THE ROLE OF E-METHANE IN NET ZERO WITH COLUMBUS AS A USE CASE

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ENGIE operate in 31 countries

IN 2022:

- **96,400** employees
- **€93.9 billion** revenue
- EBIT of **€9.0bn**
- **37,9 GW** of renewable electricity installed capacity at the end of 2022
- **€5.5 billion** growth Capex

EBIT WORLDWIDE

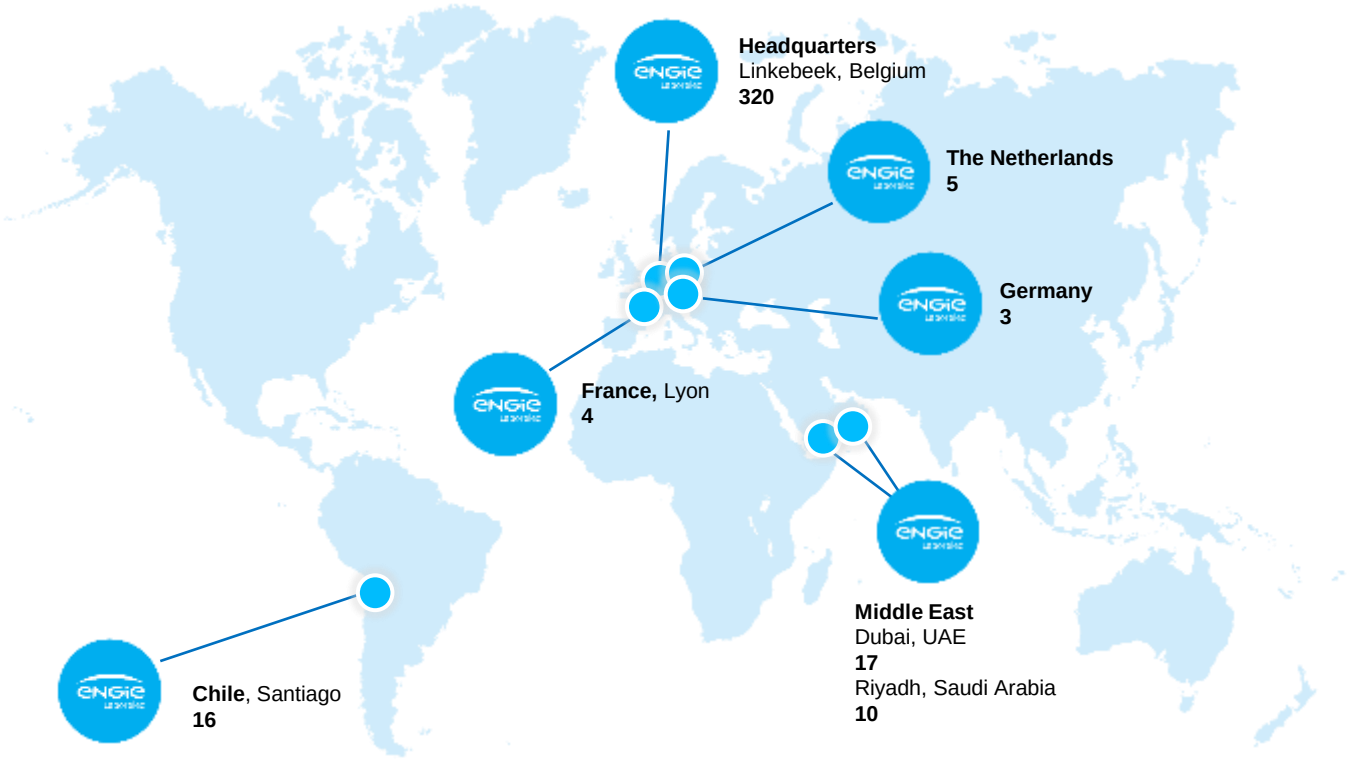
OUR BUSINESSES:

- RENEWABLES
- NETWORKS
- ENERGY SOLUTIONS
- FLEX GEN & RETAIL(3)
- NUCLEAR
- OTHERS (including GLOBAL ENERGY MANAGEMENT & SALES)

A research centre supported by a unique and multi-located group of experts

- ENGIE Laborelec is a **leading centre of expertise and research** in the area of electrical energy technologies with its headquarter in Belgium and 6 subsidiaries on 3 continents.
- Supporting the **energy transition** and accelerating the **net zero carbon journey**.
- With a **highly qualified workforce** of over 375 colleagues (PhDs, engineers, specialist technicians) from 23 different nationalities.

