Carbon Capture and Utilization (CCU)

- CO_2 Chemical Routes

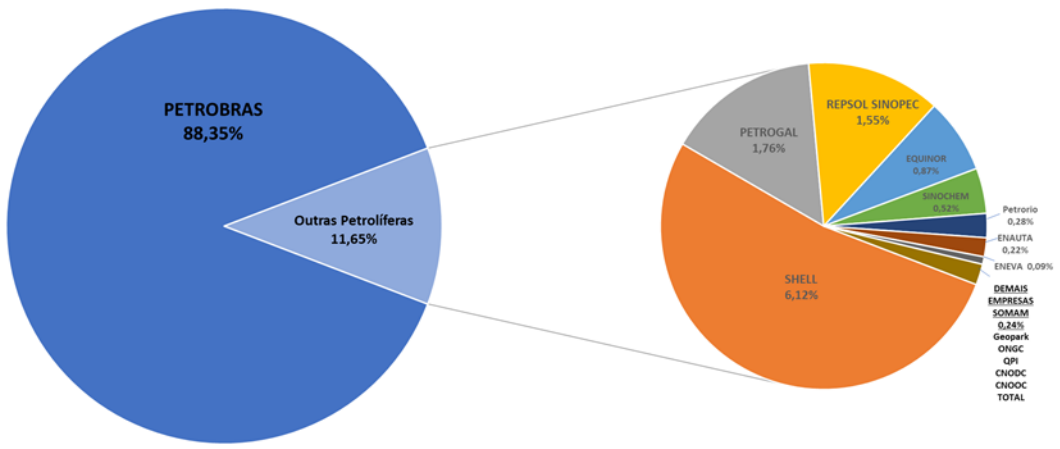
Repsol Sinopec Brasil at a glance

- **4th largest producer in Brazil**

88,9 Kboe/day

- **Joint venture in Brazil (Repsol 60% and Sinopec 40%**
- **1st IOC to operate in Brazil (1997)**

R&D Levy Distribution



Production assets:

- Sapinhoá (BM-S-9)– Petrobras (45%), RSB(25%) and Shell (30%)
- Lapa (BM-S-9A) – Total (45%), RSB (25%) and Shell (30%)
- Albacora Leste – Petrobras (90%) and RSB (10%)

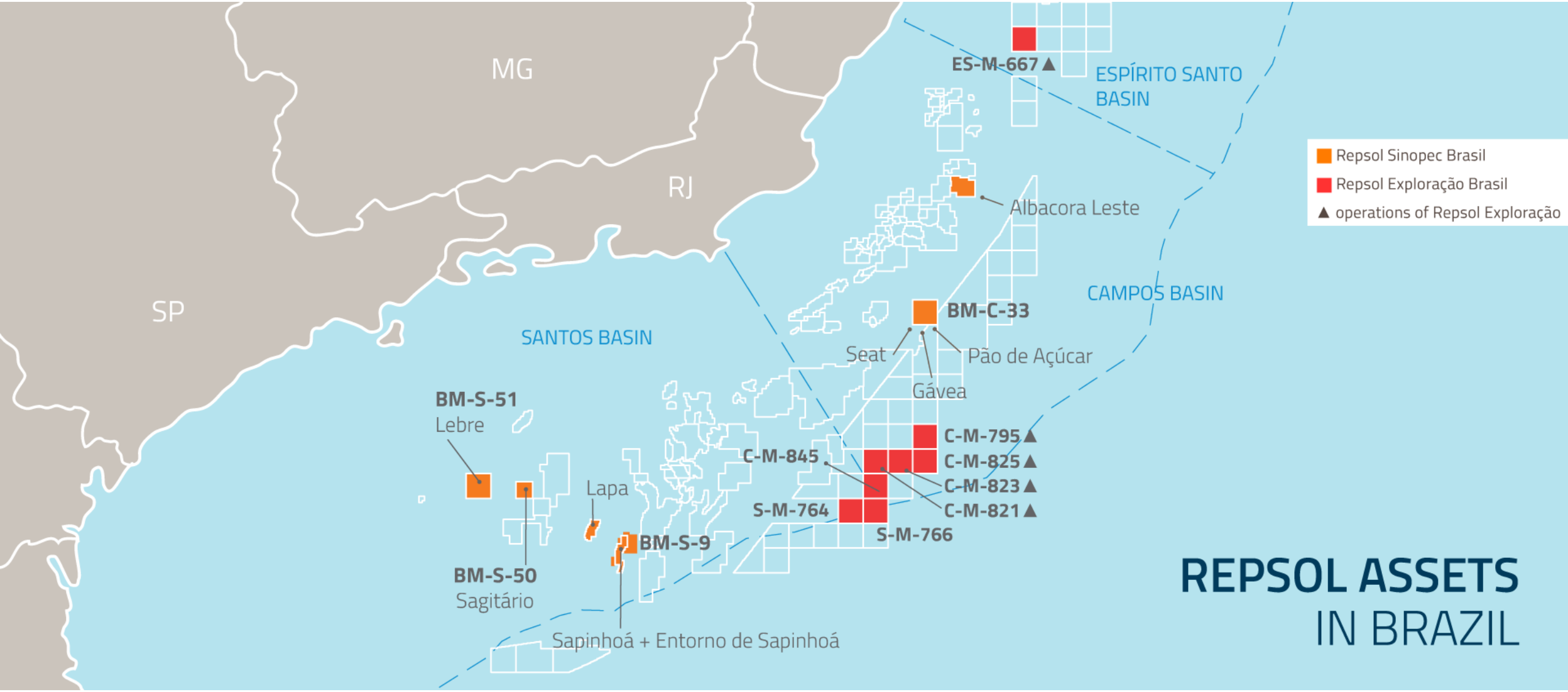
Development assets:

