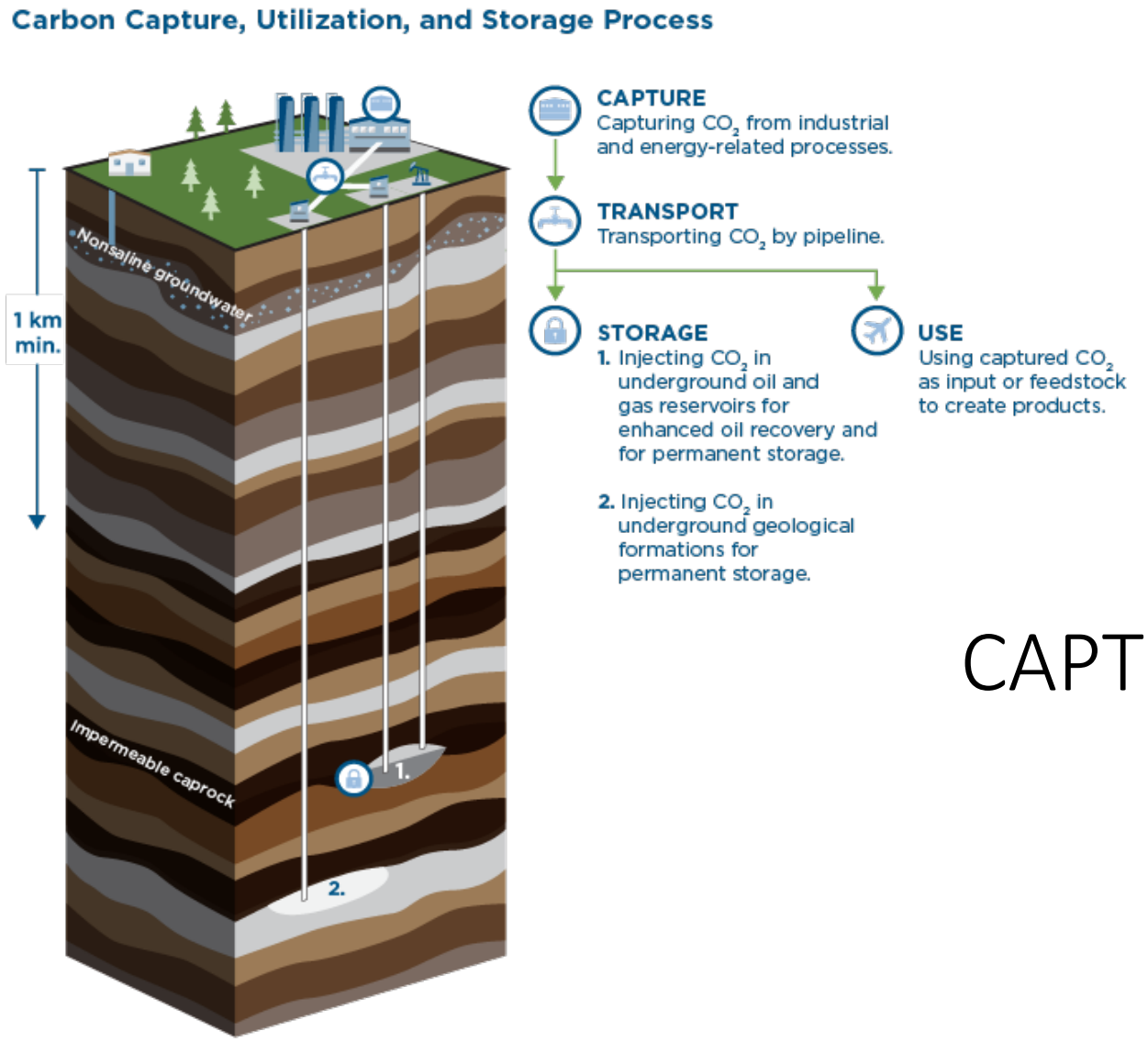
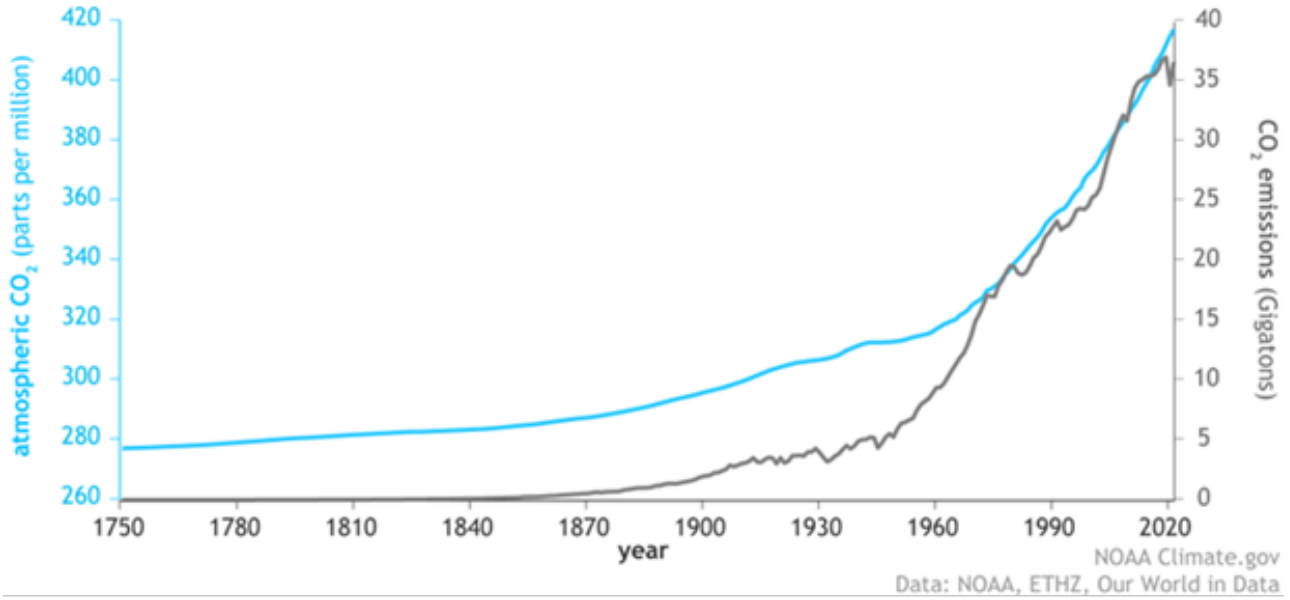