375
COLLEAGUES



(Distribution of experts: 17% in International & Emissions - 33% in Production & Infrastructure - 20% in Nuclear - 20% in Renewables - 10% in Digital)

CO_2 As a Resource LAB

We support development in CO_2 capture, reuse and valorisation for assets owned, operated or serviced by ENGIE

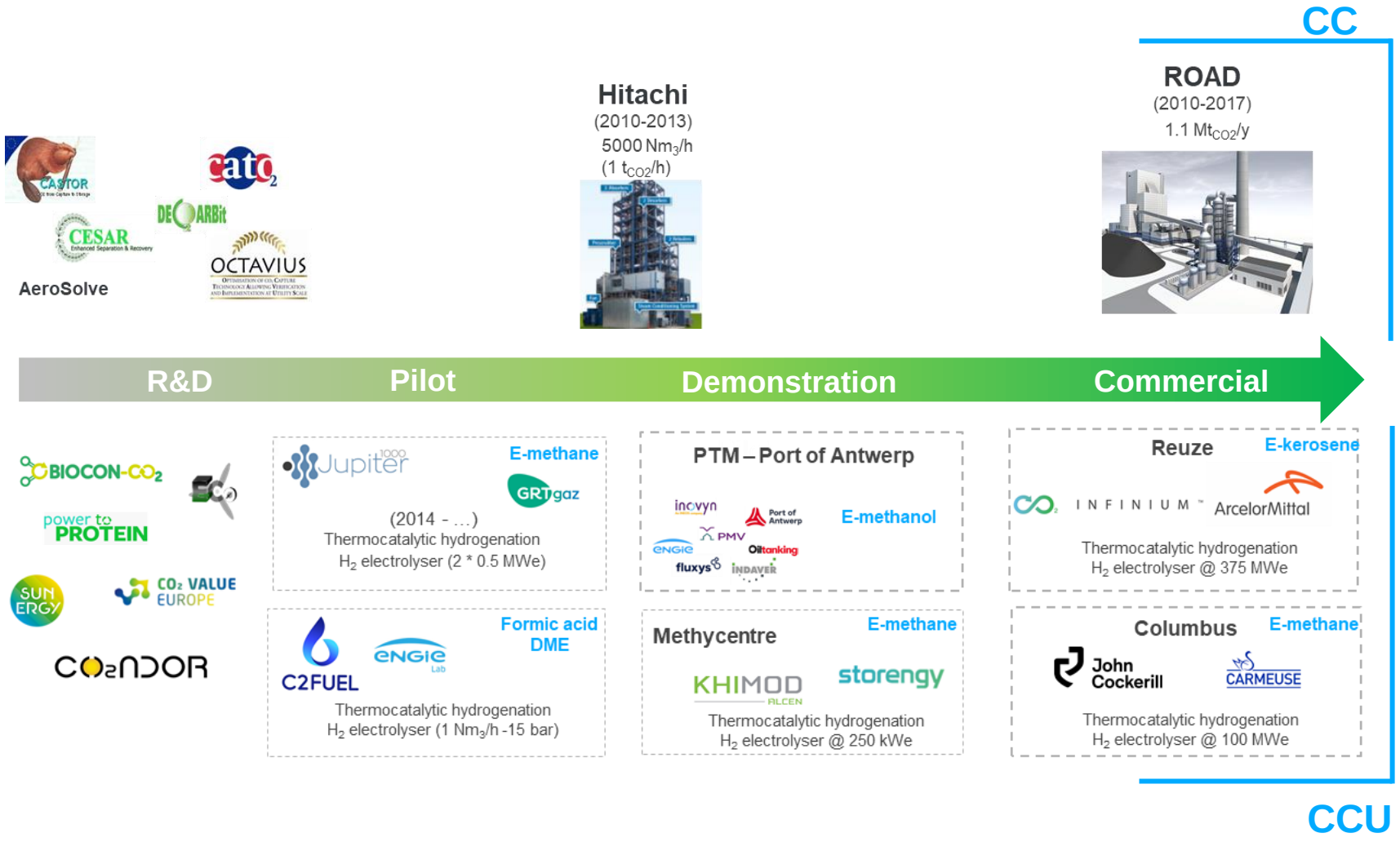
BE THE REFERENCE ON CO_2 CAPTURE AND VALORISATION TECHNOLOGIES FOR INDUSTRIES AND TERRITORIES

PROVIDE HIGH LEVEL EXPERTISE ON CO_2 AND POLLUTANTS EMISSIONS MONITORING

SUPPORT AND DEVELOP CO_2 CAPTURE AND VALORISATION TO FUELS AND CHEMICALS TO ENABLE HYDROGEN ECONOMY

SUPPORT AND DEVELOP CO2 CAPTURE AND USE TO INCREASE CIRCULARITY OF ENGIE ASSETS OR INDUSTRIES

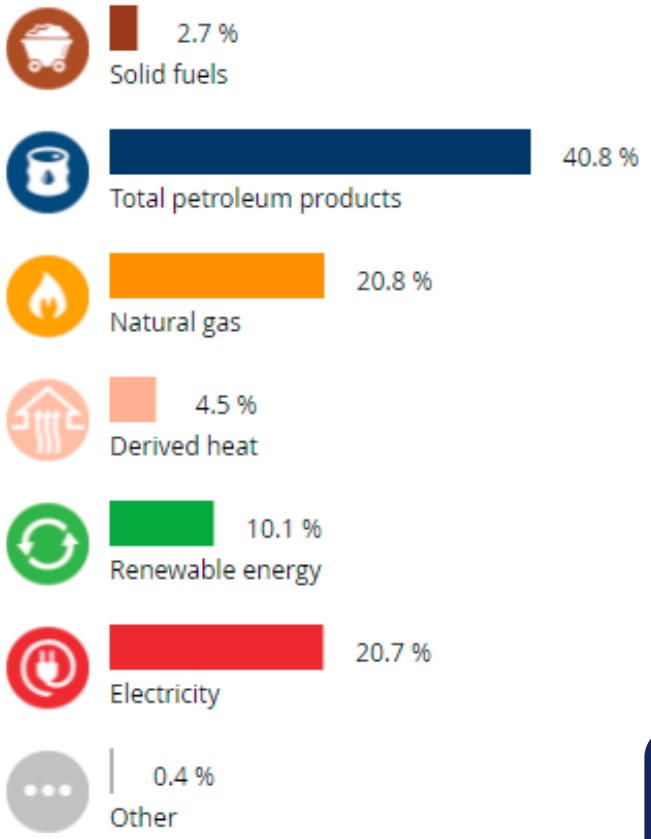
Laborelec development role: from collaborative R&D projects to commercial scale



