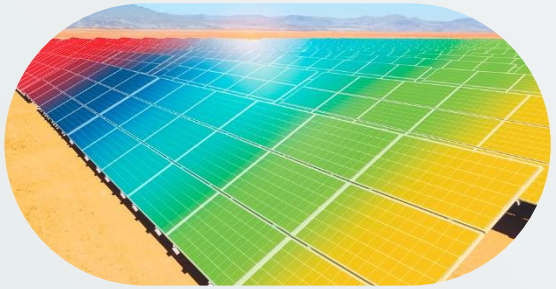


TotalEnergies

Electrification Technologies

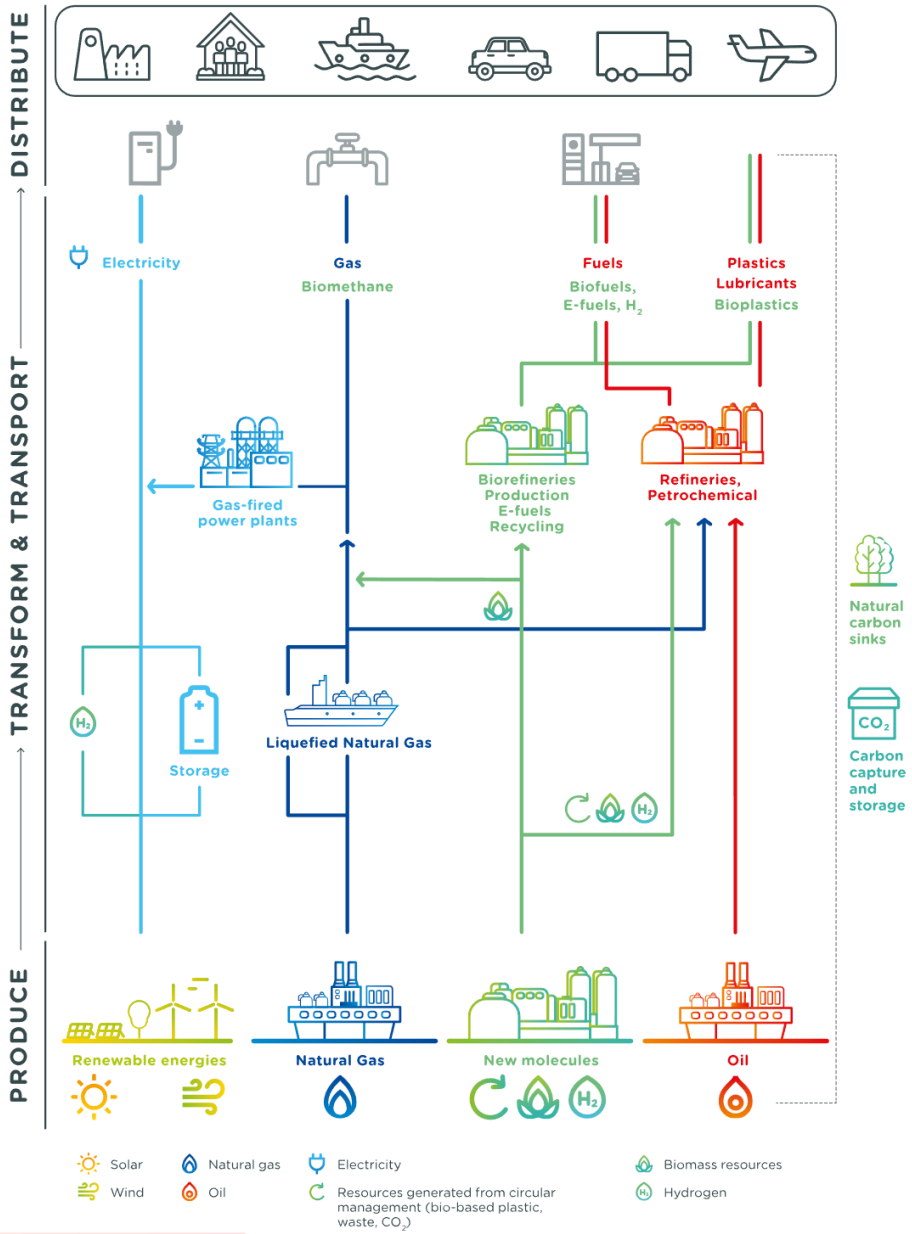
Electrify to decarbonize
=
electro-decarbonization

