



WORLD  
ENERGY  
COUNCIL

# Direct Air Capture

a key technology for Carbon Dioxide Removal

Ordentliche Generalversammlung des Schweizerischen  
Energierates

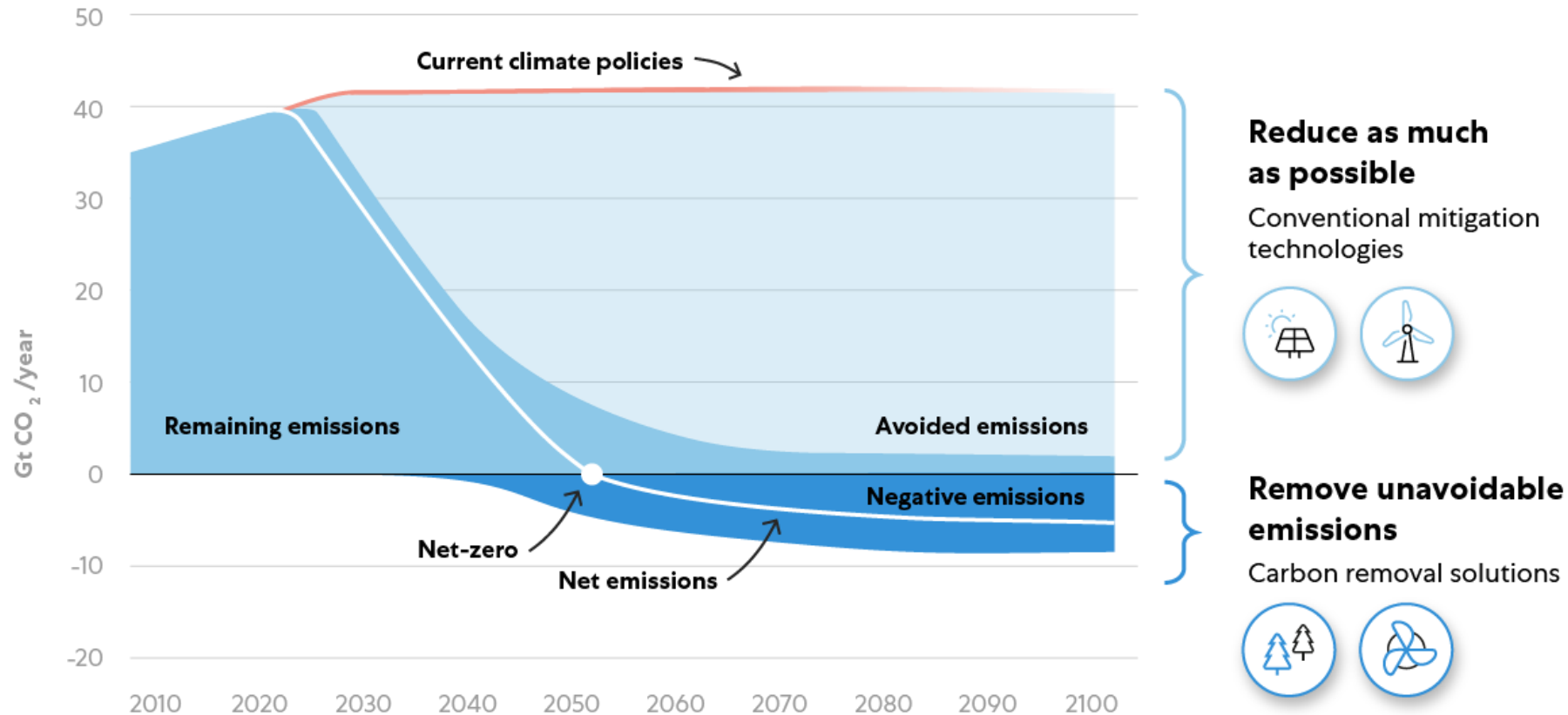
12. Juni 2023



# Why do we need Direct Air Capture?



# Direct air capture: a science-proven need



On top of necessary emissions' reduction, Climeworks provides CDR services to realize negative emissions to address:

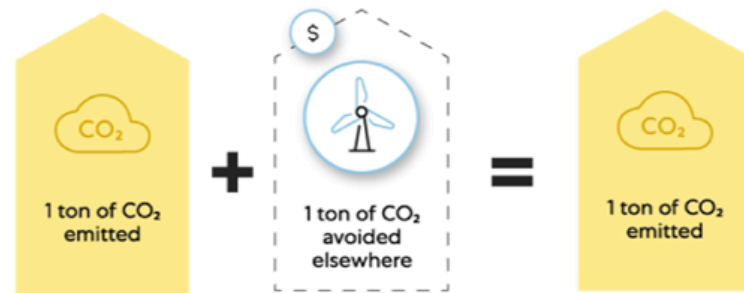
- 1** Your **unavoidable emissions**
- 2** Your **historical emissions**