Aiming at climate neutrality

Consumption mix for the European Union

11 000 TWh/year *



(*) 2019 data Eurostat EU27

How low-carbon solutions could meet the demand (by 2050)

Priority order

- **Energy efficiency**
- **Renewable Electricity**
- **Renewable Heat**
- **Hydrogen and E-molecules (CCU)**
- **Natural gas with Carbon capture and storage (CCS)**

Europe

Import & export

Green H_2 is needed but is also the most expensive way to achieve carbon neutrality so must be dedicated to hard to abate sectors.

Green H_2 needed to use excess of renewable power

Where to kick start green H_2 economy?

Mainly industrial uses (generally baseload) of H_2

Storage + grid support

Power to H_2

Existing use of H_2

Ammonia ([illegible]roduction

~ 130 TWh [illegible] 200 [illegible]reen elec
Less ex[illegible]ve to pro[illegible] green ammonia outsi[illegible].

Ref[illegible]ies

~50 TWh H_2 or 75 TWh green elec
Decreasing ma[illegible] due to mobility electrification

New use of H_2

New Steel production (only green H_2)

~180 TWh H_2 or 275 TWh green elec
Capex required for g[illegible]out green H_2
~40 b€ (for 1[illegible] green s[illegible]n EU)

Mobility

For pure H_2 mobility, s[illegible]all market

Heat/electricity production

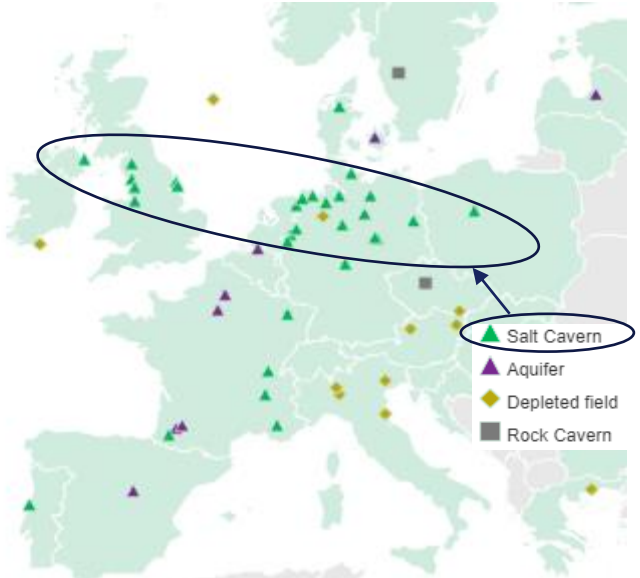
Still need of techn[illegible]evelopment
The use of blue H_2 would [illegible]ase the EU natural gas dependency

Constraints of H_2 development

1. Very limited and 100% private transport infrastructure (sized for current needs)

2. No current storage and storage potential technically limited to salt caverns ~50 TWh at European level, compared to 1200 TWh for natural gas at present.

➔ Transport infrastructure and storage are key to start the hydrogen economy, but this will be built only if there is a business case.



Source: The European Hydrogen Backbone (EHB) initiative

Energy density (LHV)				
	kWh/kg	kWh/m³	kWh/l	°t
		Gas	Liquid	
Hydrogen	33.33	2.7	2.36	-252°C
Methane	13.9	10.5	6.2	-161°C
Methanol	5.5		4.3	Ambient
Ammonia	5.2	3.8	3.2	-32°C
Diesel	12		10	Ambient

Maximizing hydrogen's potential: matching end-use sectors requirements with hydrogen's achievable premium