Walter Vermeiren

Electric Decade, January 17th, 2024

Pioneers for 100 years

Our integrated value chains



Building a multi-energy company

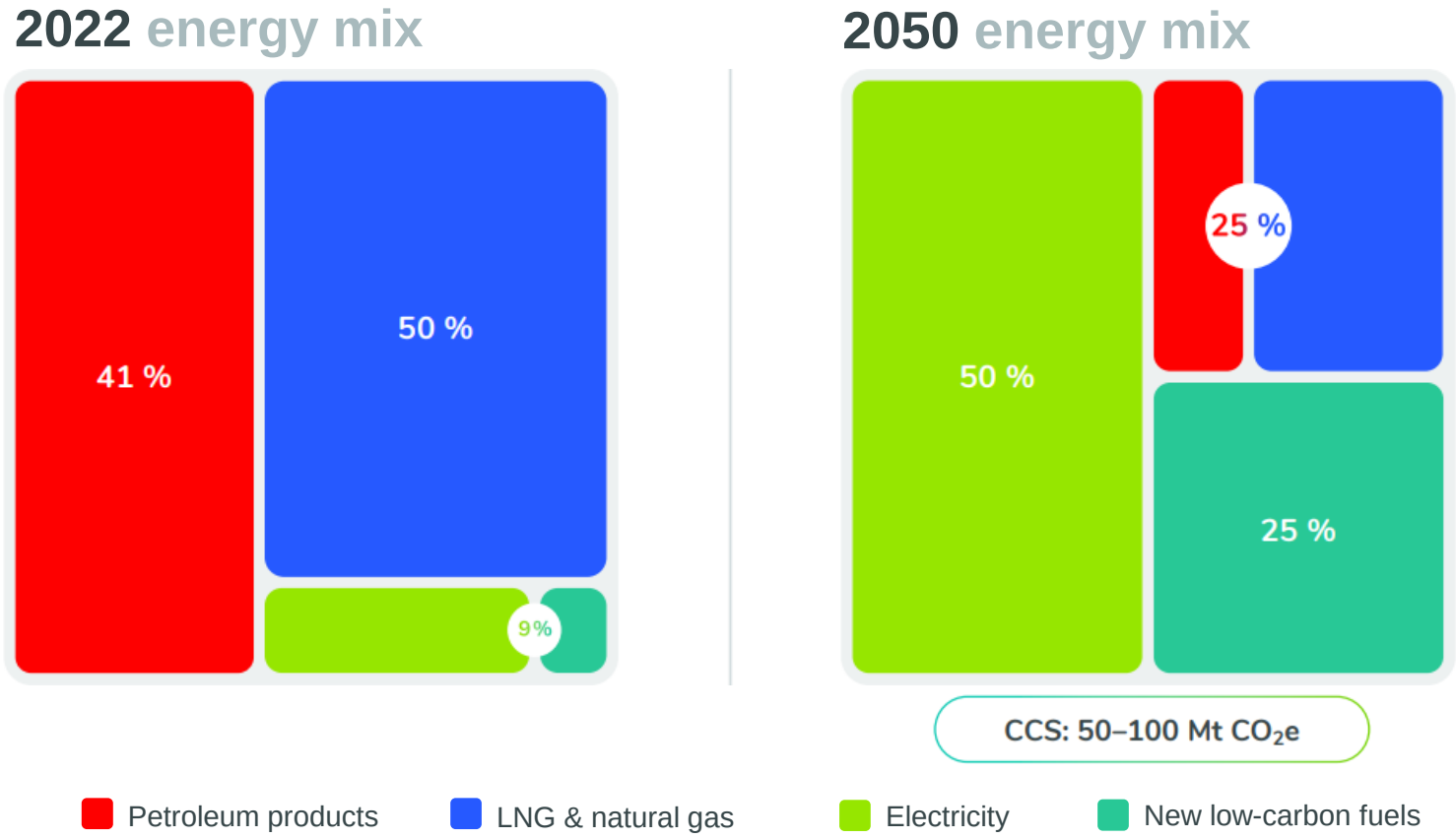
Total is transforming and becoming TotalEnergies (‘21)

TotalEnergies

- This new name and new visual identity embody the course TotalEnergies has resolutely charted for itself: that of a broad energy company committed to producing and providing energies that are ever more **affordable**, **reliable** and **clean**.
- In this context, the Company’s ambition is to reach carbon neutrality (net zero emissions) by 2050 **together with society**.

Total is Transforming and Becoming TotalEnergies| TotalEnergies.com

Our vision for TotalEnergies in 2050



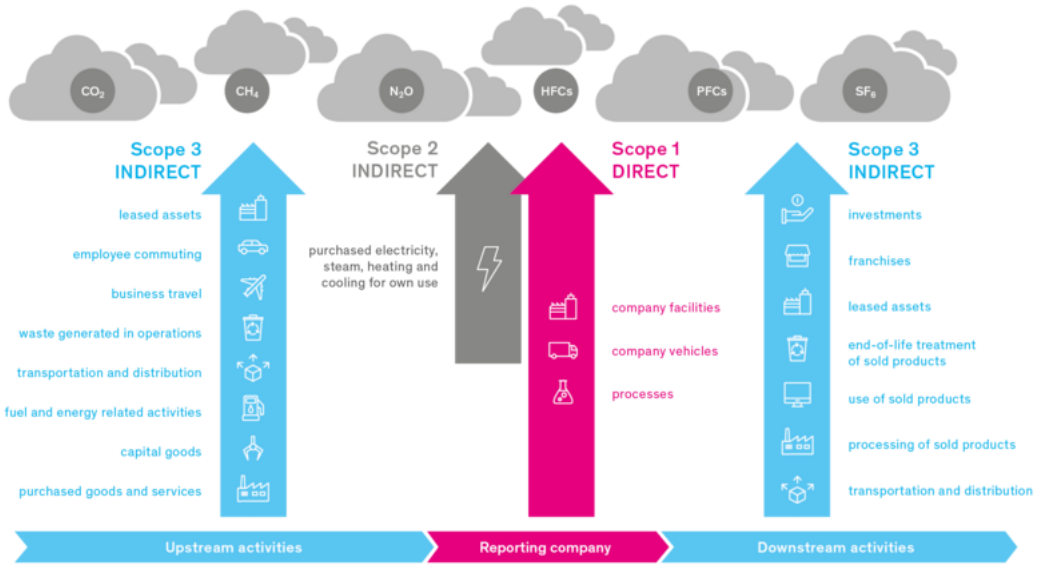
To preserve the planet in the face of the climate challenge, we are moving forward, together, towards new energies.