- BM-C-33 – Equinor (35%), RSB (35%) and Petrobras (30%)

Exploratory blocks:

- Sagitario (BM-S-50) – Petrobras (60%), RSB (20%) and Shell (20%)
- ES-M-667 – Repsol (100%)
- C-M-795 – Repsol (100%)
- C-M-825 – Repsol (60%) and Chevron (40%)
- C-M-845 – Chevron (40%), Repsol (40%) and Wintershall (20%)
- S-M-766 - Chevron (40%), Repsol (40%) and Wintershall (20%)

Repsol Sinopec Brasil at a glance



Repsol is committed to achieve carbon neutral by 2050

> We are convinced that we must set more ambitious objectives to fight climate change. We believe now it is the right time for Repsol. We do it with the utmost confidence that we're investing in the future, and addressing the significant challenges that lie ahead with strategic clarity is what will enable us to turn them into opportunities.

Josu Jon Imaz – Repsol CEO

CNBC

Repsol says it will be carbon neutral by 2050, becoming the first oil major to make a pledge of this kind

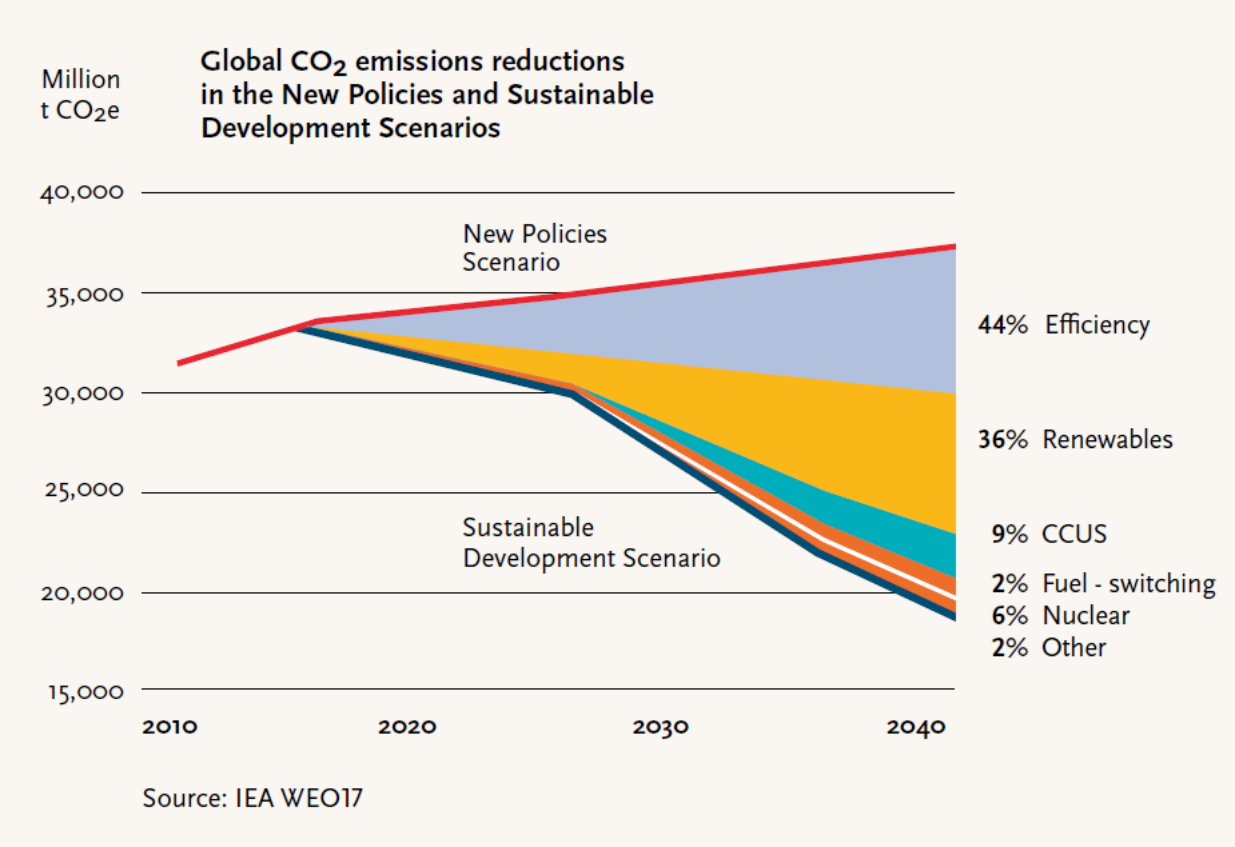
REUTERS

Repsol to cut carbon emissions to net zero by 2050 at $5.3 billion cost

Background

A Global Objective

- In 2015, Paris agreement: by the end of this century, global temperature cannot exceed an increase of 2 °C, preferentially, an increase of 1.5 °C (195 countries).
- To achieve this target, we would need to limit global emissions to less than 20 Mton of CO_2/y in 2040.

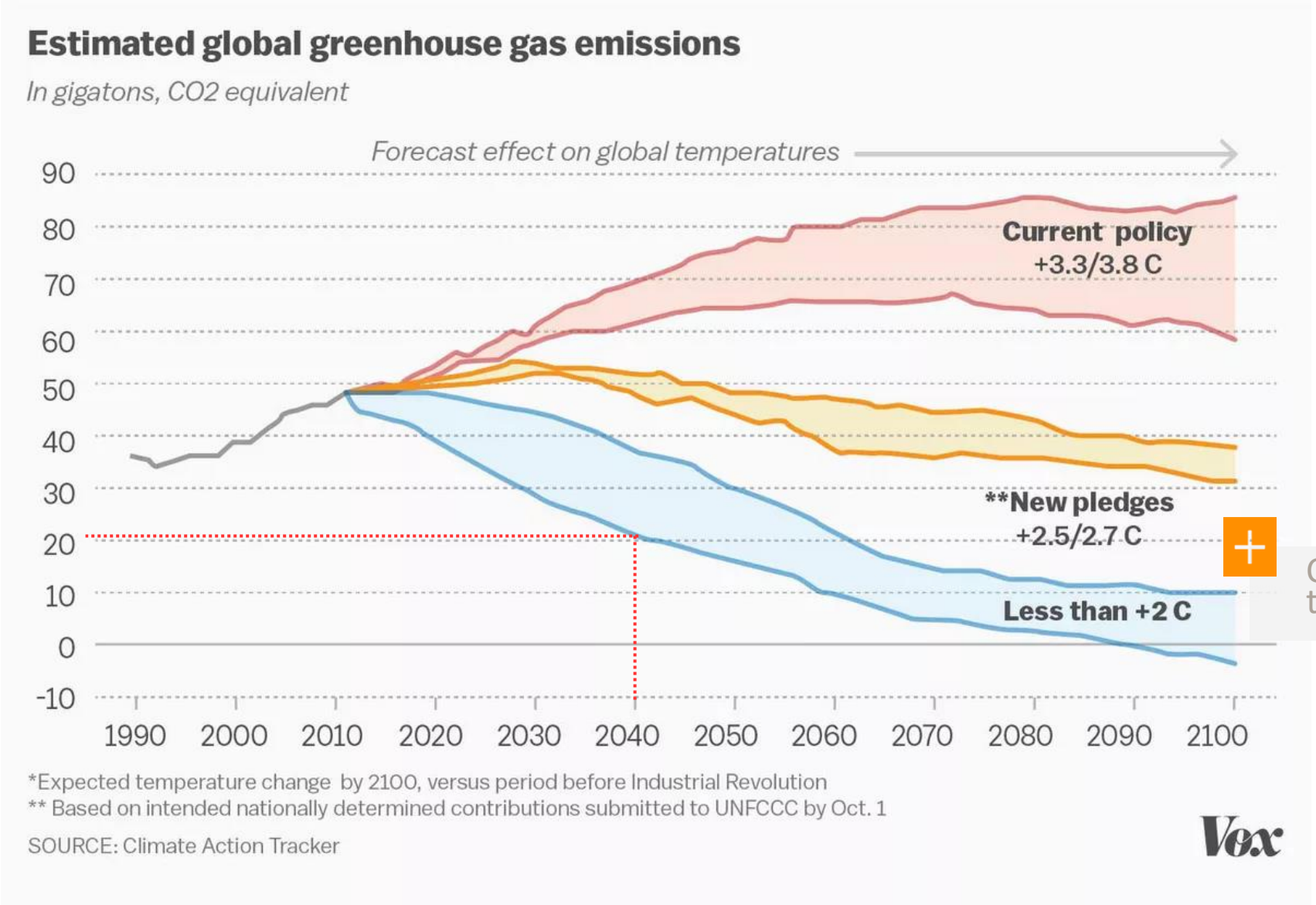


1. **Fast deployment of CCUS** is key to achieve the **emission abatement pace** needed to keep global warming at **1.5ºC.**

