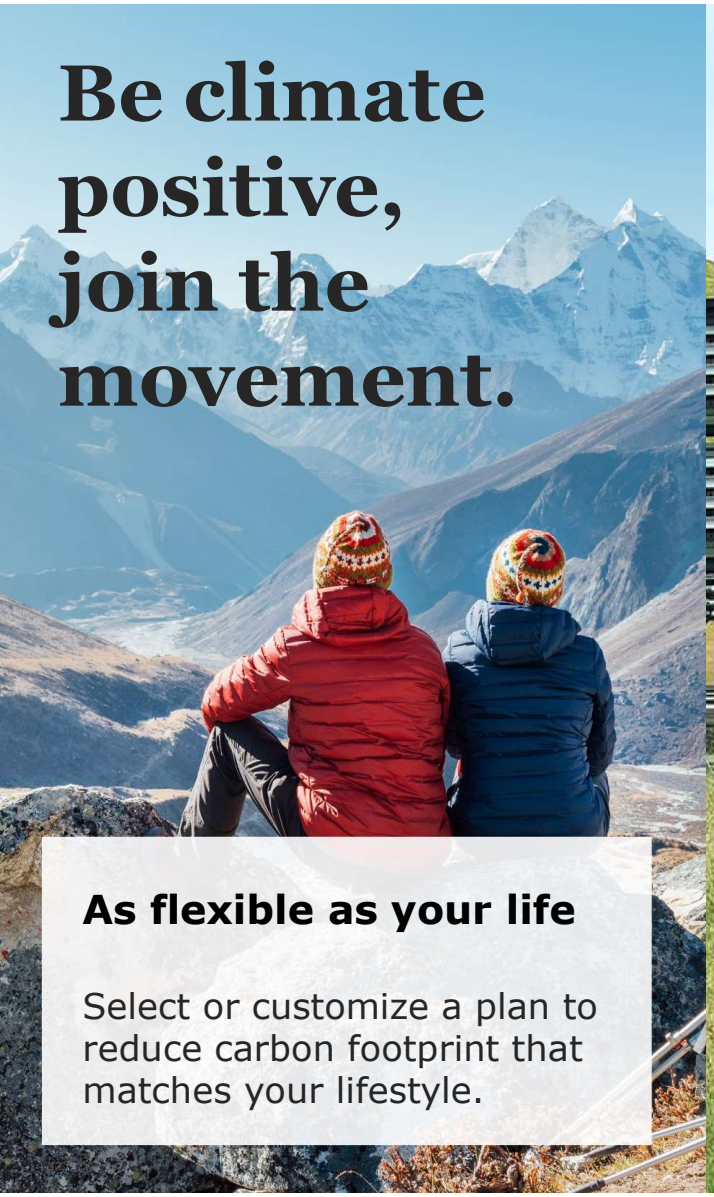
2. Transition your **avoidance credits** to high-quality removal credits