# Are carbon emissions actually removed?



## Carbon offset

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



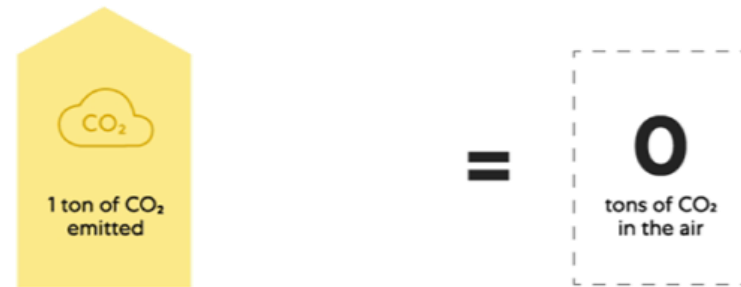
My corporate  
carbon emissions

Carbon neutral

- ✗ Not net-zero goal compatible
- ✗ Your emitted CO<sub>2</sub> remains in the air

## Carbon removal

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



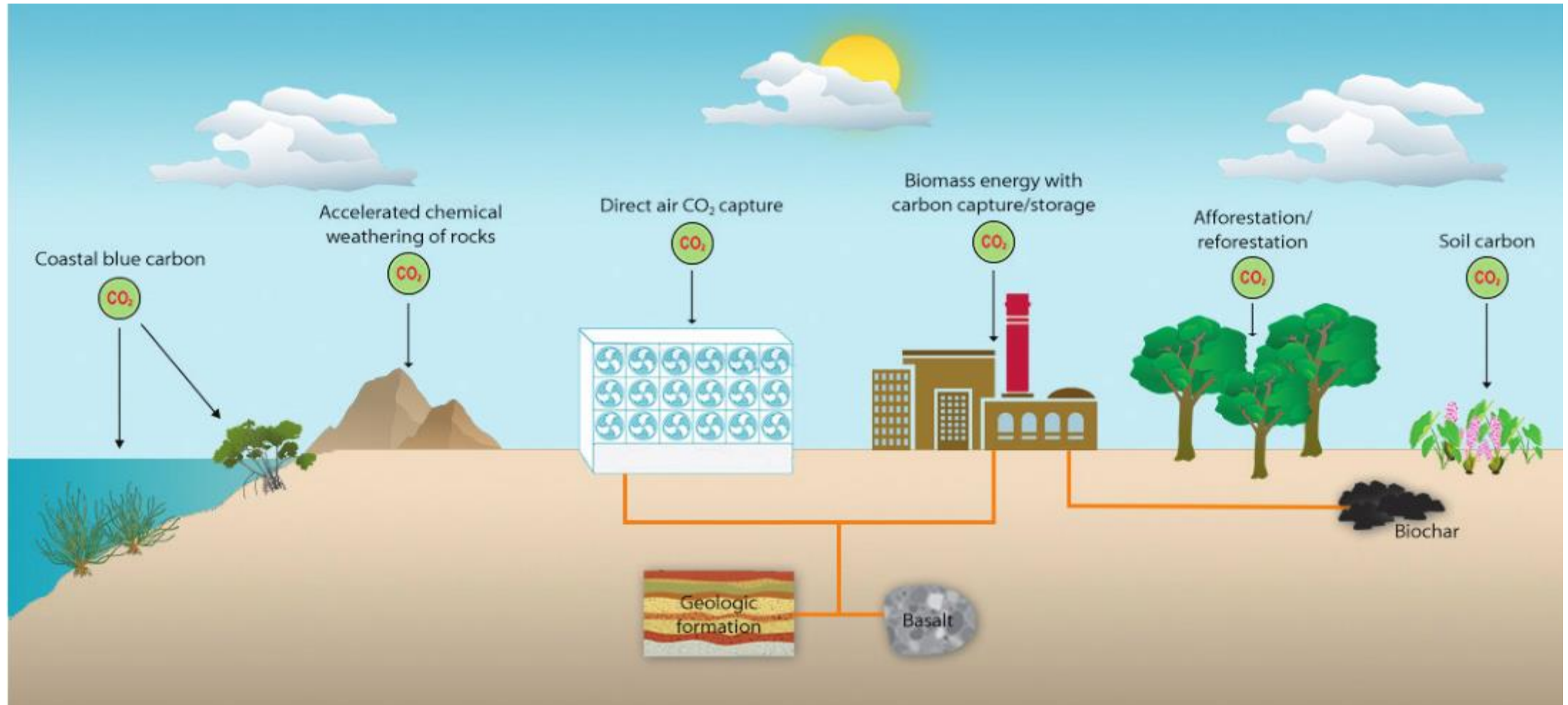
My corporate  
carbon emissions

Net-zero carbon



- ✓ Additionality guaranteed
- ✓ Your emitted CO<sub>2</sub> is removed again from the air