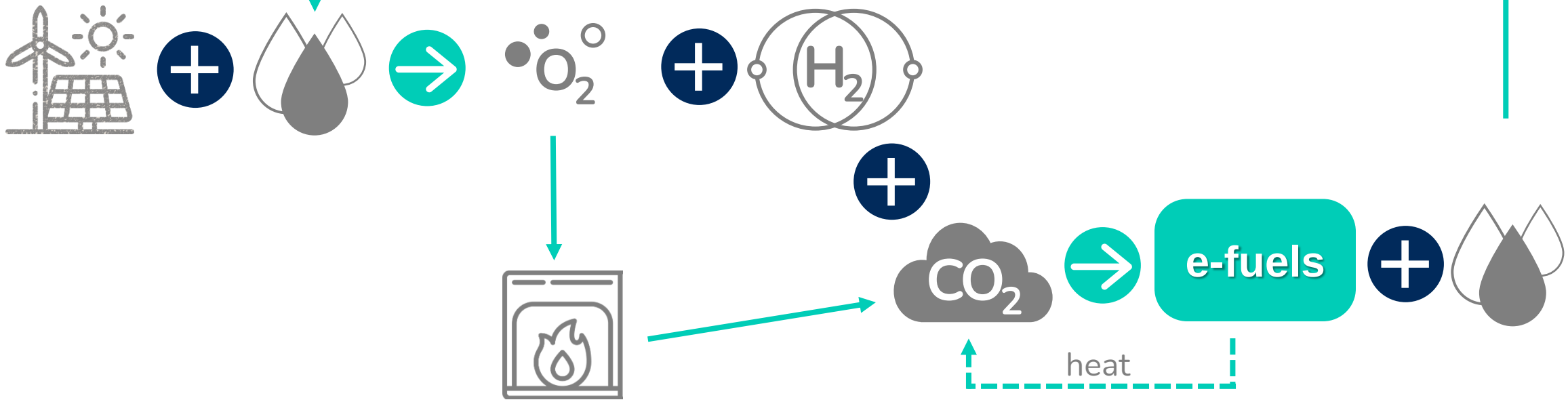
Market mostly driven by regulations targeting the transport sector in Europe. Other sectors and geographies target parity with fossil alternative (after subsidies and carbon pricing)

	Existing grey H_2 users	Industry conversion to H_2	E-fuels
Markets	**Refining / fertilizers / chemicals**	**Steel / high temperature processes**	**Aviation / maritime / heavy duty land transport**
Drivers	**Carbon pricing** **Renewable H_2 mandates** **Client's expectations**	**Carbon pricing** **Client's expectations**	**Renewable H_2 mandates** **Carbon pricing** **Client's expectation**
Requirements	**Renewable H_2** (refining) **Low carbon** (other sectors)	**Low carbon**	**Renewable H_2**
Premium	**Medium green premium** Refining impacted by H_2 mandates in the transport sector	**Low green premium** Target cost parity with fossil alternative + carbon pricing	**High green premium** Due to penalties for non-incorporation of renewable fuels

New renewable H_2 mandate in the industry (RED III) could push premiums for renewable H2 in the industry in the future

E-fuels What and Why

Defined in EU as “Renewable Fuels from Non Biological Origin” (RFNBO)