CO2 CAPTURE AND SEGREGATION TECHNOLOGIES

The use of fossil fuels for energy generation has always brought most human activities to release large quantities of carbon dioxide into the atmosphere.

In order to reach as soon as possible the goals established in 2015 by the Paris Agreement, it is clear the need to introduce additional technologies to expand the current renewable sources landscape.



Some singificant projects are:

- SFERO project (ZECOMIX infrastructure and the european ECCSELERATE project)
- SLEIPNER project
- WEYBURN project

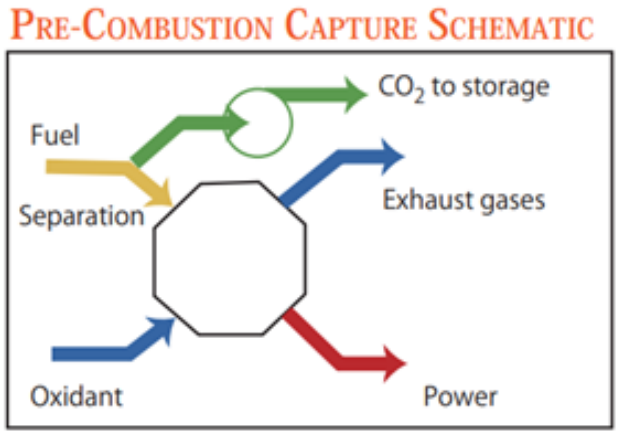
The main CO2 capture technologies can be divided into:

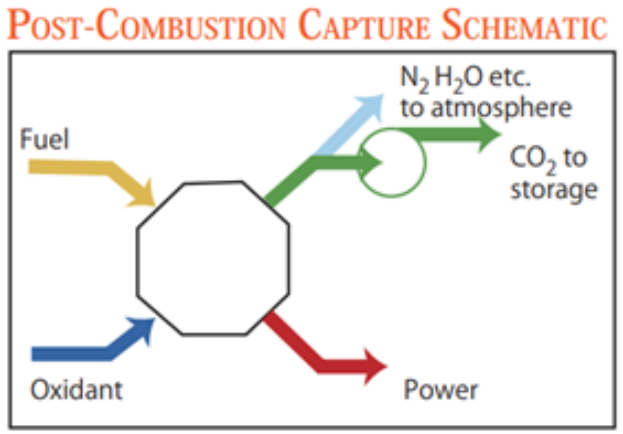
- Post-Combustion Capture
- Pre-Combustion Capture
  the fuel is processed in a gasifier reactor to produce syn-gas rich in hydrogen and carbon monoxide, which is then treated in a shift reactor to obtain a gas flow consisting only of hydrogen and CO2 (that can be separated)