2. **CCUS** is currently the only **feasible option** to decarbonize sectors **without low carbon alternative processes** such as steel or cement.

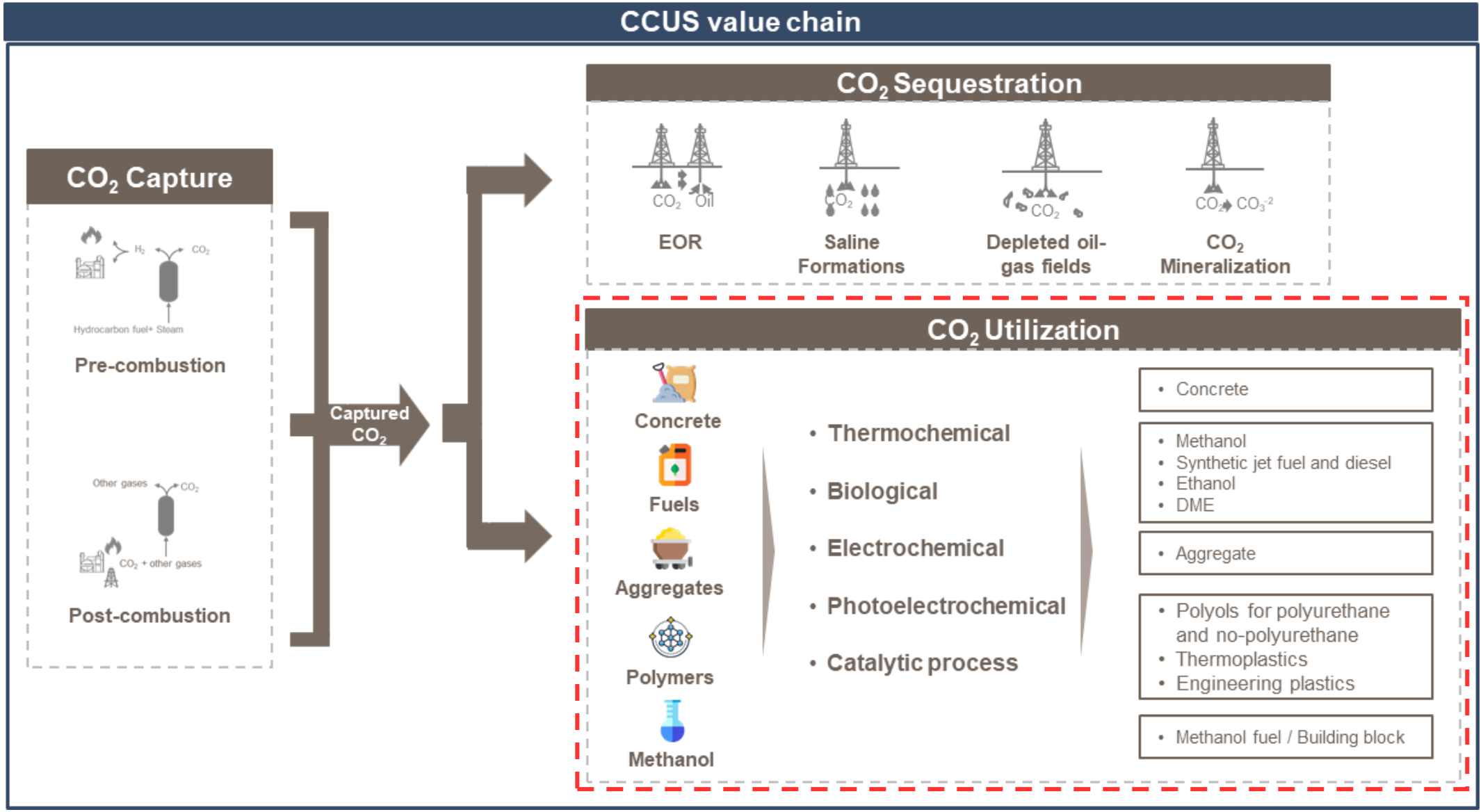
3. **CCU** can provide more **favorable business cases than CCS** by achieving **reduction of the overall abatement costs**.