OIL GAS ELECTRICITY HYDROGEN BIOMASS WIND SOLAR

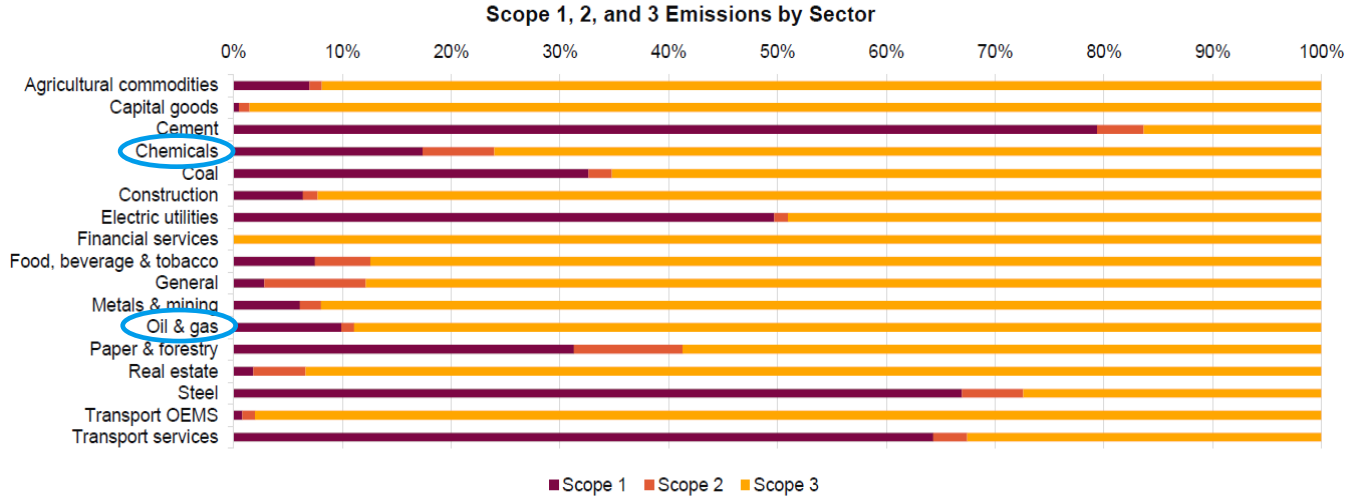
The GHG protocol defined the categories of emissions: Know your scopes across the supply value chain!

The GHG Protocol provides a standardized method for companies to measure GHG emissions in line with the COP24-Paris - To communicate and educate leaders on what business emissions need to be considered, helping organizations act to create a low-C future.

- Since COP24, companies have focused on addressing direct emissions from sources they own or control (Scope 1) and indirect emissions from generation of energy they purchased for consumption (Scope 2).
- There is now increasing focus on Scope 3 emissions, which are defined by the GHG Protocol as an optional reporting category for the treatment of all other indirect emissions generated along the corporate value chain.
- A recent analysis of 866 product carbon footprints, reported to Carbon Disclosure Project (CDP) by 145 companies spanning 30 industries and 28 countries, indicates that only 23% of total value chain emissions are associated with direct operations, while 45% and 32% arise in upstream and downstream activities.



