CCU at ENGIE

PUBLIC | INTERNAL | RESTRICTED | SECRET

20 May 2020

ENGIE

Leading the energy transition

We have

100.3 GW
of installed electricity production capacity

We produce

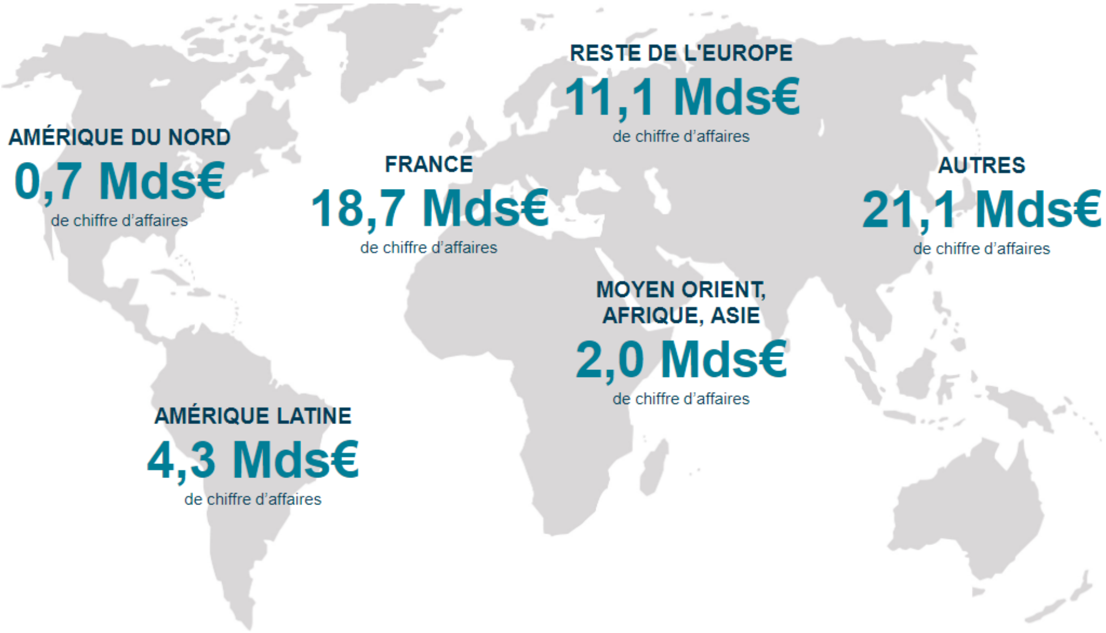
426 TWh
of electricity

We have investing in the future

€138m
in Research & Development

€180m
in ENGIE New Ventures

101,504
employees worldwide*



ENGIE Laborelec
in a nutshell

- ENGIE Laborelec is a leading **expertise and research center** in **electrical power technology with** a strong focus on the **Energy Transition** and **Net Zero Carbon**.
- ENGIE Laborelec has a **global presence wi**th offices in Belgium, France, the Netherlands, Germany, Chile and the Middle-East.
- With a strong focus on **high value delivery** for ENGIE and for our external customers, we combine:

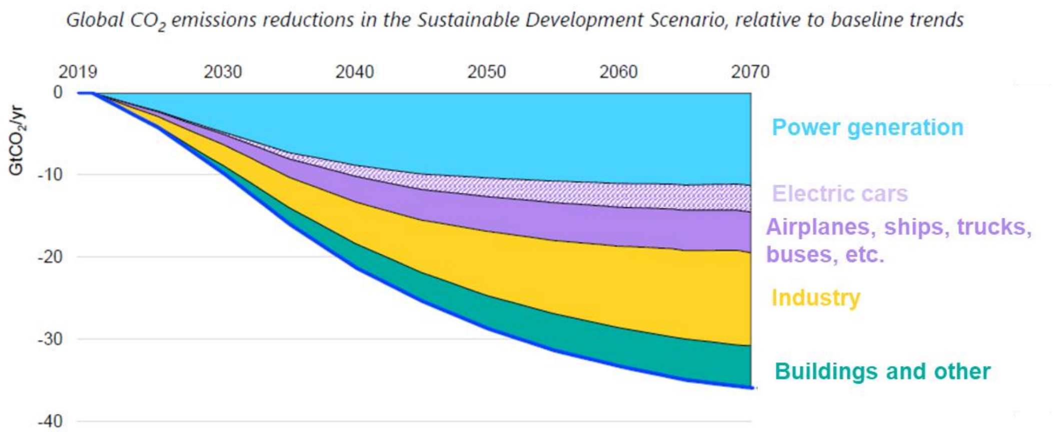
Expert knowledge | **Operational experience** | **State-of-the-art analysis & measurement capability**

- With a **highly skilled workforce** of more than 335 colleagues (PhD, engineers, specialized technicians),
- We offer:

