DIRECT AIR CAPTURE (DAC)

Technology to remove CO_2 from Air

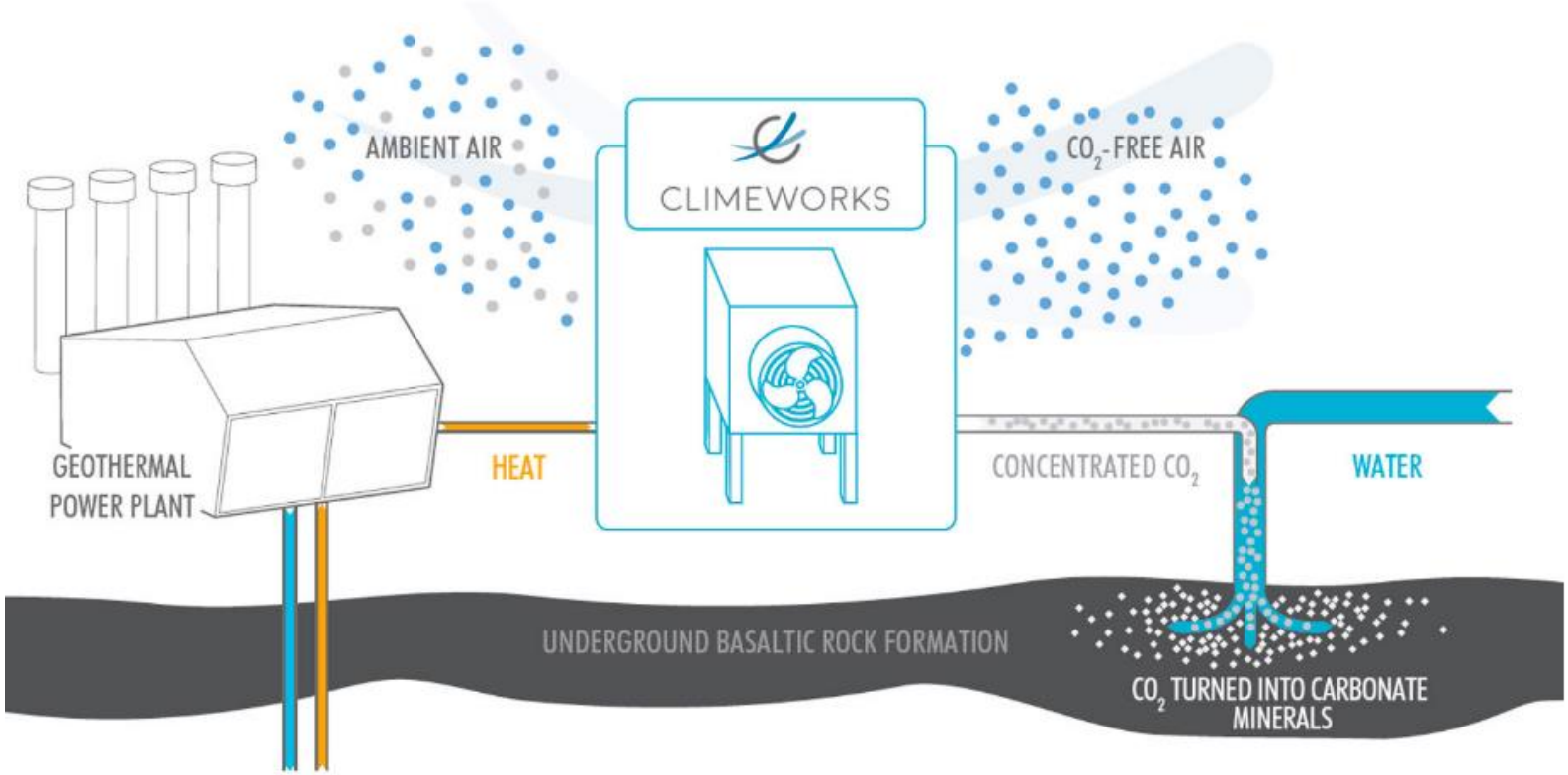
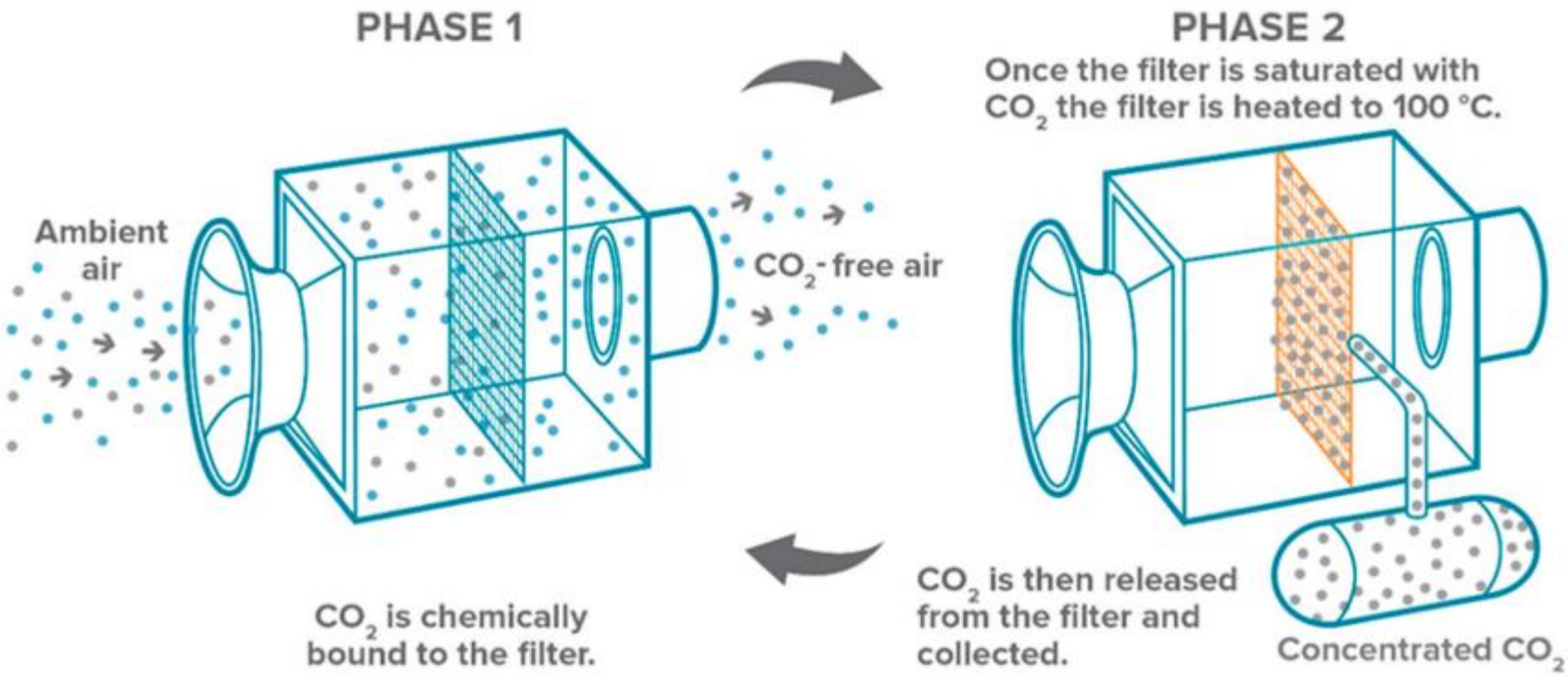