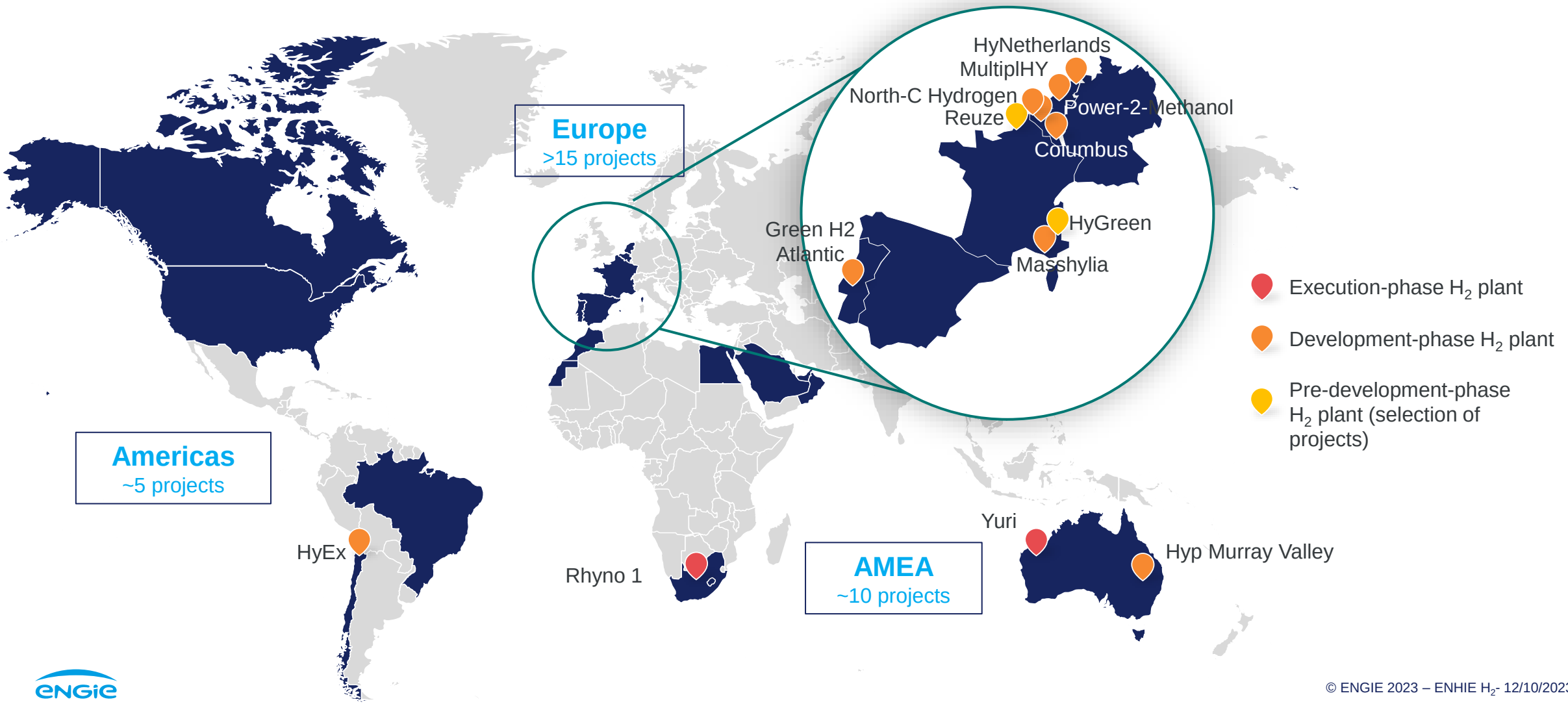


Why e-fuels:

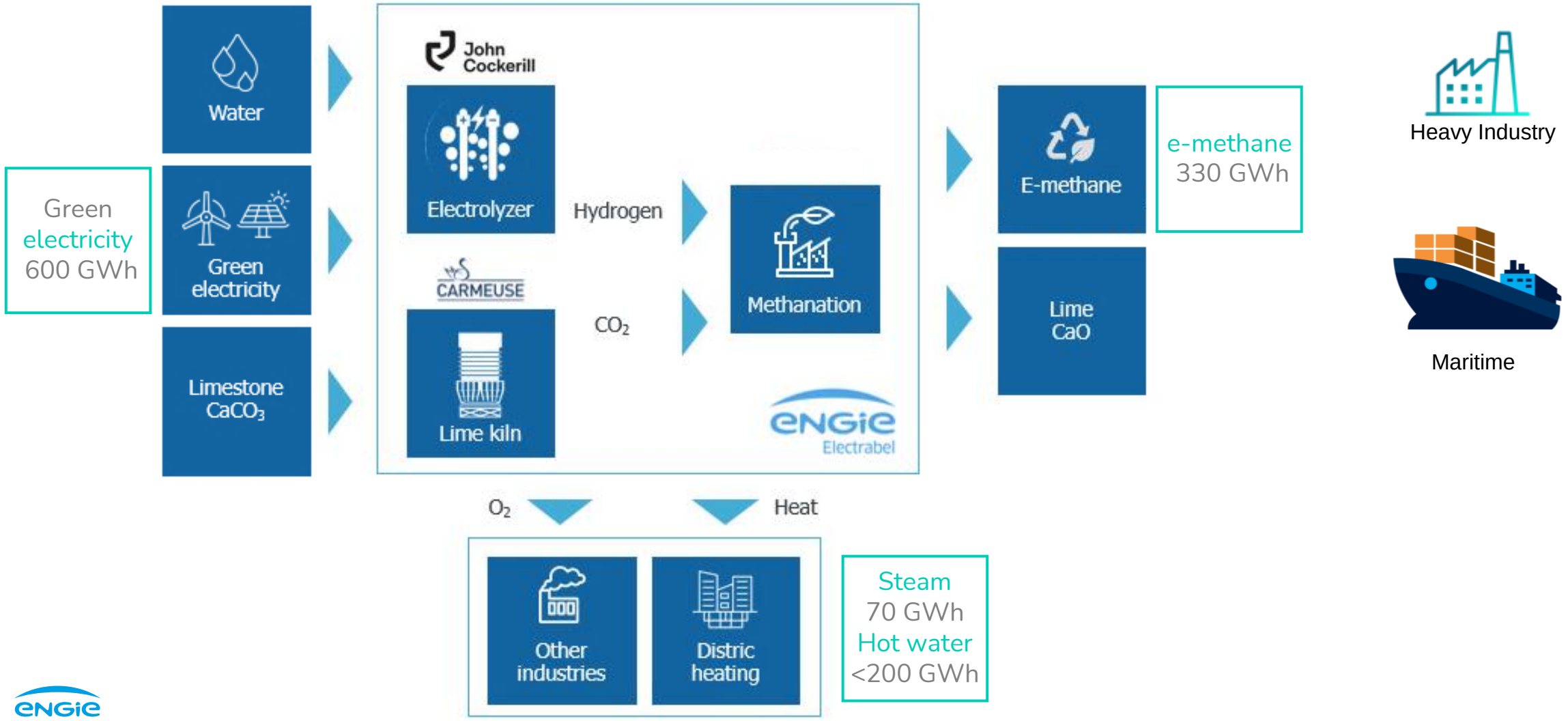
- Uses existing infrastructure to store, transport & distribute
- No capex needed for offtakers: drop-in fuels
- High energy density ⇨ easy to manipulate and can be used in aviation and shipping
- Local energy production ⇨ together with biomethane, it decreases the dependency toward gas import.