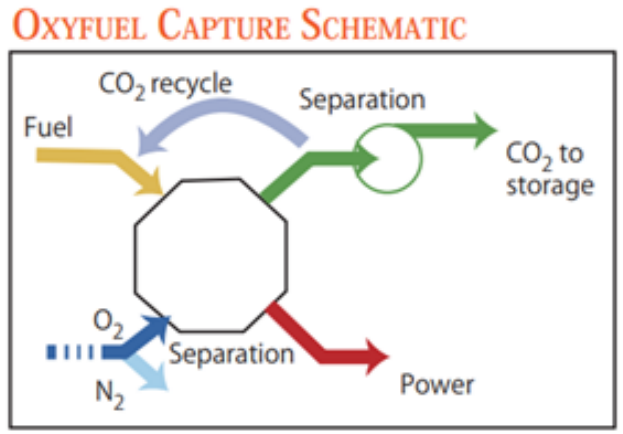
$$CH_4 + H_2O \rightarrow CO + 3H_2 \quad (1)$$

$$CO + H_2O \rightarrow CO_2 + H_2 \quad (2)$$

- Oxyfuel Capture







ITALY'S SITUATION

S2C2 (Enel)

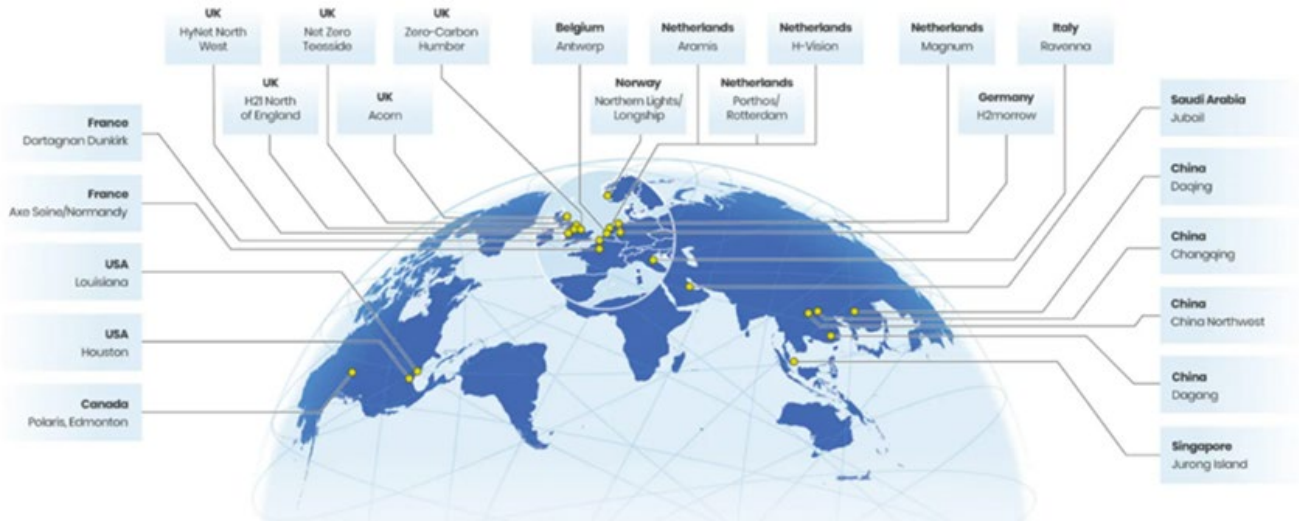
The plant, which consists of 4 adsorption/desorption units, each containing about 160 kg of sorbent, can treat up to 100 Nm3/h of combustion fumes.

Characteristics:

- good absorption capacity between 25 and 40°C (50 gCO2/kg of sorbent)
- ability to regenarate at a temperature of 85°C
- no reduction in adsorption efficiency

Ravenna CCS Hub (Eni)

Starting from an initial annual storage capacity of 4 Mt/CO2, the plant will be able to reach a total storage capacity of 500 Mt/CO2.