Greenhouse emissions estimations



CCUS can help us achieve this target

CCUS Value Chain

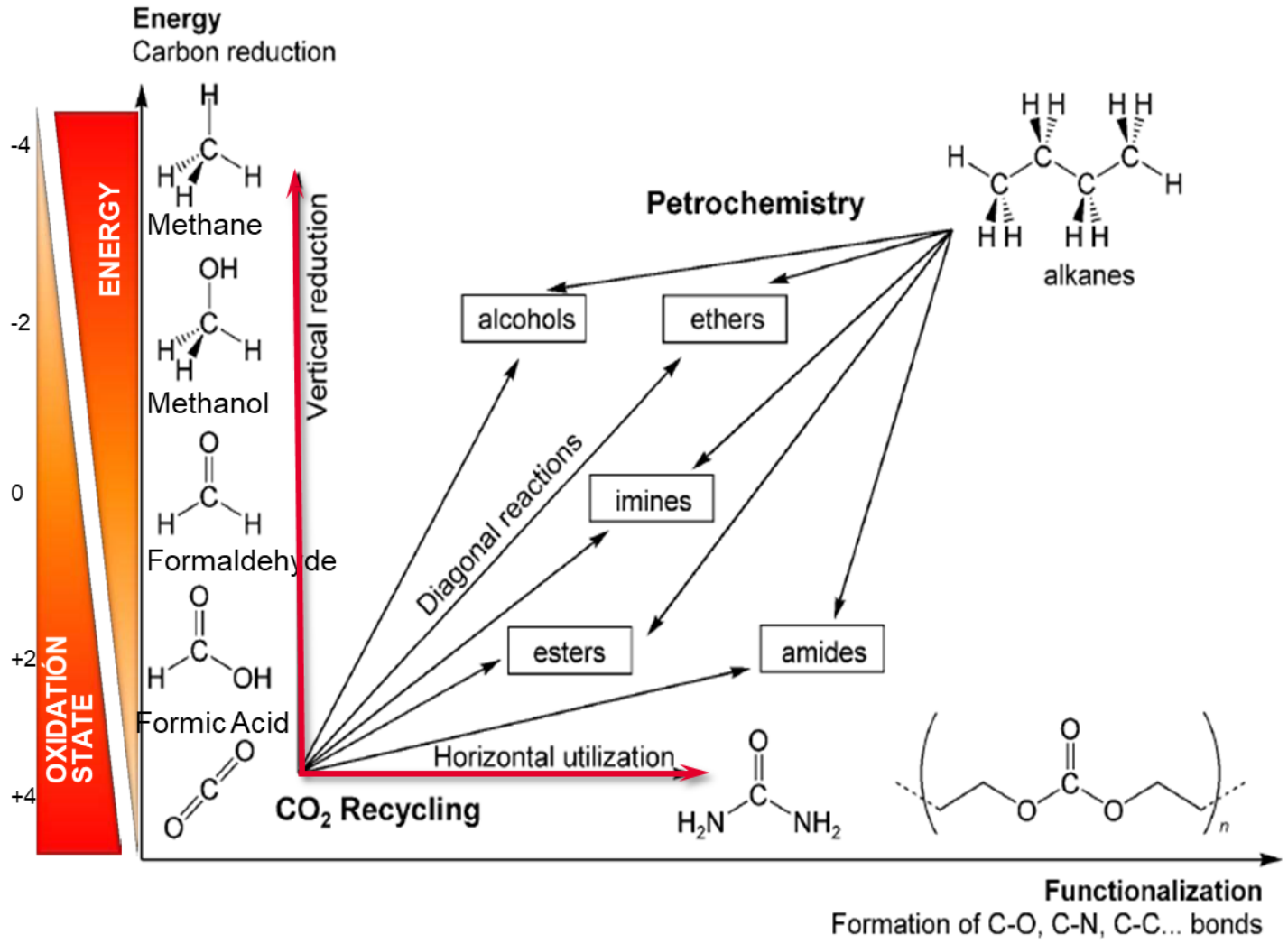


Carbon Capture and Utilization

CO_2, the last energy step

- CO_2 is the last step in the energy scale, to understand this we have to focus in the **Carbon**
- Chemical routes: **reduction of the carbon of the CO_2 molecule or use it as a reagent**