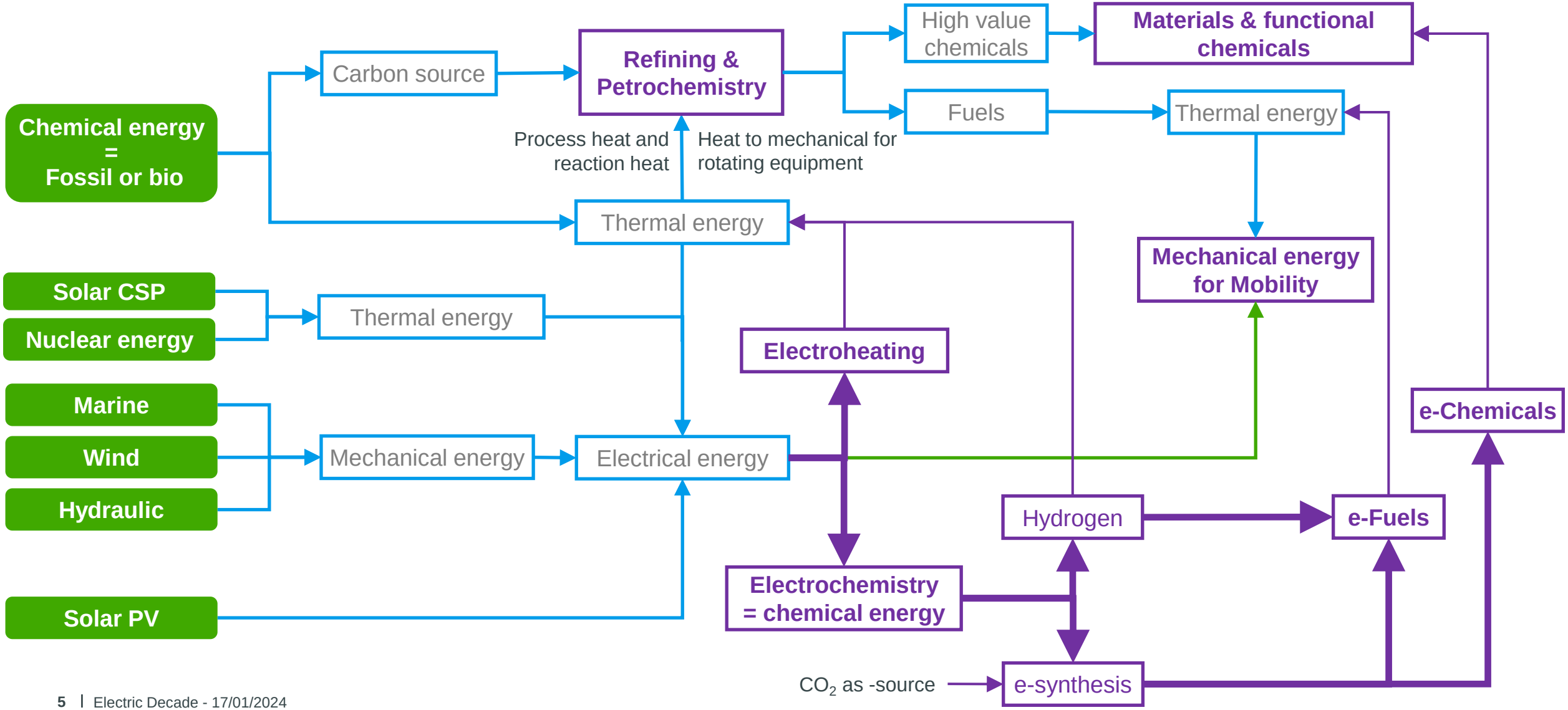
myclimate.org



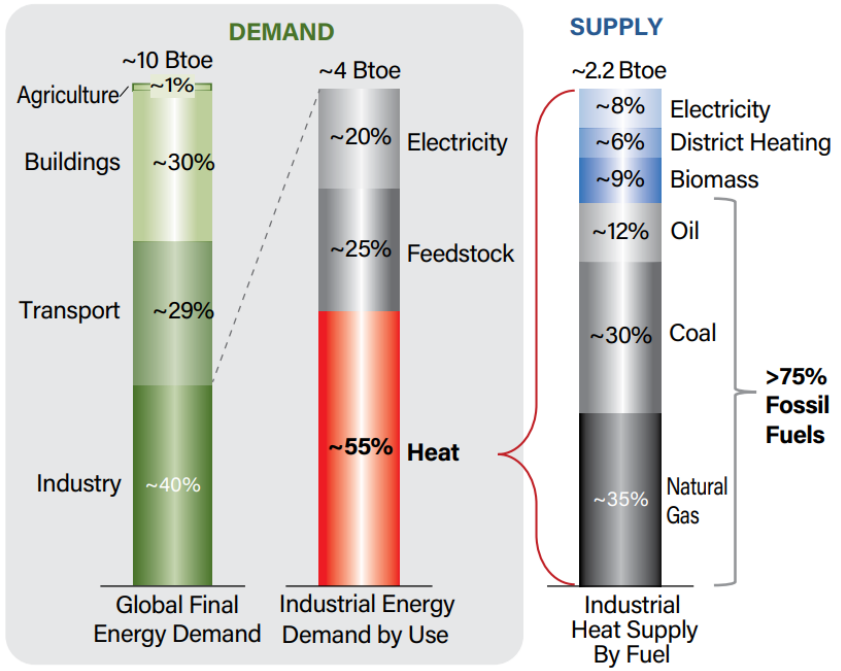
CDP-technical-note-scope-3-relevance-by-sector.pdf