⇨ Highly integrated with existing industrial clusters (O_2, CO_2, heat)

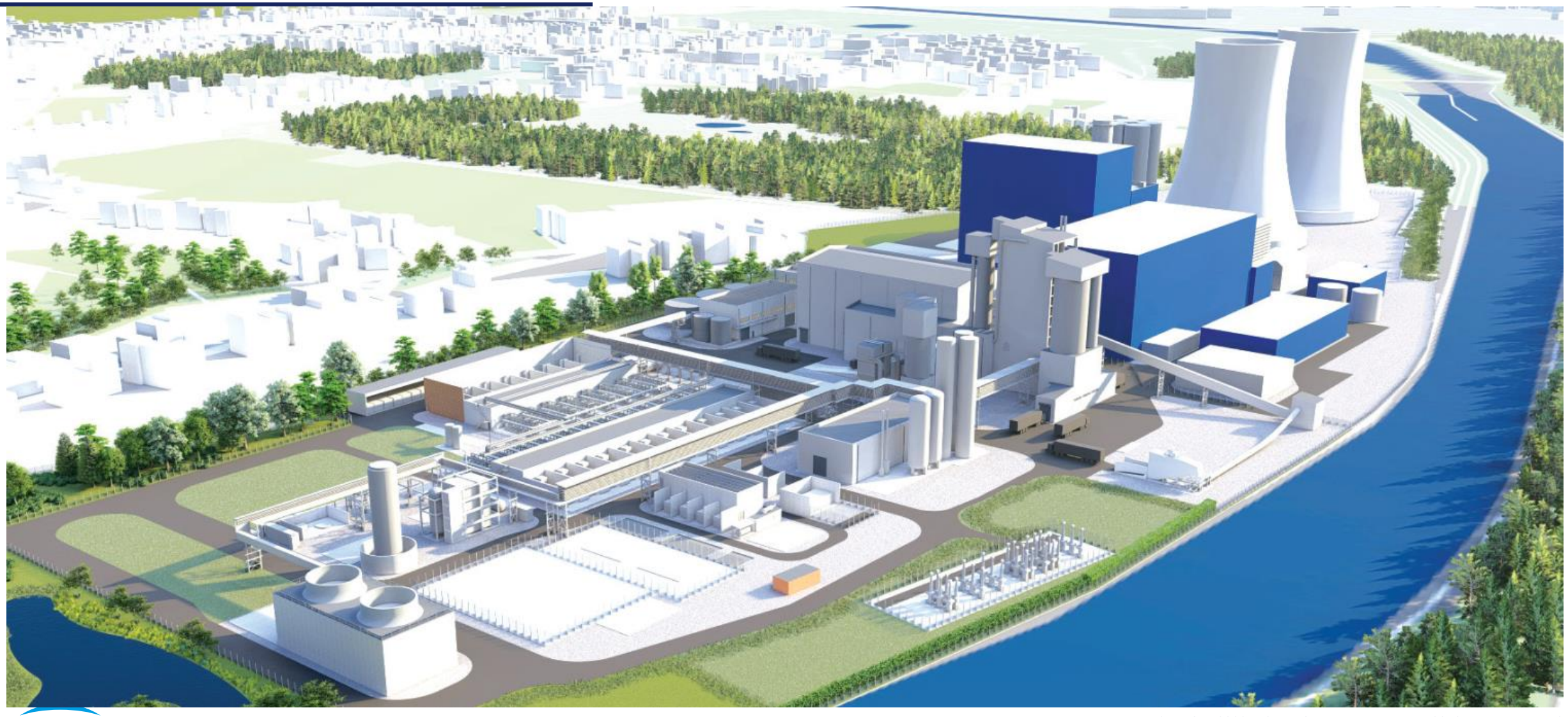
Engie renewable H_2 pipeline: 30 large-scale projects