# How to remove CO<sub>2</sub> from the atmosphere?



Climitation





**Area required**  
to remove 8 Gt CO<sub>2</sub> per year

**Water required**  
to remove 8 Gt CO<sub>2</sub> 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 km<sup>2</sup>**  
Europe = 10'500'000 km<sup>2</sup>



**740 km<sup>3</sup>**  
Yearly global freshwater withdrawal 2010 = 4'000 km<sup>3</sup>



**5–50 USD/t CO<sub>2</sub>**



**Biodiversity**



**Albedo**



**Food Security**



### BECCS

Bioenergy in combination with Carbon Capture and Storage.



**2'500'000 km<sup>2</sup>**



**480 km<sup>3</sup>**



**100–200 USD/t CO<sub>2</sub>**



**Biodiversity**



**Albedo**



**Food security**



### Enhanced weathering

Distribution of crushed silicate rocks on soil surfaces to absorb and bind CO<sub>2</sub> chemically.



**220'000 km<sup>2</sup>**



**3 km<sup>3</sup>**



**50–200 USD/t CO<sub>2</sub>**



**River/ocean chemistry**



### Direct air capture

Direct capture of CO<sub>2</sub> from ambient air through engineered chemical reactions.



**15'800km<sup>2\*\*</sup>**



**8 km<sup>3</sup>**  
Potentially zero



**< 200 USD/t CO<sub>2</sub>**



**Minor**



# Climeworks' Direct Air Capture

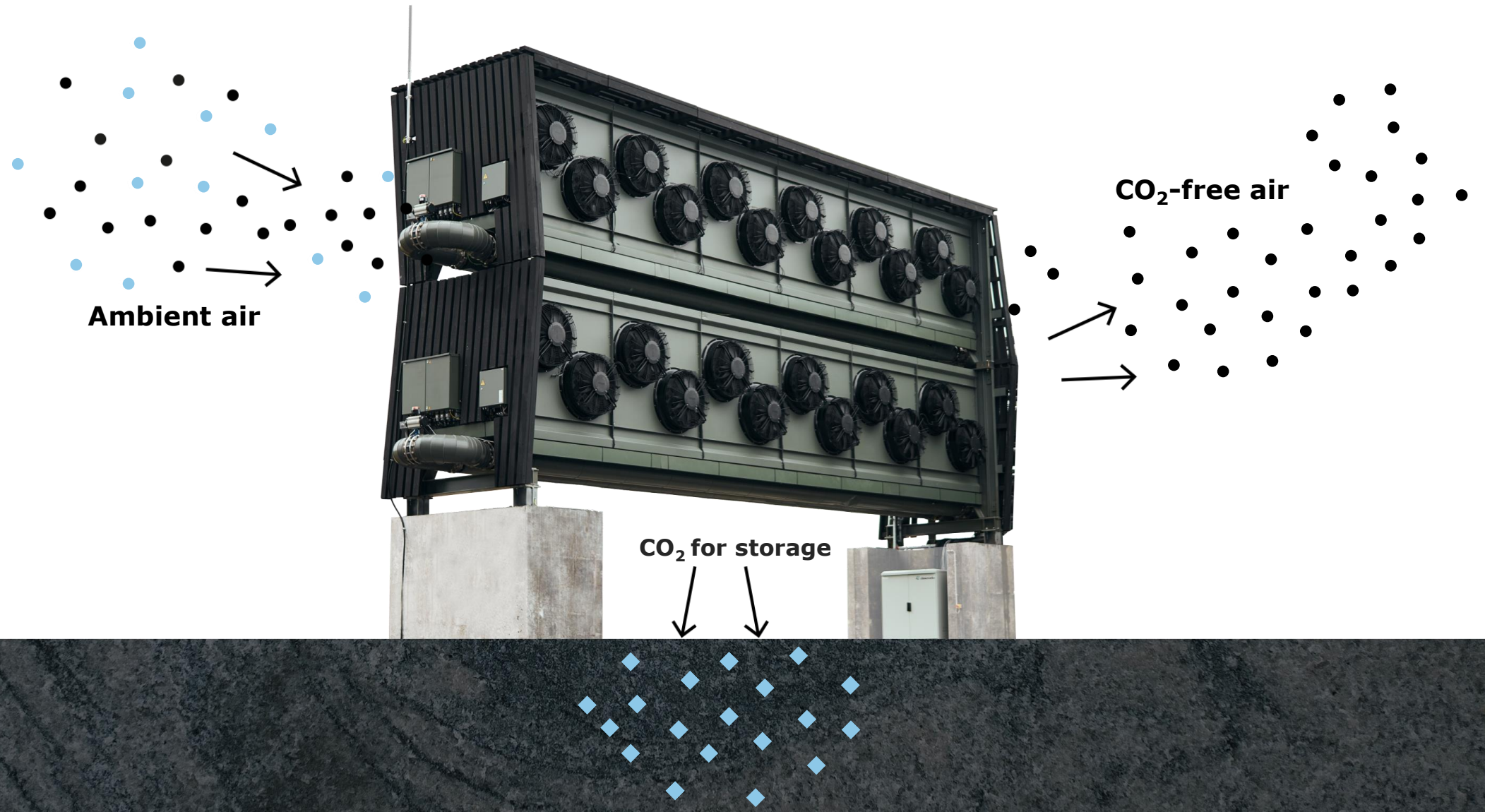