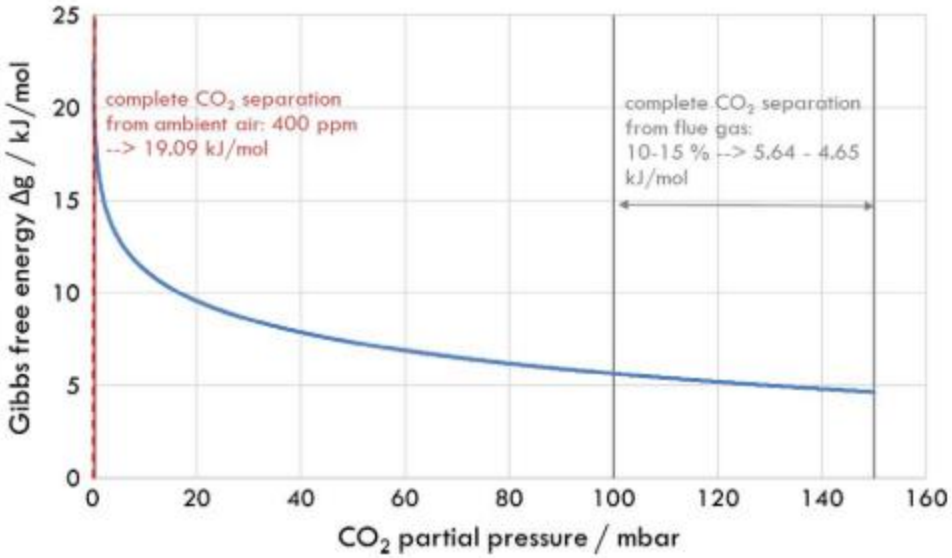
Fig. 3. Schematic illustration of the Climeworks-CarbFix injection at Hellisheidi, Iceland

How does it work?



Features

- Very challenging:
  - Very low CO2 concentration (400ppm)
  - Ambient T and P
  - Very large volumes of air must be “moved”
- Inherently high energy (“only” 4 times more than CCS)



Touted Benefits

- Can be located anywhere, particularly close to sequestration site
- Can be placed in “windy” areas where fan energy can be reduced
- “out of the way” to maximize footprint

Techno-Economics and Footprint

- Large number of studies reporting costs from \$20/t CO_2 to \$1300/t CO_2 with most clustering from \$600-\$1000
- Investment costs of ~ \$3b per 1Mtpa CO2
- Energy costs ~4 times larger than conventional CCS
- For the CO2 separation plant with a capacity of 14150 tCO2/a, a land requirement of 600m2 was estimated
- Australia's emission is 133 MtCO2e pa – 10% reduction by DAC would mean plant size of ~10 times the Loy Yang B power plant and ~\$40bn

Krekel, D.; Samsun, R. C.; Peters, R.; Stolten, D., The separation of CO 2 from ambient air – A techno-economic assessment. Applied Energy 2018, 218, 361-381.

Current Status

TABLE 5.1 Companies Working to Commercialize Direct Air Capture Systems

Company	System Type	Technology	Regeneration	Purity/ Application	Scale
Carbon Engineering	Liquid solvent	Potassium hydroxide solution/calcium carbonation	Temperature	99%	Pilot 1 t/d
Climeworks	Solid sorbent	Amine-functionalized filter	Temperature or vacuum	99% w/dilution depending on application	Demonstration 900 t/y
Global Thermostat	Solid sorbent	Amine-modified monolith	Temperature and/or vacuum	99%	1,000 t/y
Infinitree	Solid sorbent	Ion-exchange sorbent	Humidity	3-5% algae	Laboratory
Skytree	Solid sorbent	Porous plastic beads functionalized with benzylamines (Alesi and Kitchin, 2012)	Temperature	Air purification, greenhouses	Appliance