Focus on E methane
Columbus : biggest power to methane in the world 100 MWe

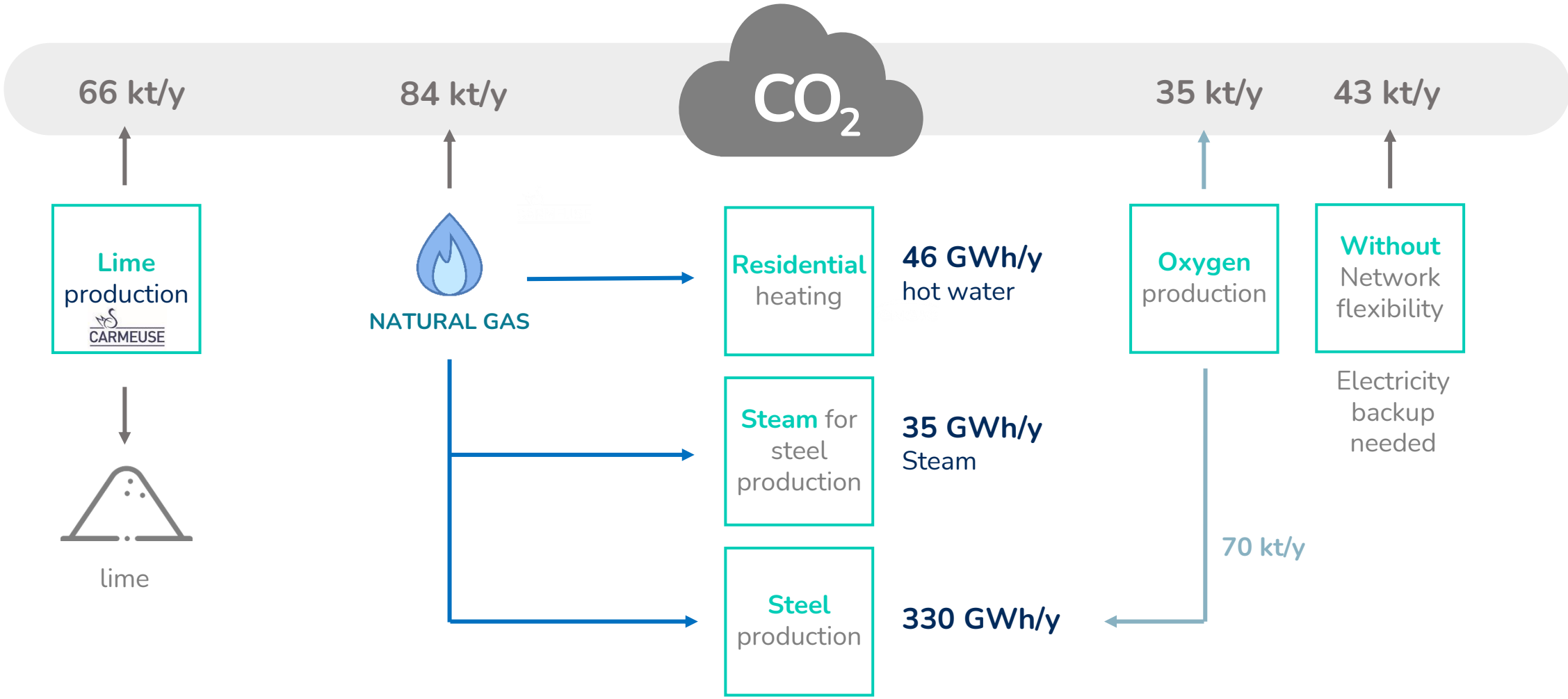


Columbus: a 3D view



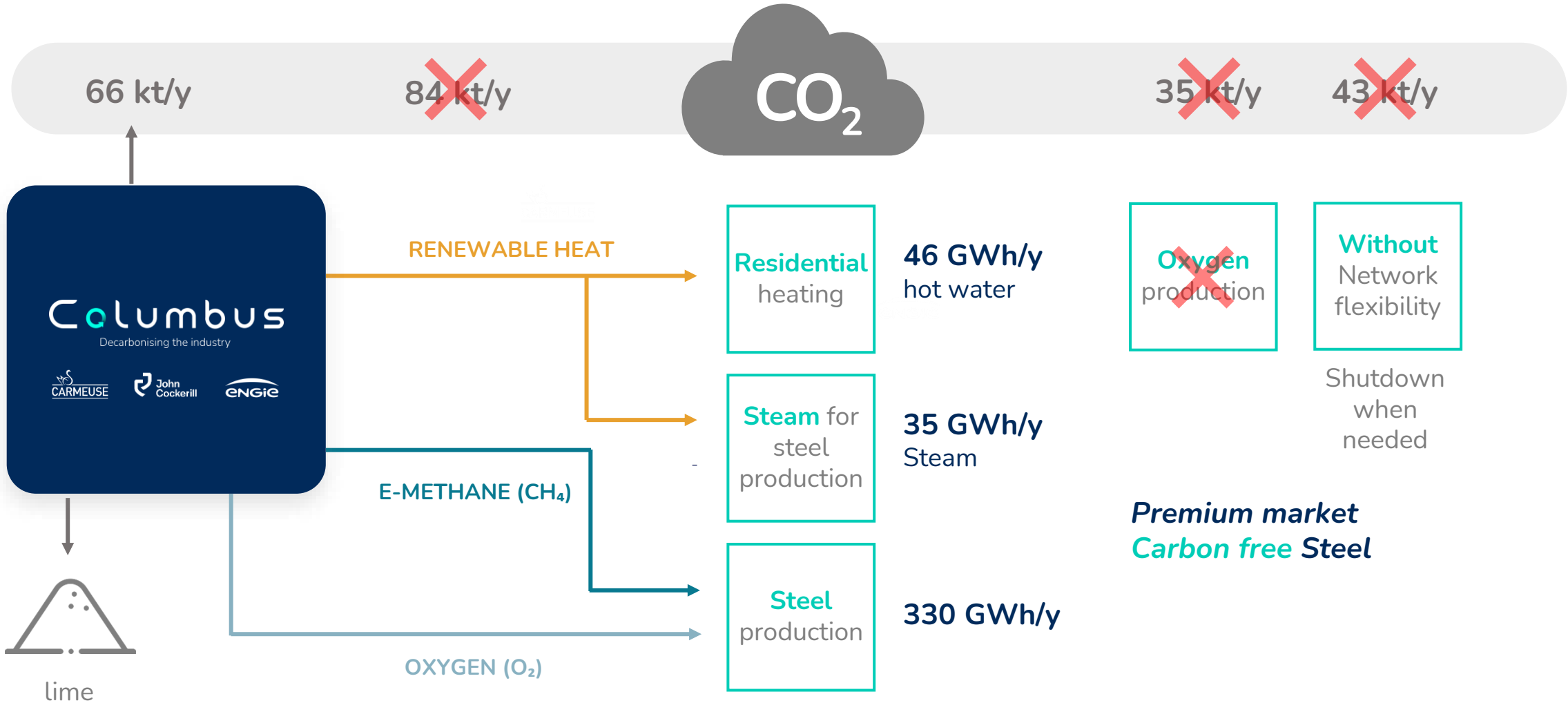
CO2 saving: Current situation Linear Economy

No integration



CO2 saving: Current situation Linear Economy

New hub : CCU brings more saving than CCS !