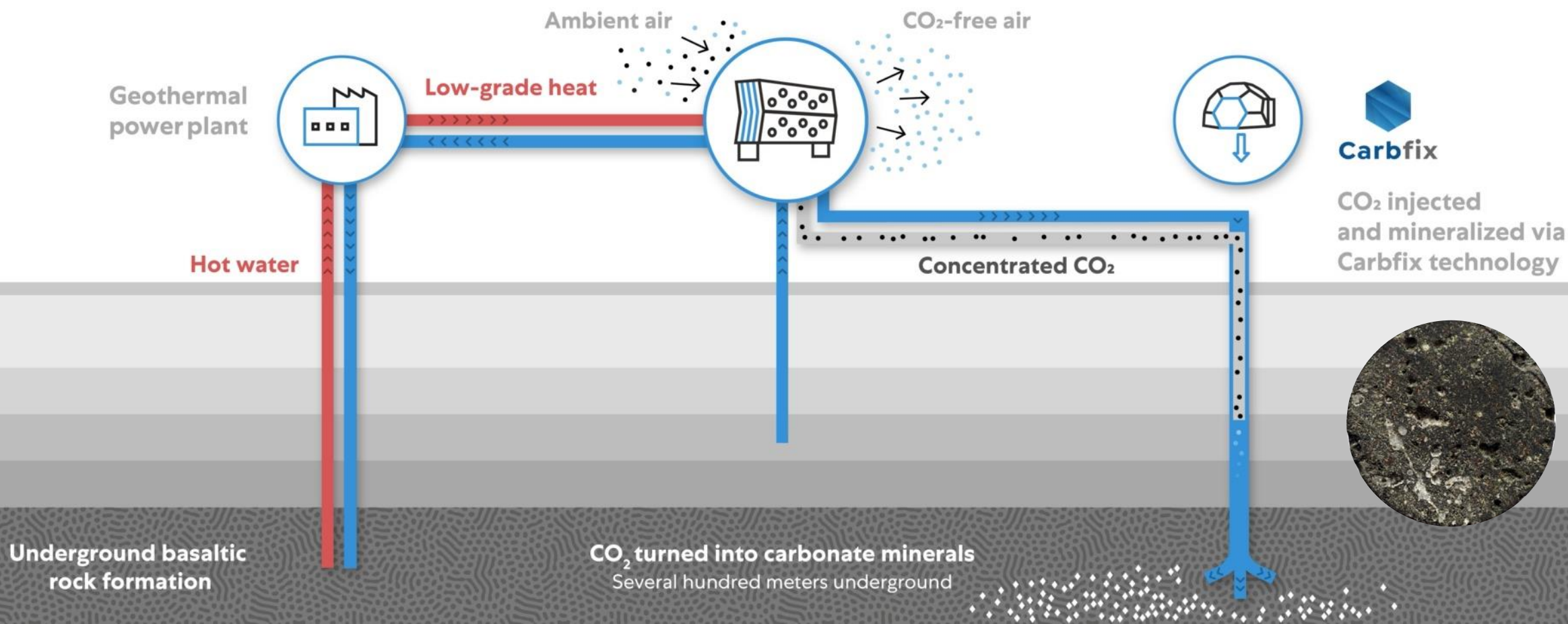
# Capturing CO<sub>2</sub> from the air



# Direct air capture and mineralization



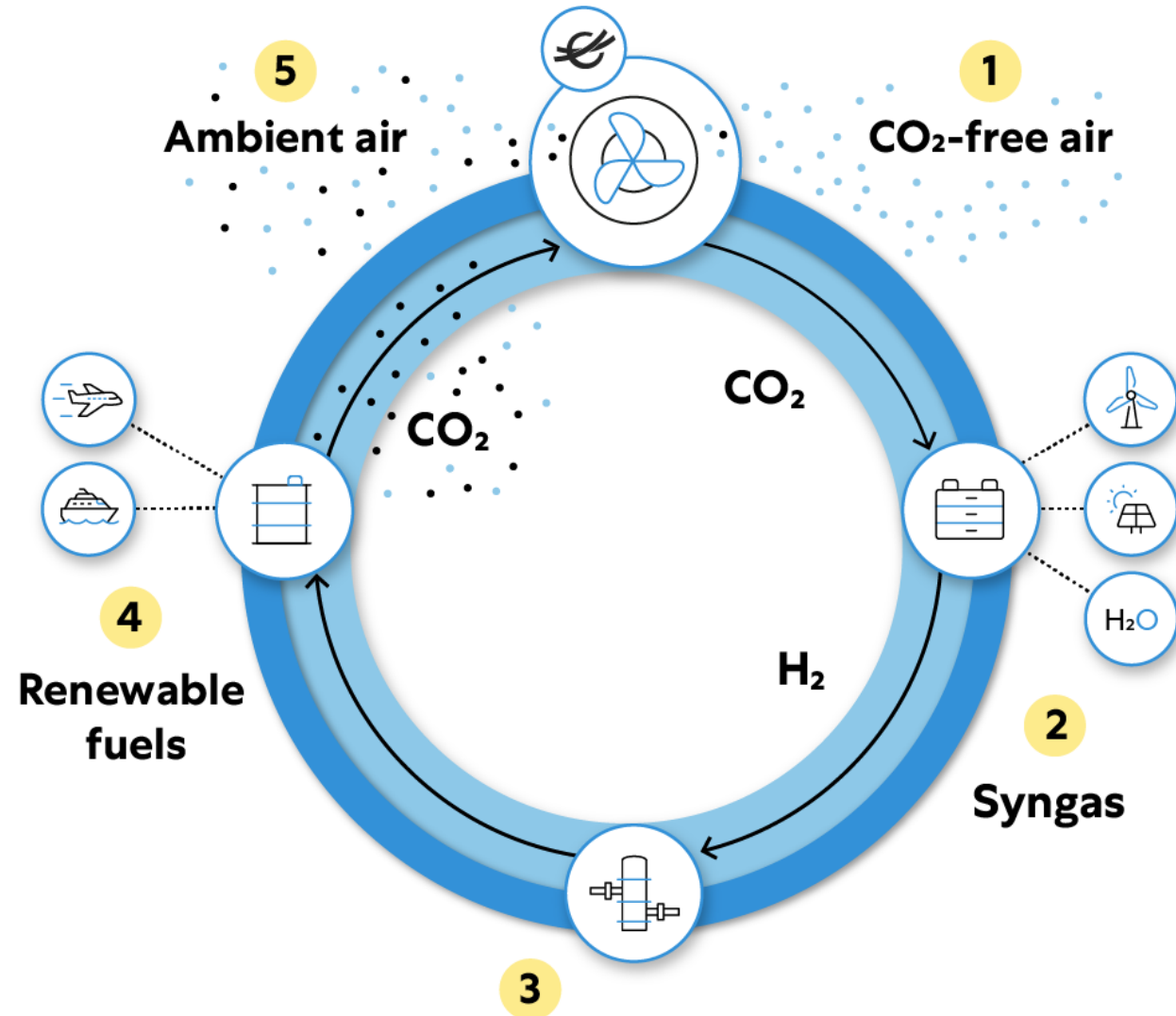
Energy supply, direct air capture and storage with Climeworks' Orca



# Renewable synthetic fuels made from air

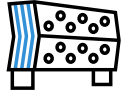


- 1** Climeworks captures pure CO<sub>2</sub> from air
- 2** Syngas produced from CO<sub>2</sub> and water using 100% renewable energy
- 3** Fully circular fuels generated from syngas
- 4** Refined to final product
- 5** Utilization of fully circular fuels releases CO<sub>2</sub> back into the atmosphere