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CARBON DIOXIDE REMOVAL STRATEGIES

Among the types of carbon biological sequestration, which consists in the storage of carbon in «carbon pools» through continuous biological processes and/or enhanced biological processes, we can list afforestation and reforestation, supported by a sustainable forests management (Glasgow Leaders' Declaration on Forests and Land Use – COP 26); but also the Direct Air Carbon Capture and Storage (DACCS) and the Bioenergy with Carbon Capture and Storage (BECCS).

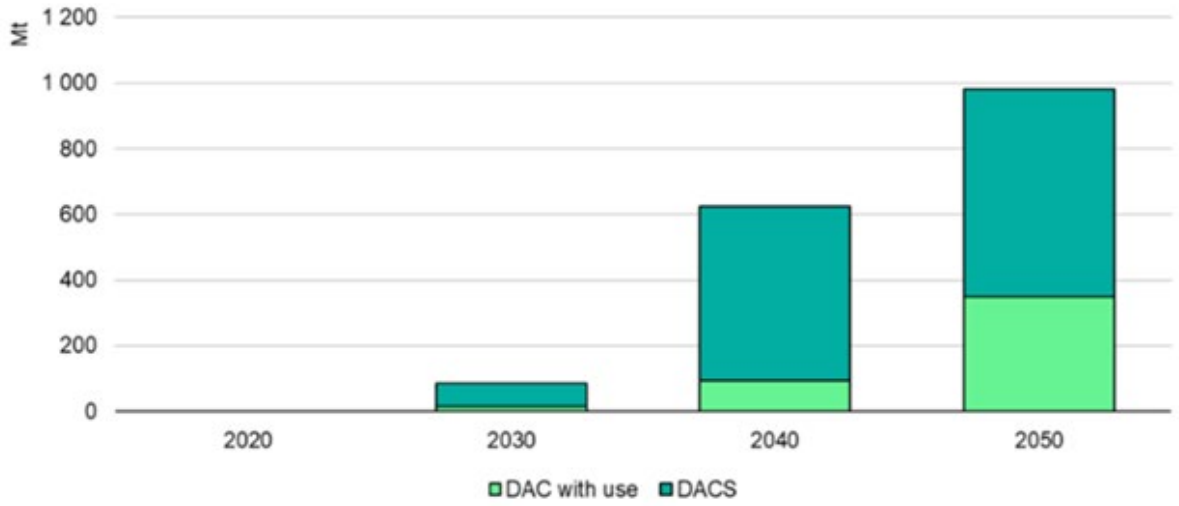
Afforestation and reforestation

The European Union is trying to take advantage of the fact that its forests are able to absorb the equivalent of about 7% of all greenhouse gases emitted by the EU every year: recently the European Parliament endorsed the Committee's proposal to improve natural carbon wells in the LULUCF sectors, in order to icrease the 2030 greenhouse gas reduction target to 57%, currently set at 55% of the emissions compared to the 1990 values (515.2 MtCO2eq).

Direct Air Carbon Capture and Storage

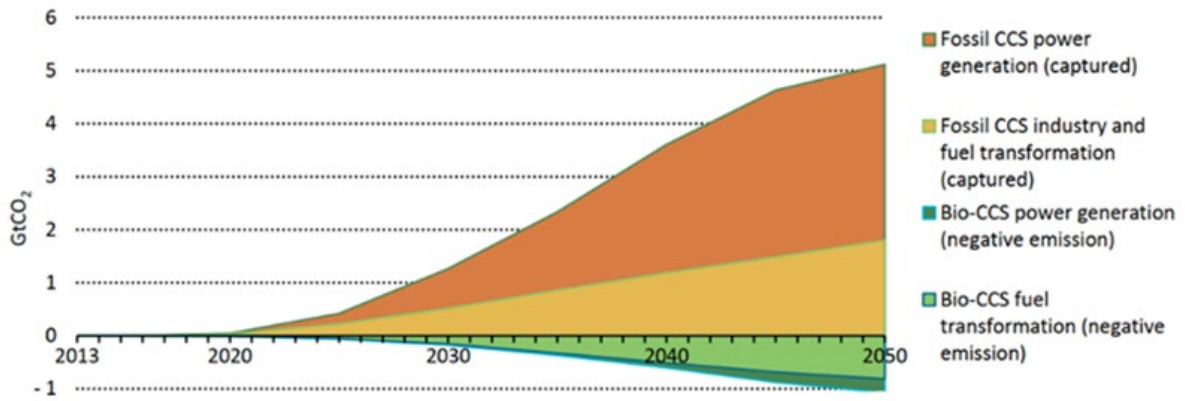
It's an emergent technology that consists in capturing the CO2 directly from the air through an engineered mechanical system which currently has a TRL equal to 6, therefore it has a significant potential for performance improvement and cost reduction (which are still very high given the lower concentration of CO2 in the atmosphere).

