DIRECT AIR CAPTURE (DAC)
Technology to remove CO$_2$ from Air

Fig. 3. Schematic illustration of the ClimeWorks-CarbFix injection at Hellisheiði, Iceland
How does it work?

**PHASE 1**

- Ambient air
- CO₂ is chemically bound to the filter.

**PHASE 2**

- CO₂ is then released from the filter and collected.
- CO₂ is then collected.
- Concentrated CO₂

Once the filter is saturated with CO₂, the filter is heated to 100 °C.
• 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
• Large number of studies reporting costs from $20/t CO₂ to $1300/t CO₂ 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
**TABLE 5.1** Companies Working to Commercialize Direct Air Capture Systems

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