Diagram of how primary energy sources are transformed

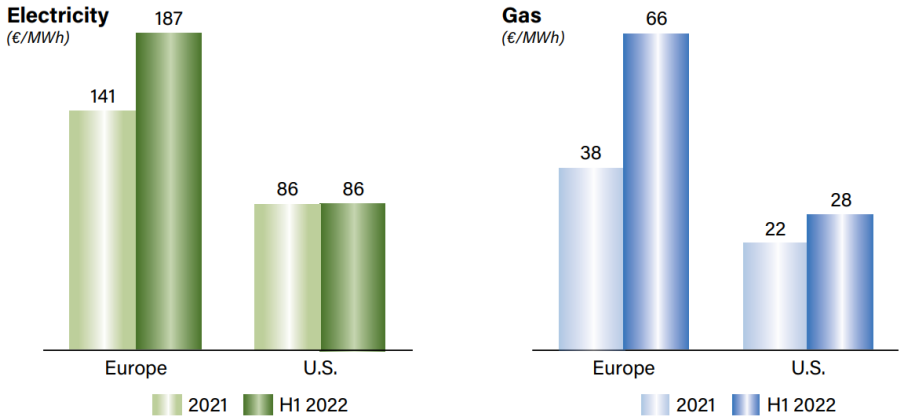
Two ways to electro-decarbonize



Industrial Heat In Global Energy Demand

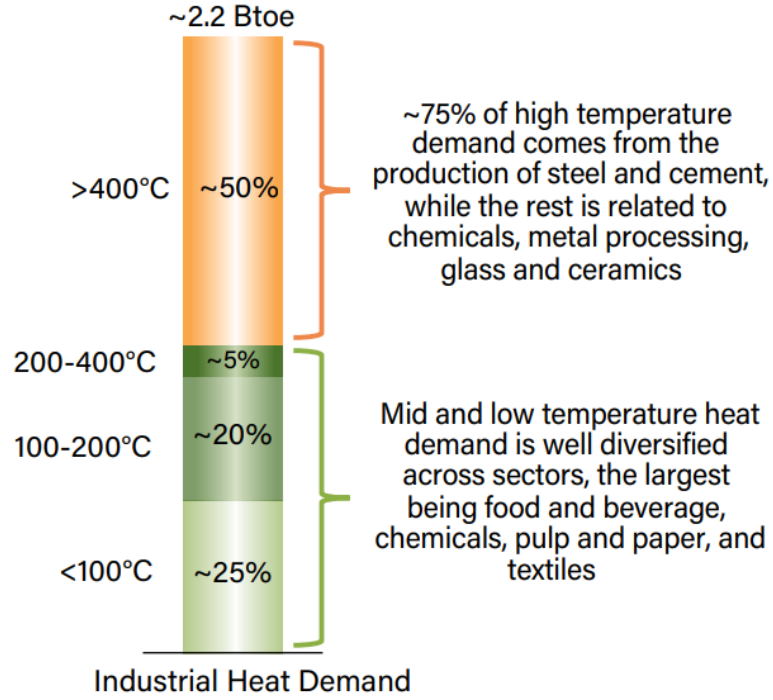


Source: Ambienta analysis on IEA and McKinsey Data



Sources: Eurostat, EIA

Lens on electrifying industrial heat



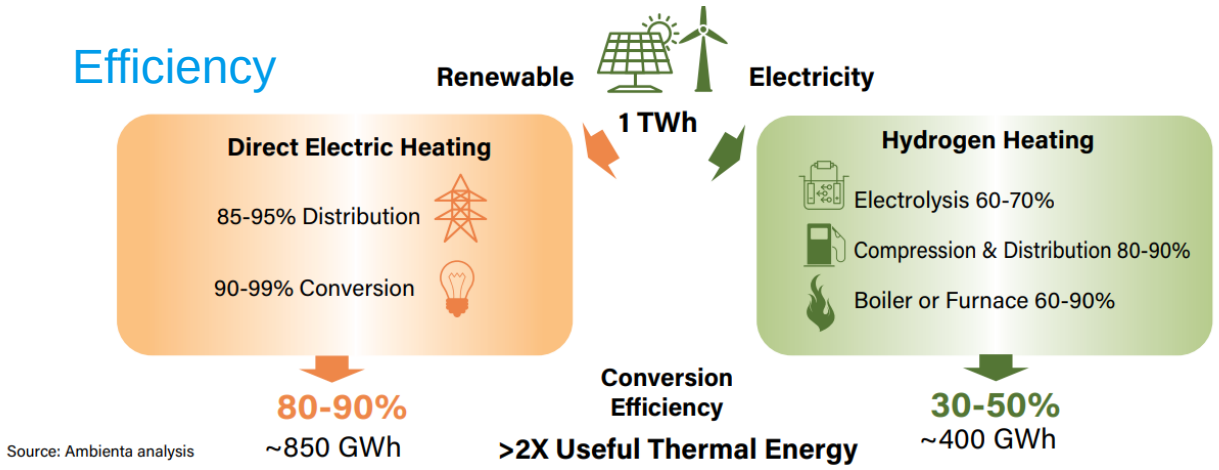
Source: Ambienta analysis on IEA data

LOW-TEMPERATURE HEAT PROCESSES (BELOW 150 C)	MEDIUM-TEMPERATURE HEAT PROCESSES (150–400 C)	HIGH-TEMPERATURE HEAT PROCESSES (ABOVE 400 C)
Food and beverages	Food and beverages	Steel
Paper	Paper	Cement
Textiles	Chemicals	Glass
Agro-industry	Plastics	Refining
Pharmaceuticals	Mining	Chemicals
Plastics	Pulp (paper)	Fertilizer
Chemicals	Ethyl alcohol	
Mining		

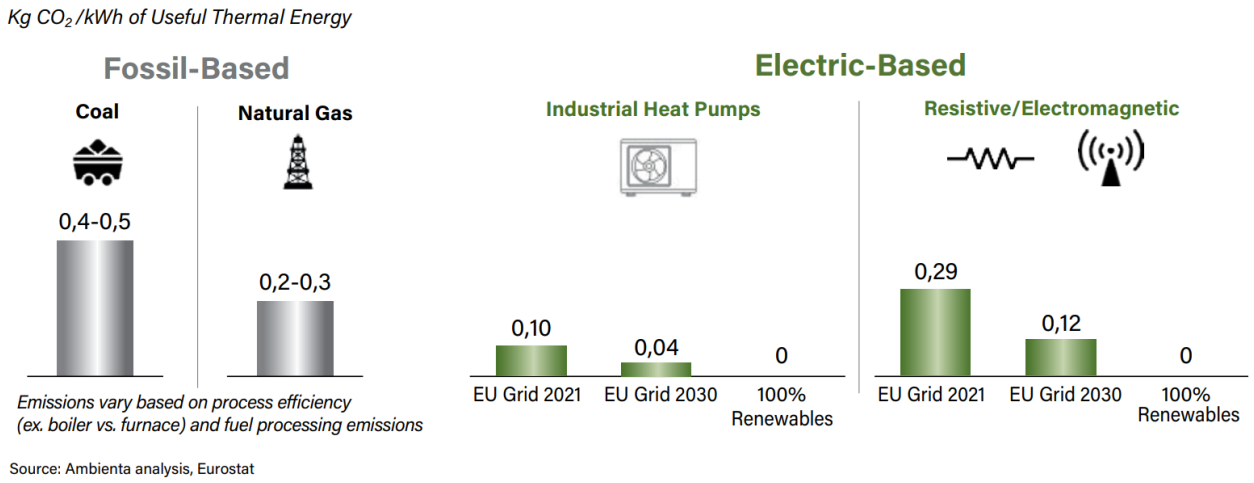
Sources: International Energy Agency (2017), German Energy Agency (2016), Columbia Center on Global Energy Policy (2019), National Renewable Energy Laboratory (2016)