# Orca, our living proof



The world's **only** commercial direct air capture & storage facility



Started operation in September **2021**



Nominal capture capacity of **4,000 tons of CO<sub>2</sub>** per year



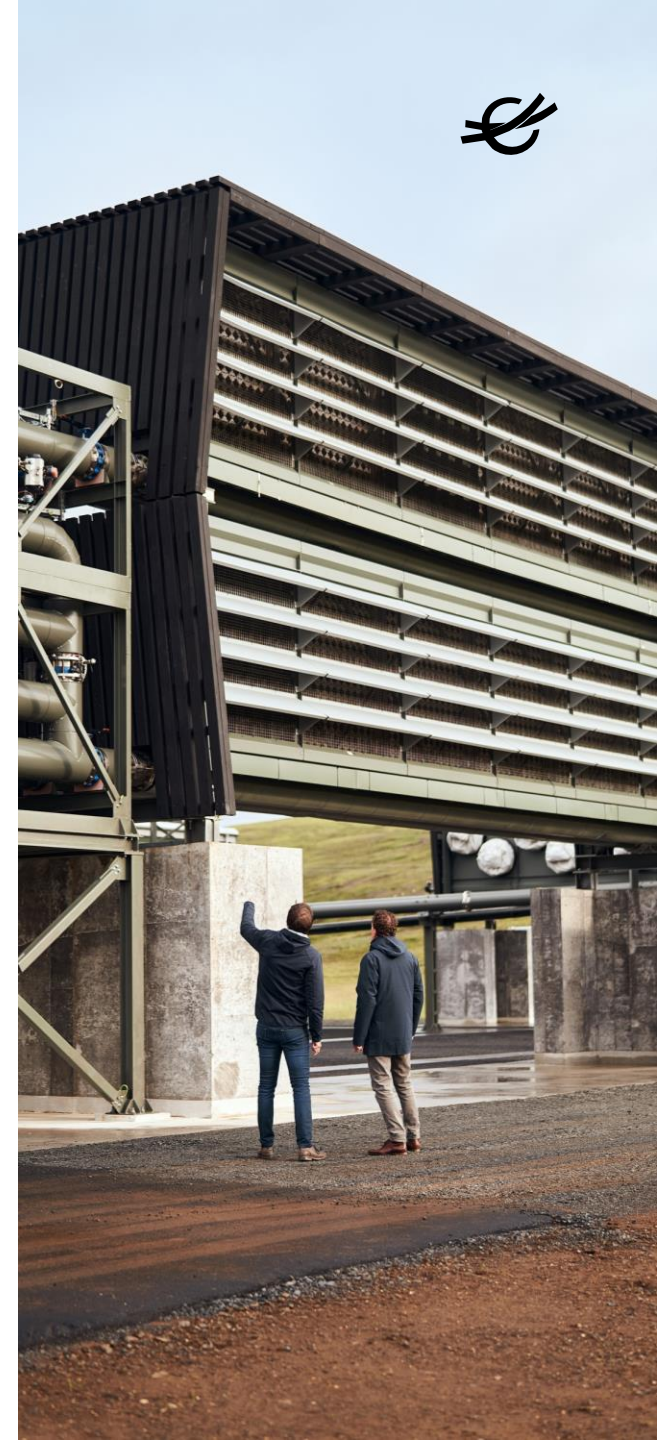
Located in **Iceland**



Powered 100% by **geothermal energy**



CO<sub>2</sub> permanently stored underground through **mineralization** (via Carbfix)





# What's next?



**Mammoth**, Climeworks' newest and largest DAC+S plant; **36,000 tons of CO<sub>2</sub>** as nominal capture capacity per year.



The construction is expected to last 18-24 months before **operations start in 2024**.

- Jun 2022: **Groundbreaking** in Iceland.
- Dec 2022: **Construction hall** completed.