3. Grow your stock of **high-quality carbon dioxide removal (CDR)**

Example of annual corporate carbon emissions

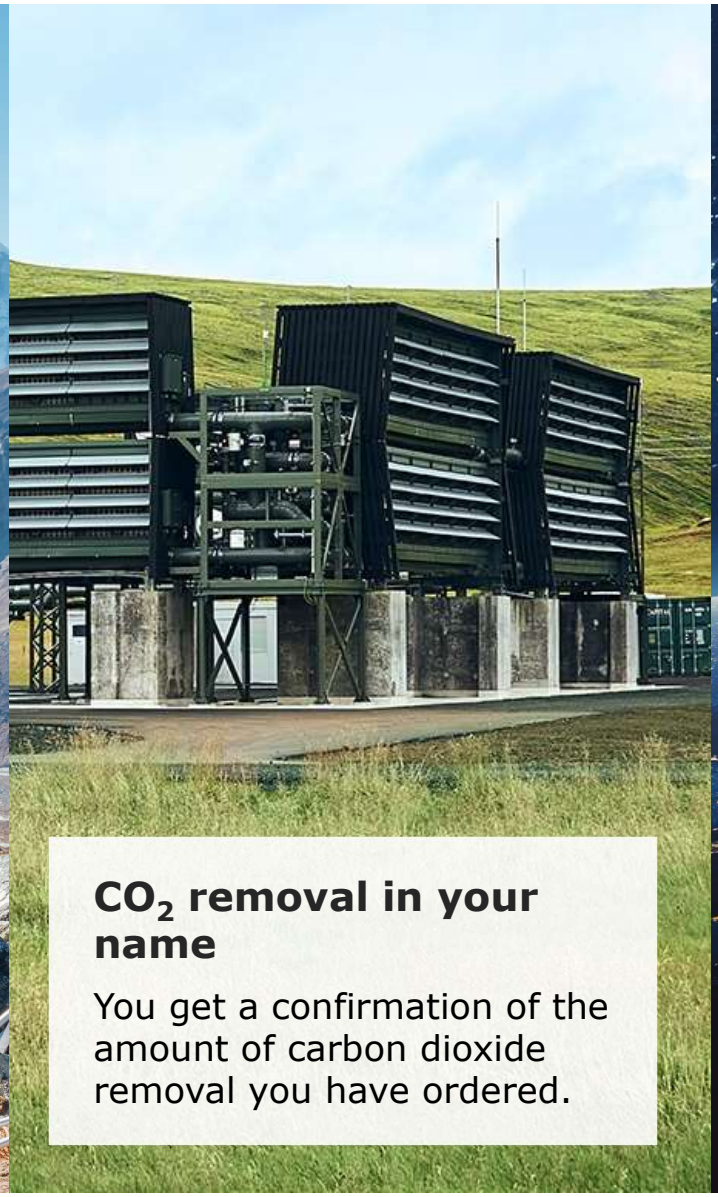


Be climate positive, join the movement.



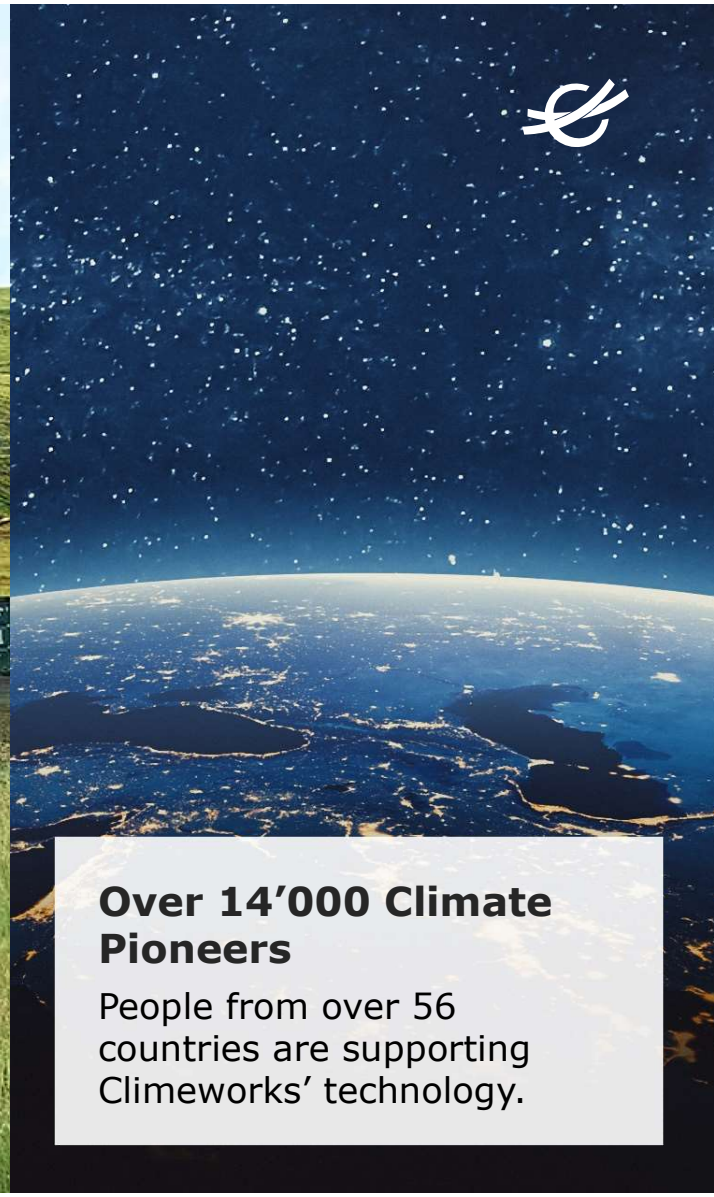
As flexible as your life

Select or customize a plan to reduce carbon footprint that matches your lifestyle.



CO_2 removal in your name

You get a confirmation of the amount of carbon dioxide removal you have ordered.



Over 14’000 Climate Pioneers

People from over 56 countries are supporting Climeworks’ technology.

Lead the race against global warming with Climeworks!

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