- Energy is welcome!
- Energy is acceptable
- Energy is dismissed



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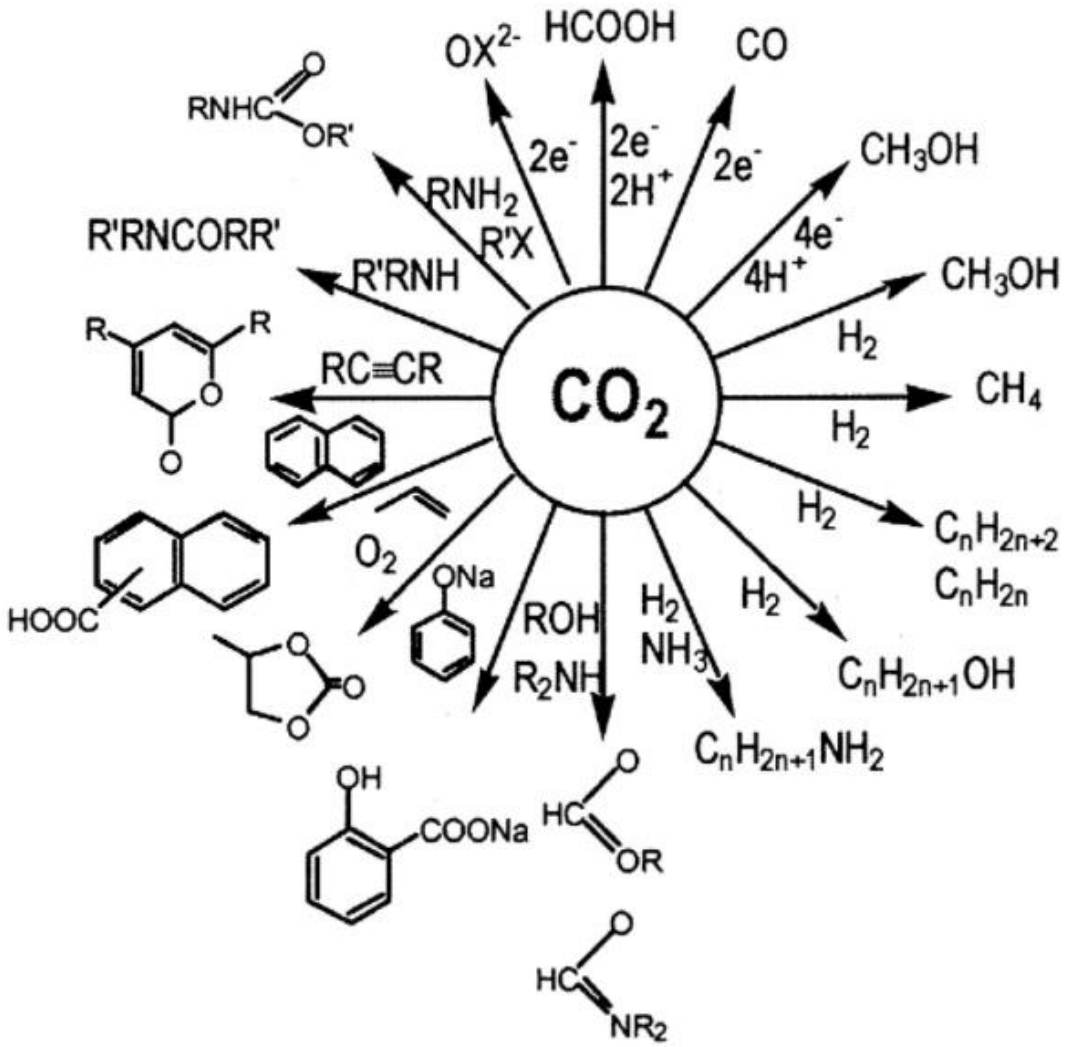
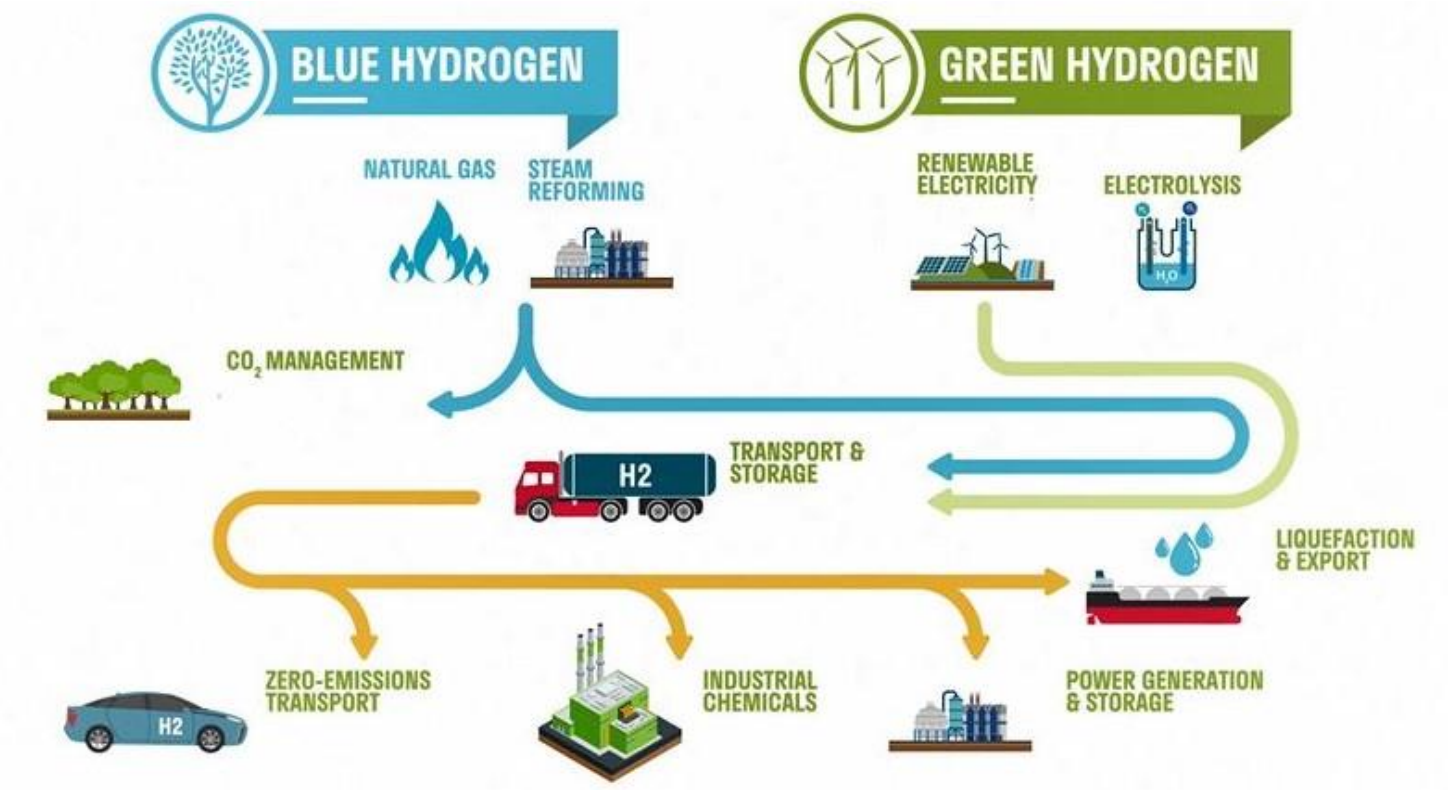