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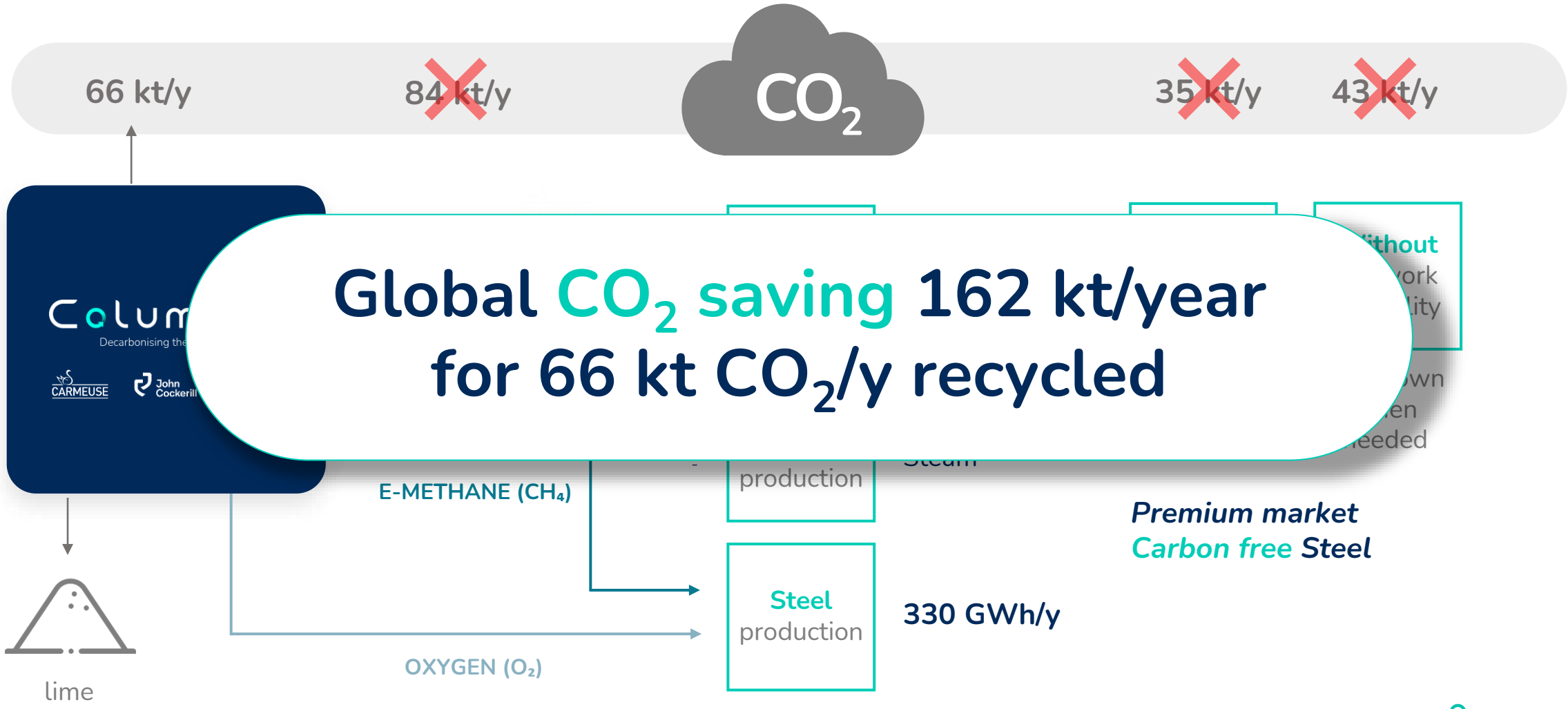

Timeline until commercial operation in 2026

2021 Q4
- Design studies
- IPCEI nomination

Avec le soutien de la Wallonie

2022 Q1
- Term Sheet (offtakers)

2022 Q4
- Grid connection secured
- IPCEI funding secured
- FEED studies

Funded by the European Union
NextGenerationEU

2023 Q2
- IF2023 funding Secured
- Environmental Impact Assessment

INNOVATION FUND

2023 Q3
- Permit application
- Capacity booking electrolyser

2024 Q2
- Permits obtained
- Key contracts in place: construction, sourcing, offtake
- All funding secured
- Regulatory framework in place
- Final Investment Decision (May. 2024)
- Financial close (June. 2024)

2024 2026
- Long lead items
- Site works
- Grid connection

2026 Q2
- **Commercial Operation**

ENGIE

Final conclusion

- Carbon neutrality in 2050 is a big challenge.
- Electrification will take RES demand to levels never seen before.
- Electricity storage is key, but also currently the bottleneck.
- H_2 allows to transform electricity into valuable product.
- H_2 infrastructure do not exist yet, Emethane a smart way to use existing infrastructure
- Columbus to demonstrate it is feasible

Today we are building the low-carbon system of tomorrow!

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