CO_2 capture from atmospheric air – commonly referred to as direct air capture (DAC) – can address CO_2 emissions released by the transportation sector, other distributed sources and emissions from the past. It can be coupled with CO_2 storage to reduce the atmosphere's CO_2 content (carbon dioxide removal technology), or with the conversion into CO_2-neutral liquid or gaseous hydrocarbon fuels using renewable energy (renewable fuels). On the one hand such renewable fuels are CO_2-neutral and on the other hand the concept of hydrocarbon fuel synthesis from CO_2 offers the potential to store renewable energy in the form of a chemical fuel, which can be stored, transported and used in today's hydrocarbon energy infrastructure without limitation. Upon combustion of renewable fuels CO_2 is emitted back to the atmosphere which can be re-captured at an arbitrary location by a DAC plant, thus closing the carbon material cycle. In the short term, DAC in combination with technologies for hydrocarbon fuel synthesis constitutes a scalable, location independent and CO_2-neutral possibility to store, transport and use renewable energy which is fully compatible with the existing energy system. In the long term, DAC may become indispensable for stabilizing the global CO_2 concentration in the atmosphere in view of continuously increasing emissions above threshold limits. More than 85% of IPCC modeling scenarios consistent with 2°C of warming involve large scale deployments of negative emission technology.

Generally DAC proceeds via exothermic sorption of atmospheric CO_2 by a chemical sorbent followed by its subsequent endothermic regeneration. Because of the need to process at least 2600 moles air per mole of CO_2 captured, the feasibility of the chemical DAC system will be strongly dependent on its ability to capture CO_2 in the presence of moisture without heating, cooling or compressing the air stream. Amine-functionalized adsorbents are especially suitable for this purpose, since amines react selectively with atmospheric CO_2 in the presence of moisture at ambient temperature and pressure while it has been experimentally shown that high purity CO_2 can subsequently be released in one step through temperature-vacuum-swing desorption.

Climeworks offers solutions for efficiently capturing CO_2 from air based on a cyclic adsorption/desorption process on amine-functionalized adsorbents. During adsorption, atmospheric CO_2 is chemically bound to the sorbent's surface. Once the sorbent is saturated, the CO_2 is driven off the sorbent by heating it to 100 °C, thereby delivering high-purity gaseous CO_2. The CO_2-free sorbent can be re-used for many adsorption/desorption cycles. The beauty of the process is the fact that above 80% of the energy demand (2000-2500 kWh/t CO_2) can be supplied by heat at 100°C; the remaining energy is required in the form of electricity for pumping and control purposes.

Climeworks will present opportunities how DAC can be an attractive source for CO_2 for the production of renewable fuels.