Industrial Heat In Global Energy Demand
Direct vs. Indirect (Hydrogen) Electrification Efficiency

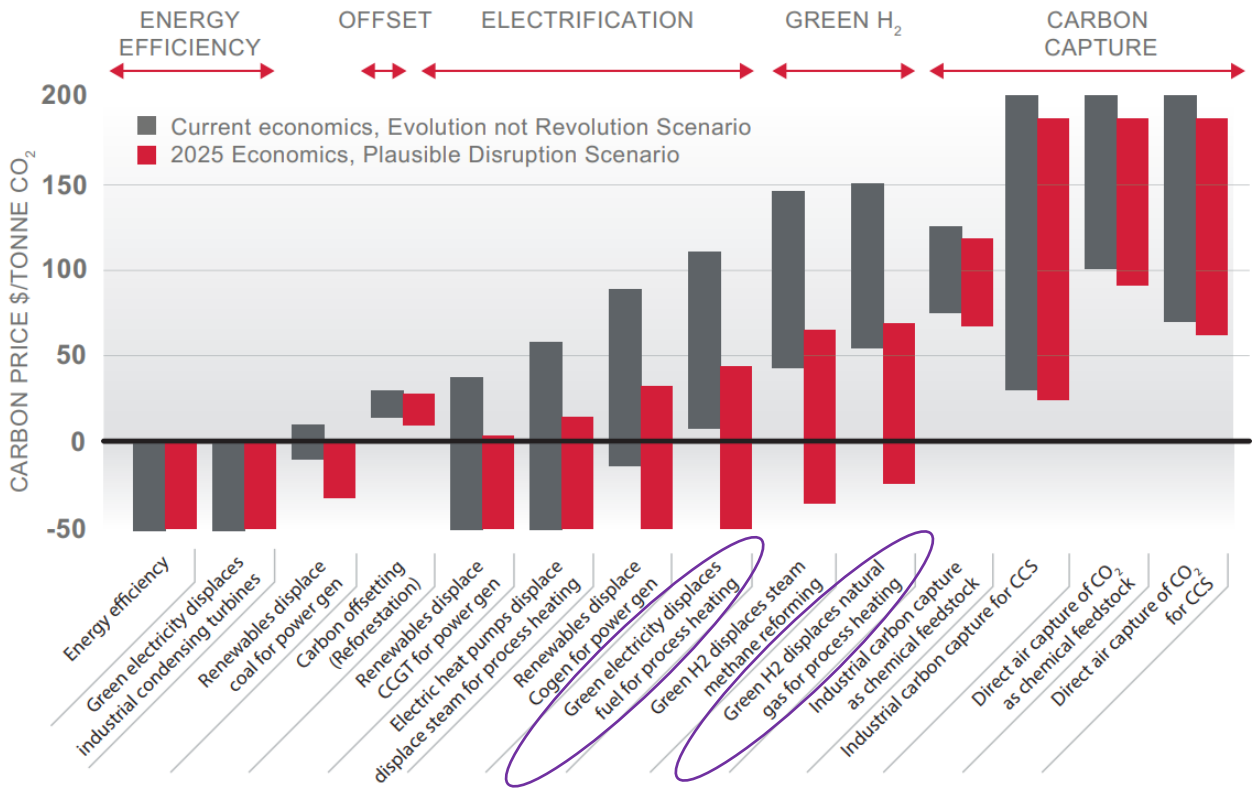
Efficiency



C-footprint of electricity



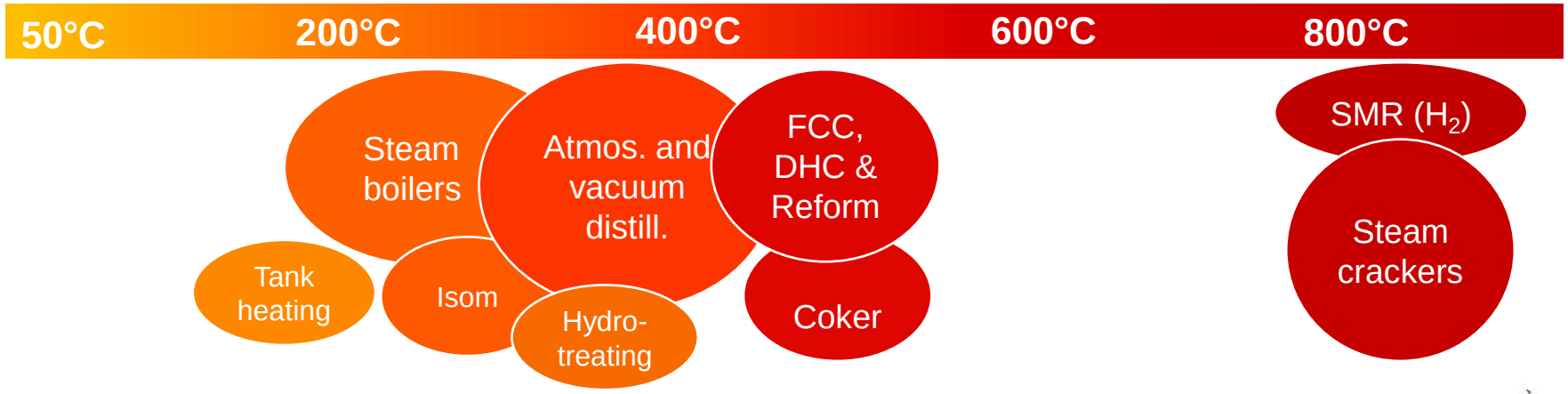
Source: Ambienta analysis, Eurostat

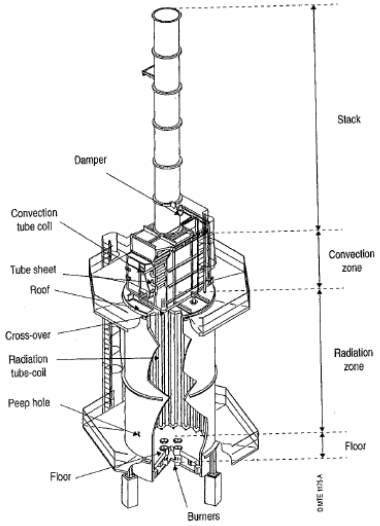


Lens on electrifying industrial heat

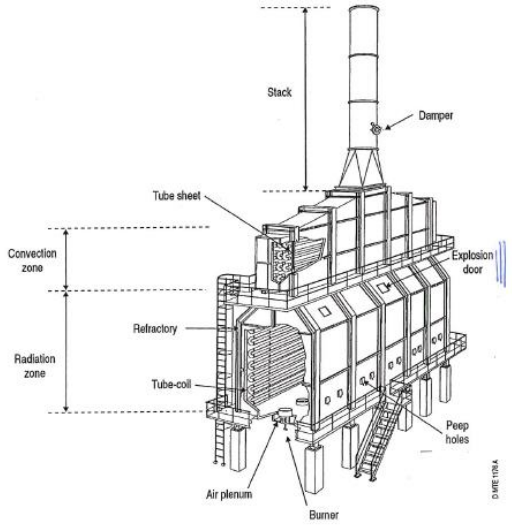
INDUSTRIAL ENERGY TRANSITION MANIFESTO High Stakes Choices