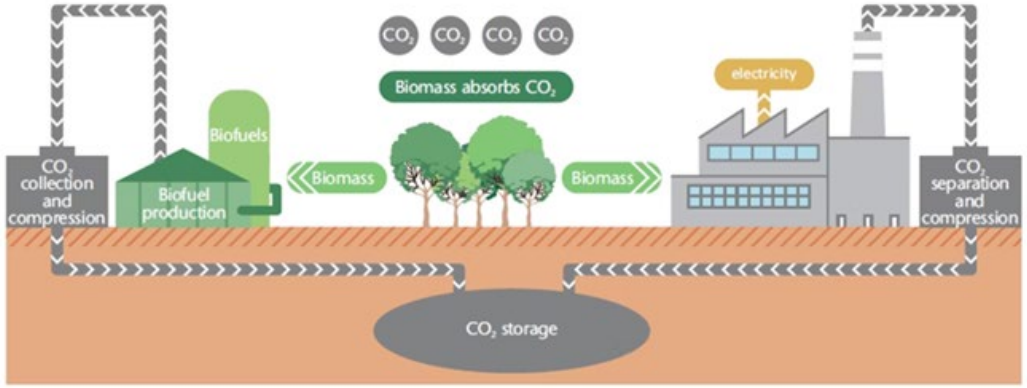
DACCS is a solution already taken into consideration in the IEA report "Net Zero by 2050: A Roadmap for the Global Energy Sector", where it is expected to develop from about 85 MtCO2 captured per year in 2030, reaching 620 MtCO2/year in 2040 up to 980 MtCO2/year in 2050.



Bioenergy with Carbon Capture and Storage

In the IEA 2DS scenario, BECCS provides around 14 Gt of «negative emissions» in the period up to 2050 and in particular 1,1 GtCO2 in 2050 (16% of the 6 GtCO2 captured for that year).





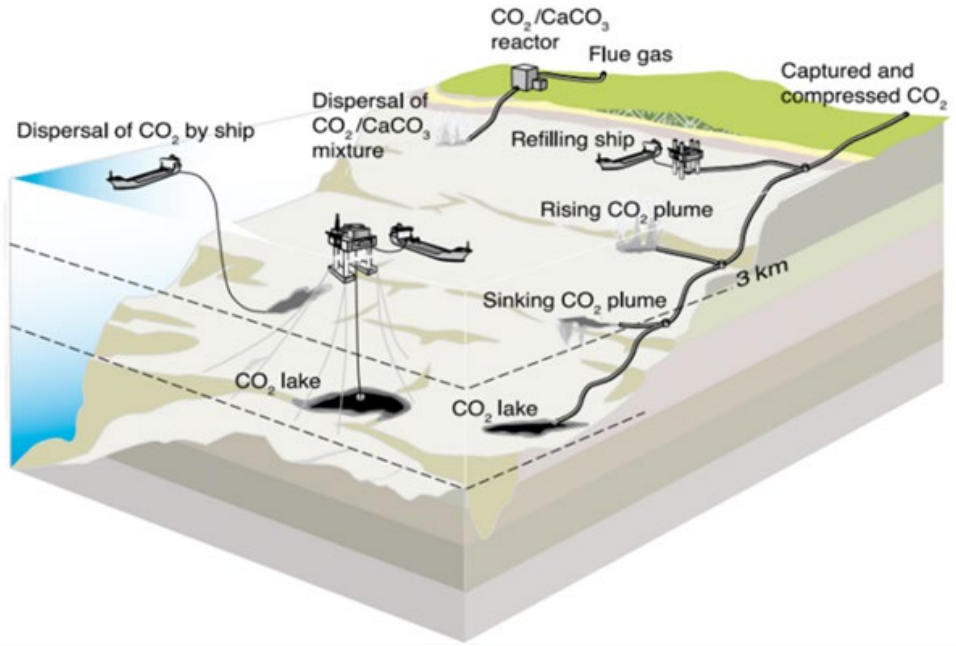
Biomass absorbs CO2 as it grows and when it is burned to produce energy, it is released back into the atmosphere thus creating a complete cycle with a neutral impact, so if we combine this solution with the CO2 capture and storage process, part of it will permanently be removed from the atmosphere.