Source: Creutz, 2001.

Blue and Green, what's the difference?



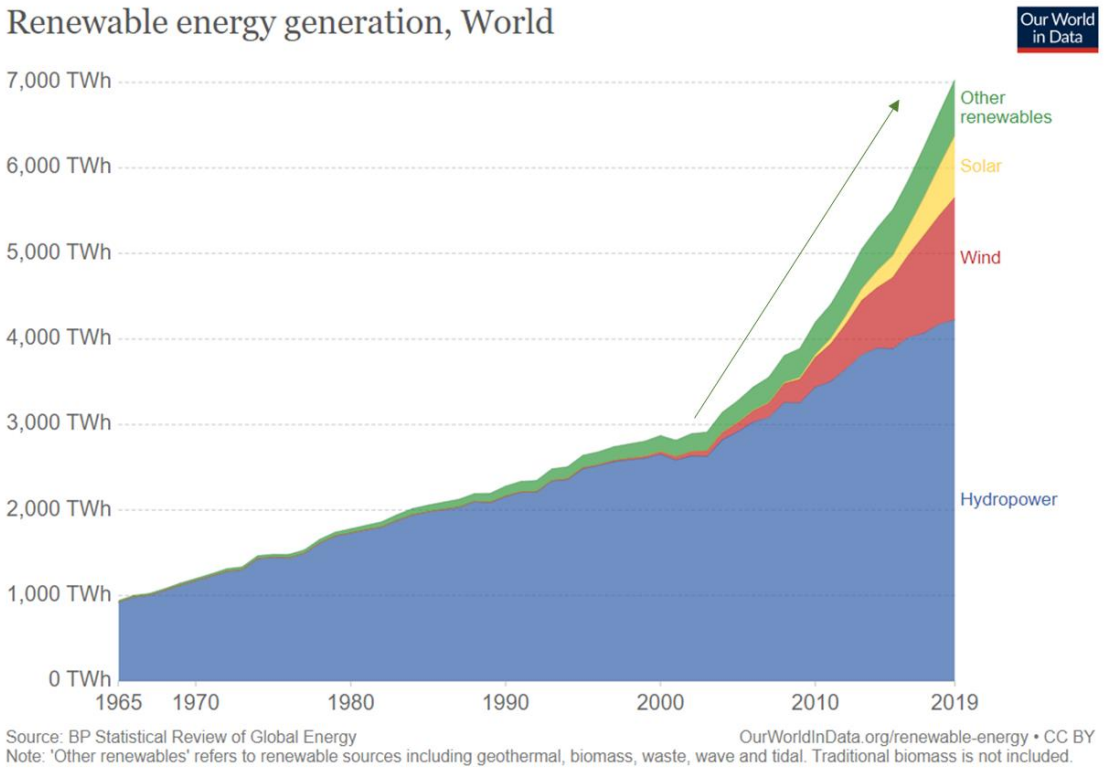
Source: Woodsite, 2020.