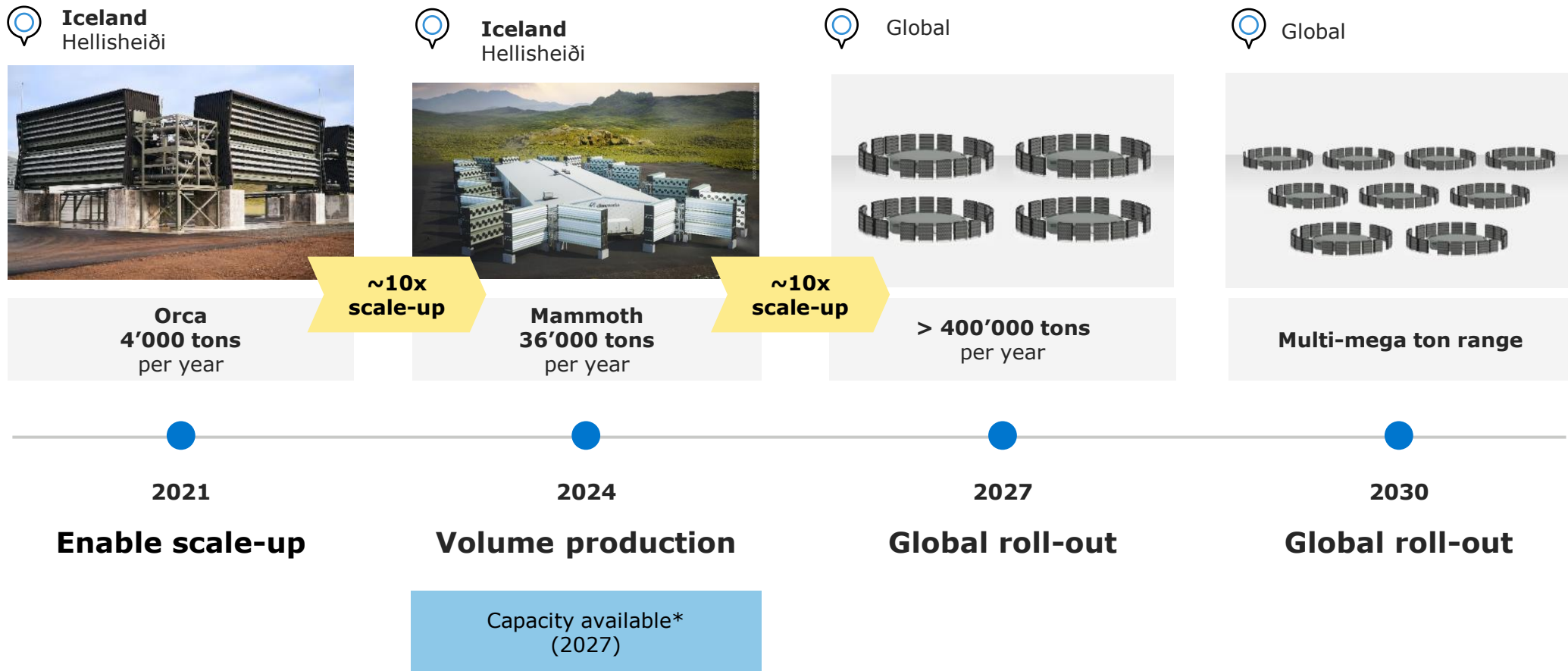








# Climeworks plans continuous capture capacity increase



\* Serves as an example and is subject to changes.



**Lead the race against  
global warming with Climeworks!**







## **Climeworks AG**

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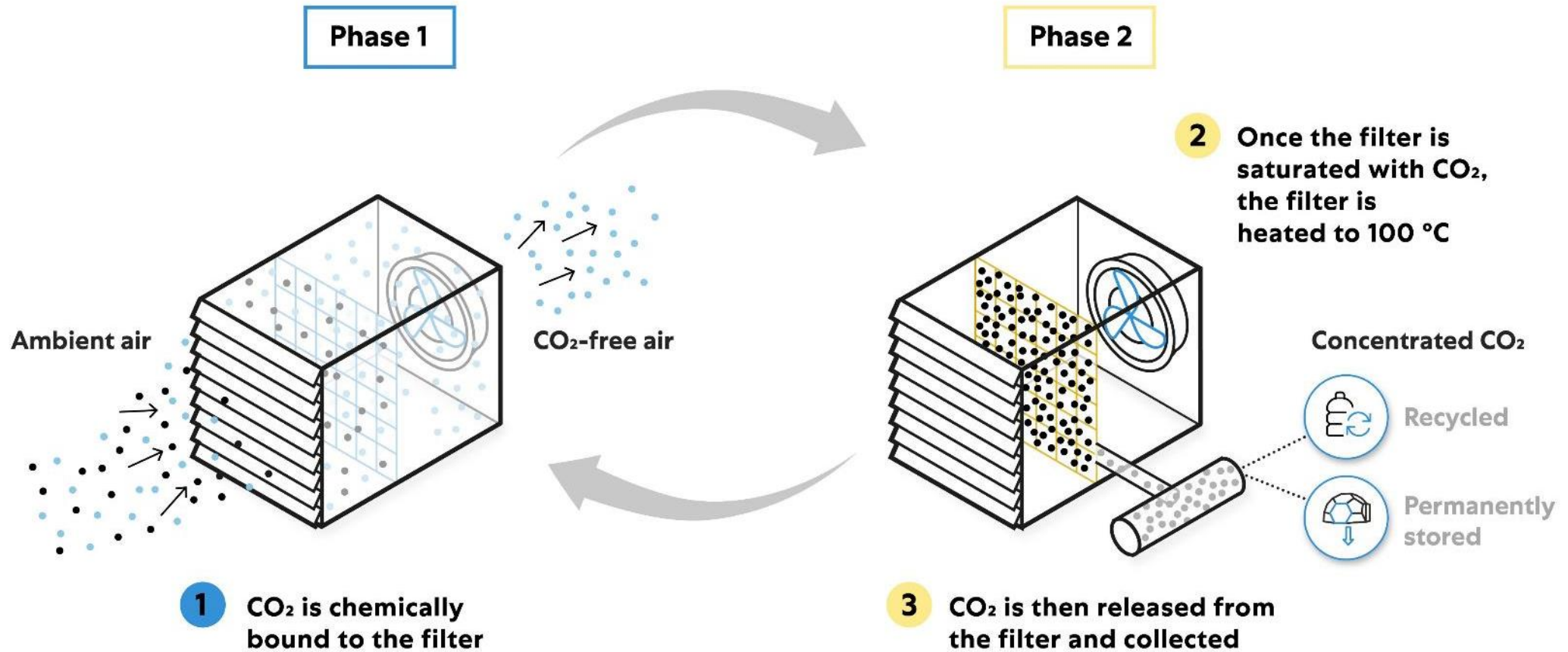
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# How our technology works