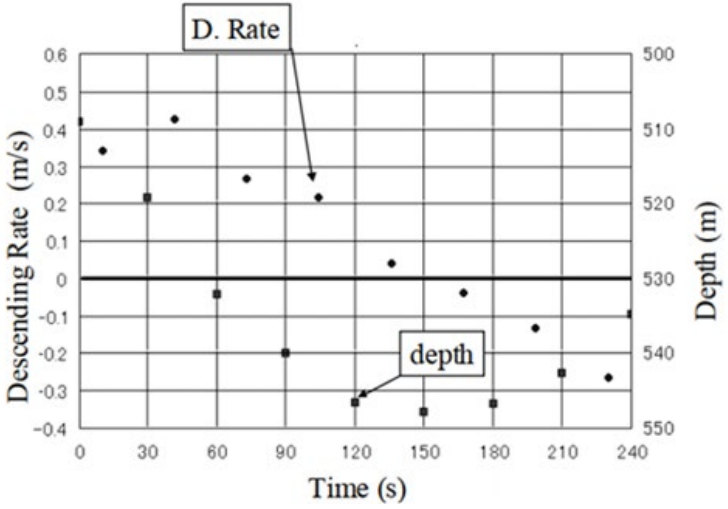
The world's first large-scale project was the Illinois Basin Decatur Project, who eventually became the Illinois Industrial CCS Project.

OCEAN STORAGE

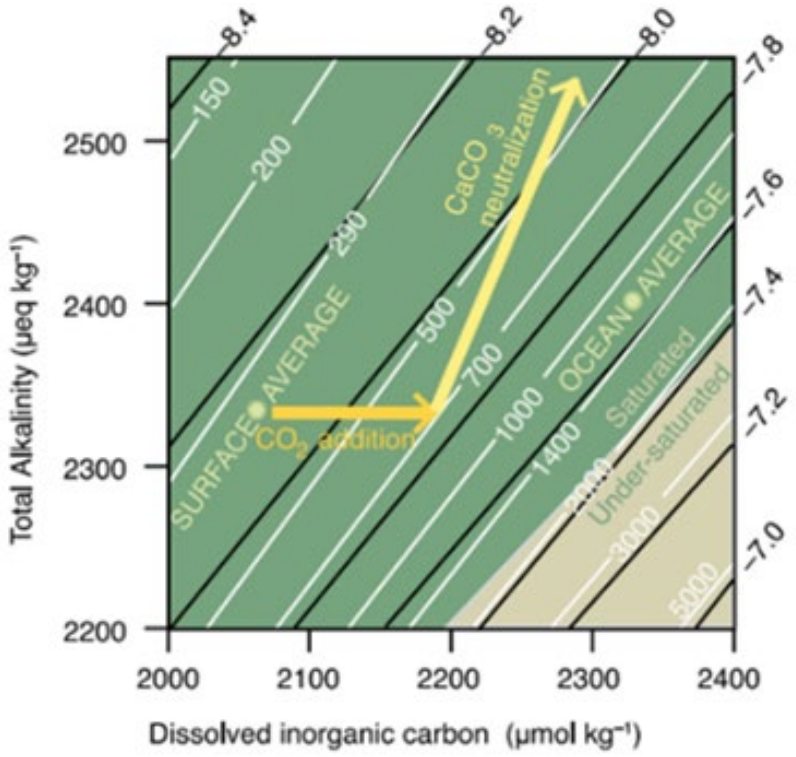
The concept behind this strategy is to take a relatively pure stream of CO2 (previously treated and compressed) and transport it to the ocean depths where it is released becoming part of the ocean carbon cycle.

Among the main strategies, some of them consist of transporting this stream of CO2 by ship and inject it into the ocean, or deposit it directly on the seabed. In the first case the CO2 can be released by towed pipes or transported to fixed platforms that feed CO2 lakes which must be at depths greater than 3 km where the CO2 is denser than sea water.





An alternative was identified by a team of scholars who proposed to realize a mixture of liquid CO2 and dry ice and release it in the ocean at 200-500 m depth (4 in situ experiments were conducted near the Monterey Bay in California).



While a method that would allow more carbon dioxide to be stored, with fewer effects on atmospheric CO2 and on the marine environment, consists in increasing the ocean's alkalinity by dissolving carbonate rocks (for example CaCO3).

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