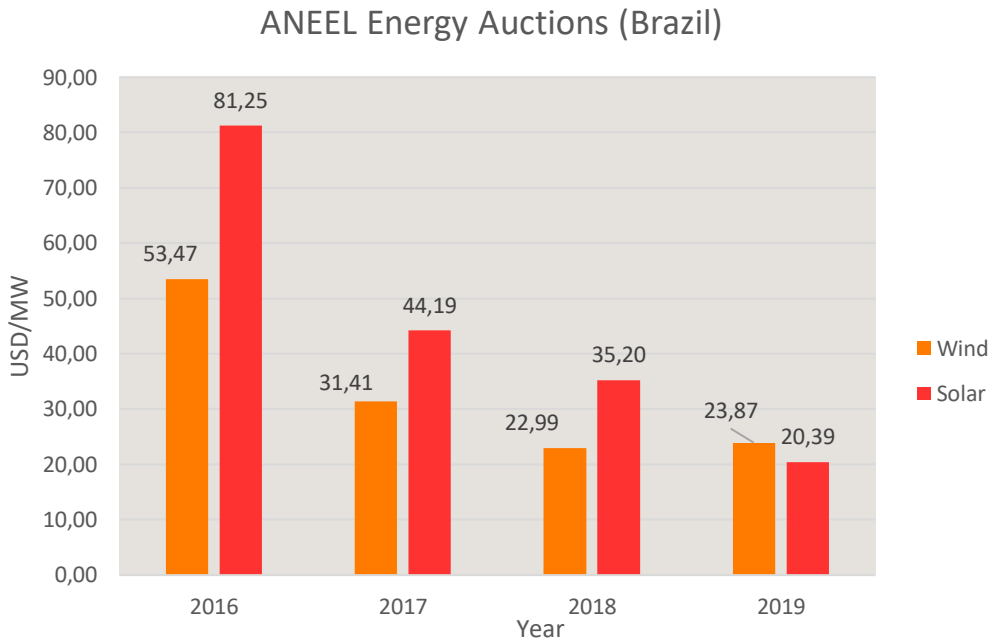
+ Chemicals follows the same idea as hydrogen is the main reduction agent for carbon molecules

- Using Hydrogen as an example:
- **BLUE:** uses **low emission energy** such as **natural gas** and **compensates its emissions** (i.e. **planting trees** to abate CO_2, **capturing generated CO_2** to use it in the green way)
- **GREEN:** uses **renewable energy** sources such as **wind and solar** energies.

Chemical CCU – Energy needs

The Energy we need...





Source: Aneel, 2020.

... is getting cheaper

CHALLENGES

CHEMICAL CONVERSION: MERITS AND FLAWS

Merits

- Potential to obtain value from CO_2
- Wide range of possible products make this kind of technology very flexible
- With some development and available energy, compact CCU could be used anywhere worldwide.
- No long term environmental liability when compared to CCS techniques

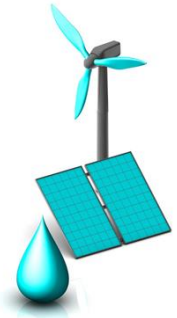
Flaws

- Integrated systems are still with low TRLs and even lower for in-site offshore applications.
- Future integration with CCS solutions is a challenge.
- Carbon credit values are still an issue globally. Feasibility highly dependable of energy cost.
- There is still doubts if it could be considered as a biofuel, even coming from green sources

CO2 Refinery Example

Solar, Hydro, Wind

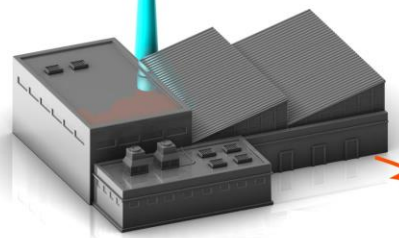
Natural Gas



Water

Gas Turbine

Carbon Capture from industry



Electrochemical CO_2 conversion

Chemical feedstocks

H2

Fuels

Gasoline, Diesel, jet fuel

Green Chemicals
(i.e. Petrochemical raw materials, Methanol, Polymers)

Repsol Sinopec Brasil

THANK YOU!