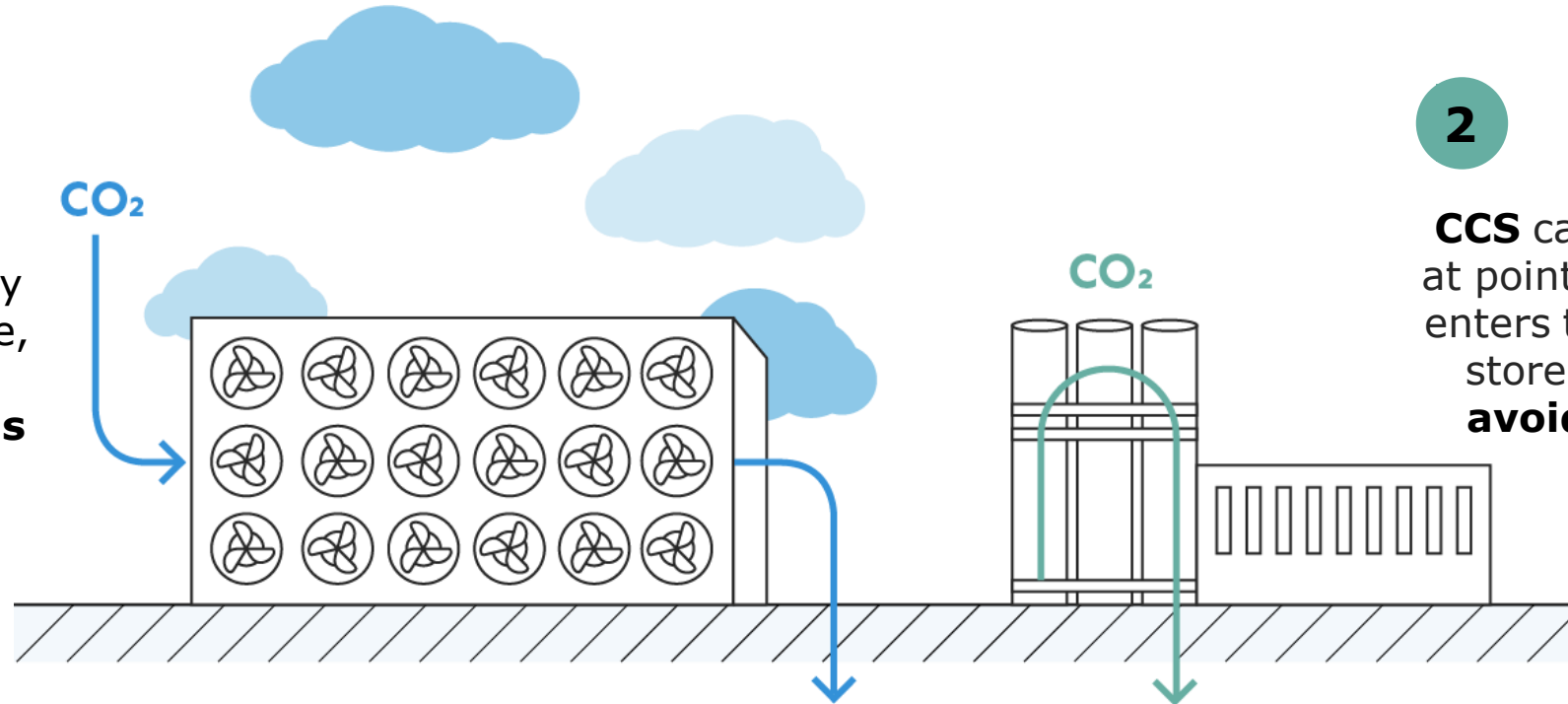


# Direct Air Capture and Storage (DAC+S) vs. Carbon Capture and Storage (CCS)



1

CDR via **DAC+S** removes CO<sub>2</sub> directly from the atmosphere, resulting in **negative emissions**



2

**CCS** captures fossil CO<sub>2</sub> at point sources before it enters the atmosphere & stores it, resulting in **avoided emissions**