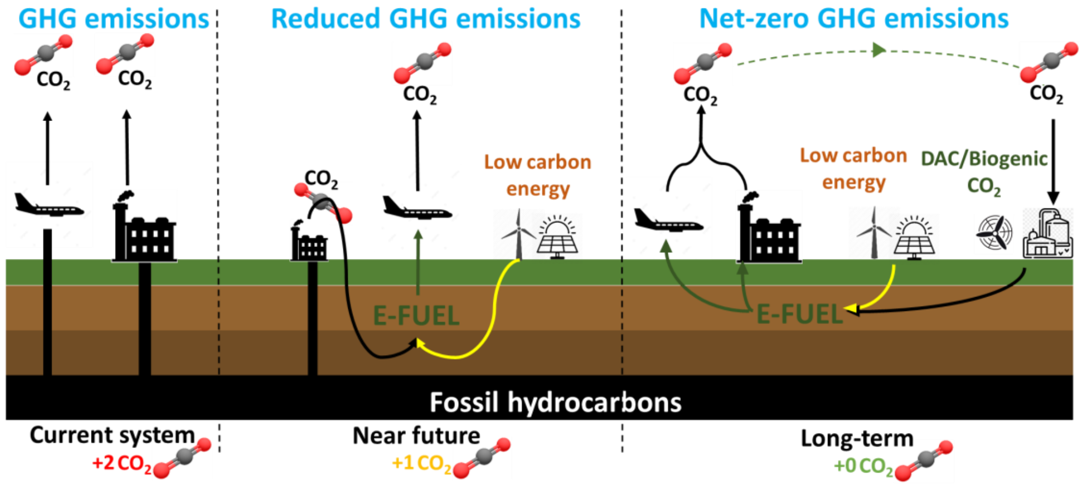
Operational R&D | **Specialized expertise** | **Tailor-made global solutions**

CO_2 to molecules for a complete transition

To tackle the hard to abate emissions for a complete energy transition, CO_2 to molecules will be necessary



Adapted from Energy Technology Perspectives 2020, IEA



Defossilizing power generation is **not enough** to reach net zero.

Additionally to energy efficiency, direct electrification, etc. **sector coupling** through power-to-molecules will be necessary for **hard-to-abate** sectors:

- Heavy transport
- Existing heavy industry infrastructures

These sectors are said to be hard-to-abate as there is **no direct alternatives** to the existing system. E.g. industries that have process related emissions, aviation relying on high density fuels, etc.

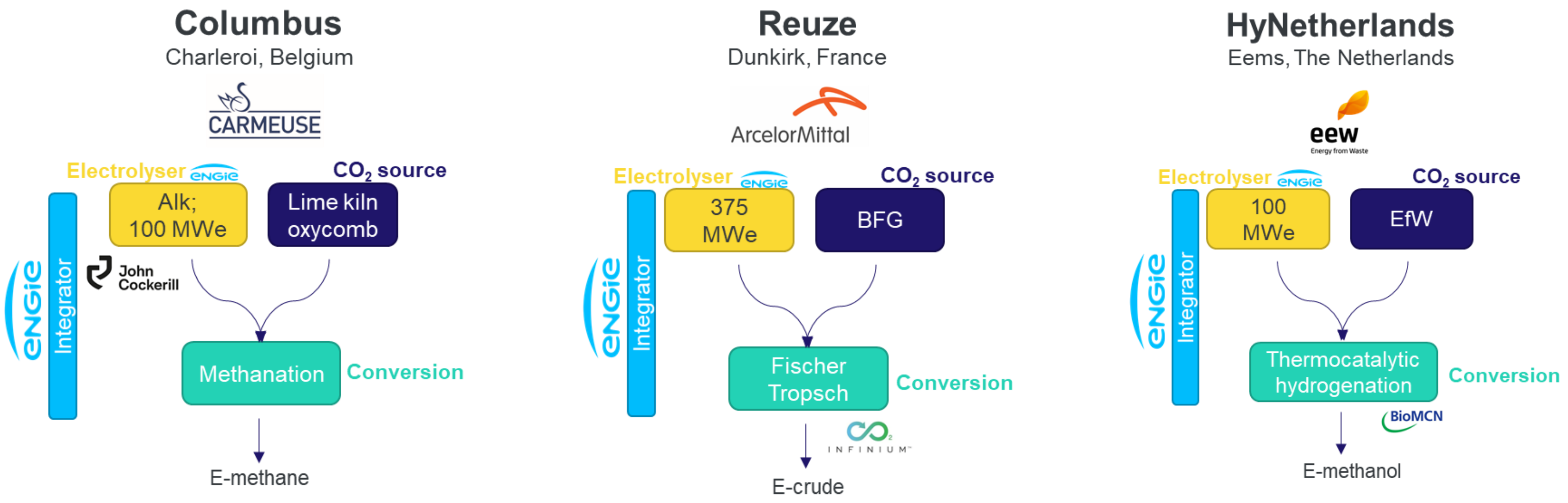
Low-carbon H_2 can be a solution to store energy on the long term but is complicated to utilize for those sectors for several reasons:

- Low volumetric energy density
- Material embrittlement
- Non drop-in use

Combining the low-carbon H_2 with CO_2, we can produce the molecules we rely upon while offsetting the CO_2 emissions linked to their use. This offers a **link between renewable energy assets and hard-to-abate** emissions sectors **while recycling CO_2**, enabling a net-zero cycle.

Iconic CCU projects at ENGIE

High-level outlook



Drivers

1. Decarbonisation of clients
2. Utilisation of existing assets
3. Sale of large amounts of RE

BioCCU v thermocatalytic CCU

	Biocatalytic	Thermocatalytic
Process flexibility		
Impurities	Microorganisms more resistant to poisons in the feed gases (exception of anaerobes & O_2)	Highly sensitive metallic catalysts
Load	Theoretically more able to adapt its load flexibly	Theoretically less able to adapt its load flexibly
Added-value molecules	Potential for selectivity to high value molecules	Mainly fuels/precursors
Footprint	Gas fermentation = solubility-induced mass transfer limitations = Lower GHSV	Higher GHSV