Range of industrial heat use and furnace technology

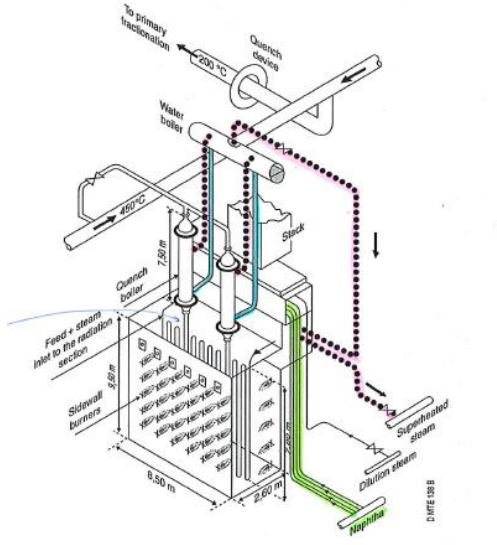




Vertical Cylindrical Furnace



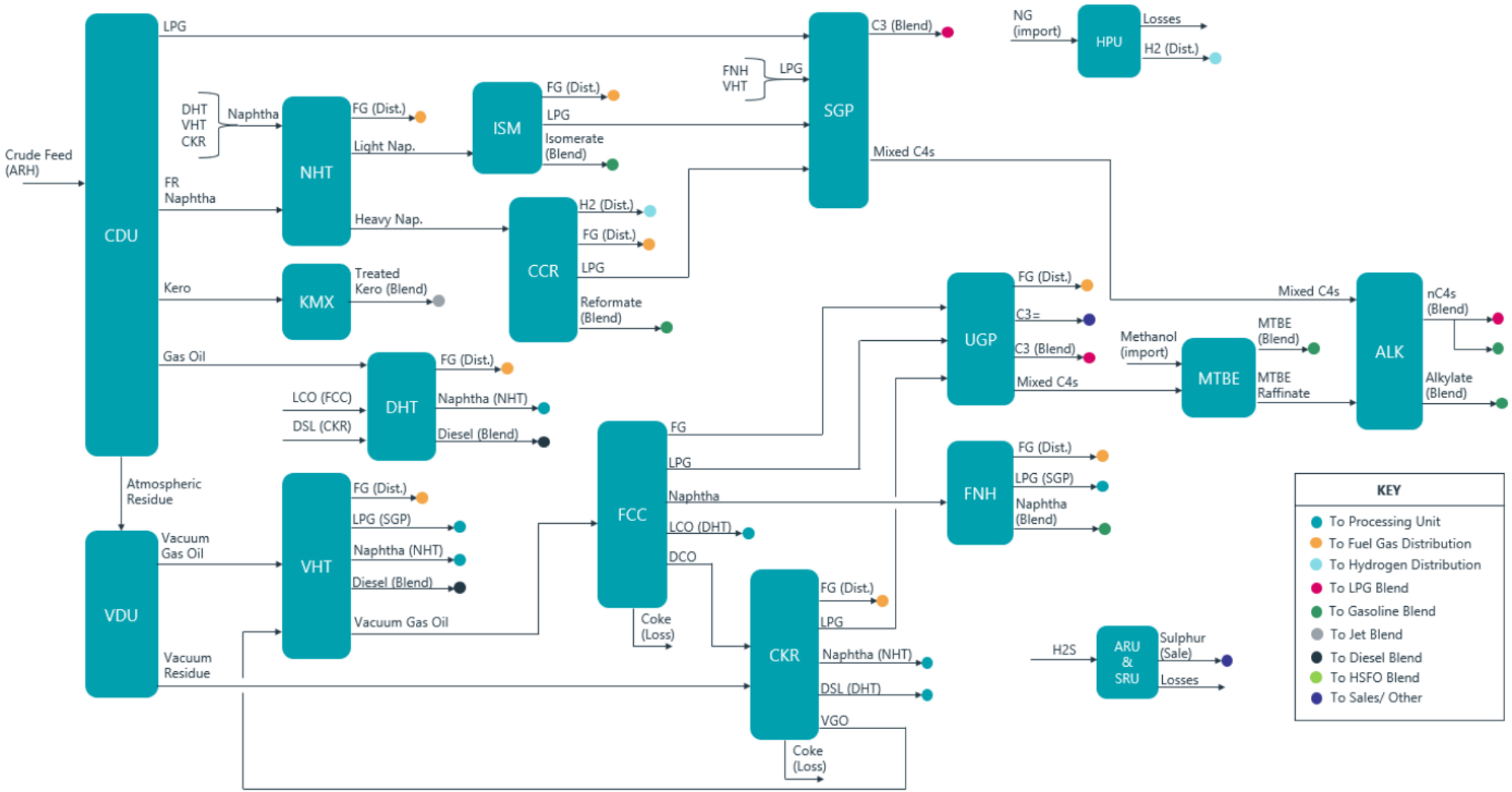
Floor-fired cabin Furnace



Sidewall-fired cabin Furnace

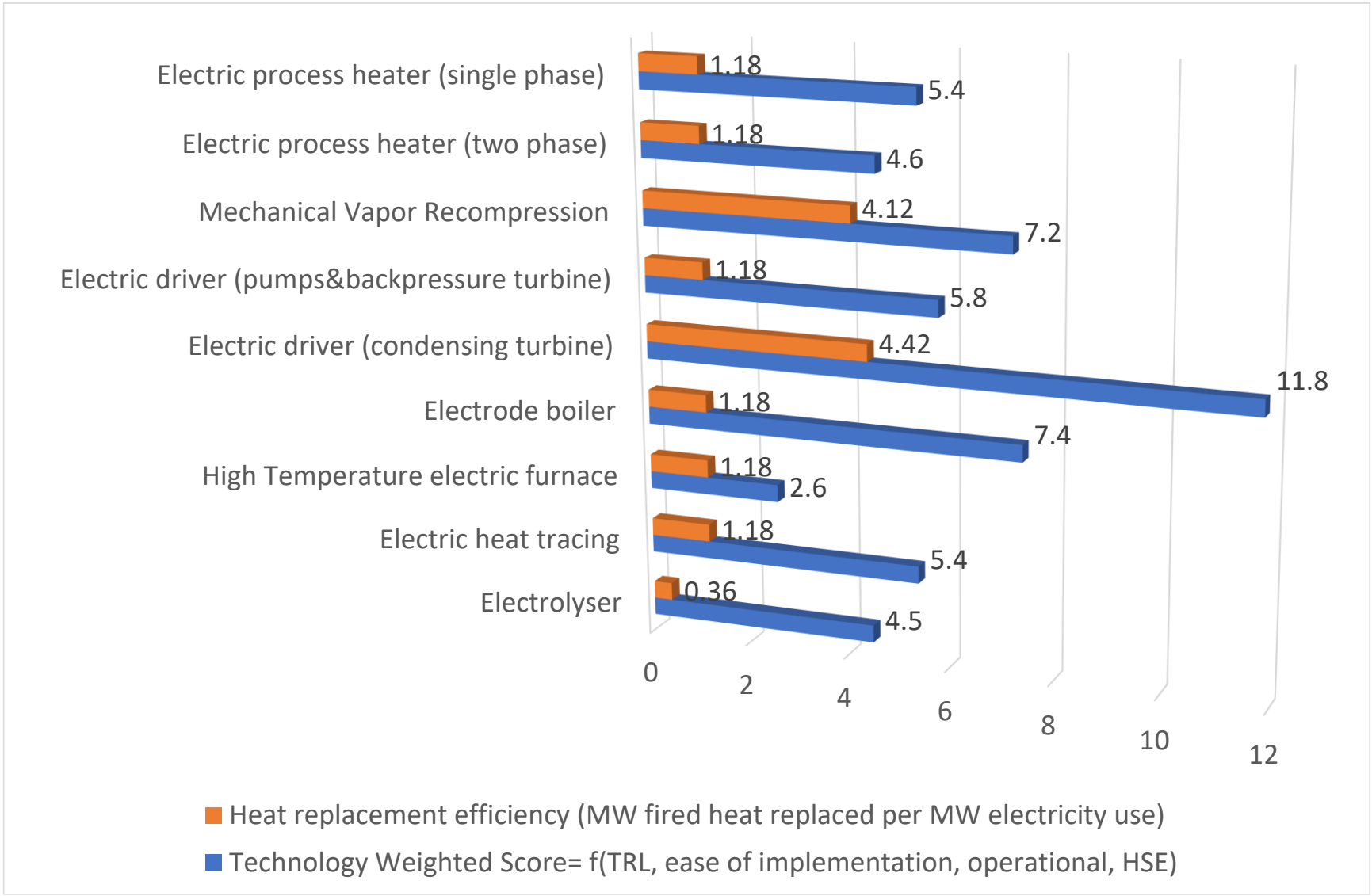
Complex refineries: scope 1 & 2 decarbonization

Using fuel fired feed heater for high T conversion processes & destillation, steam for low T conversion and product destillation (however steam is produced by fired furnaces)



Pathways-to-Decarbonize-Refining-Report.pdf (ogci.com)

Complex refineries: scope 1 & 2 decarbonization Reviewed options by KBC



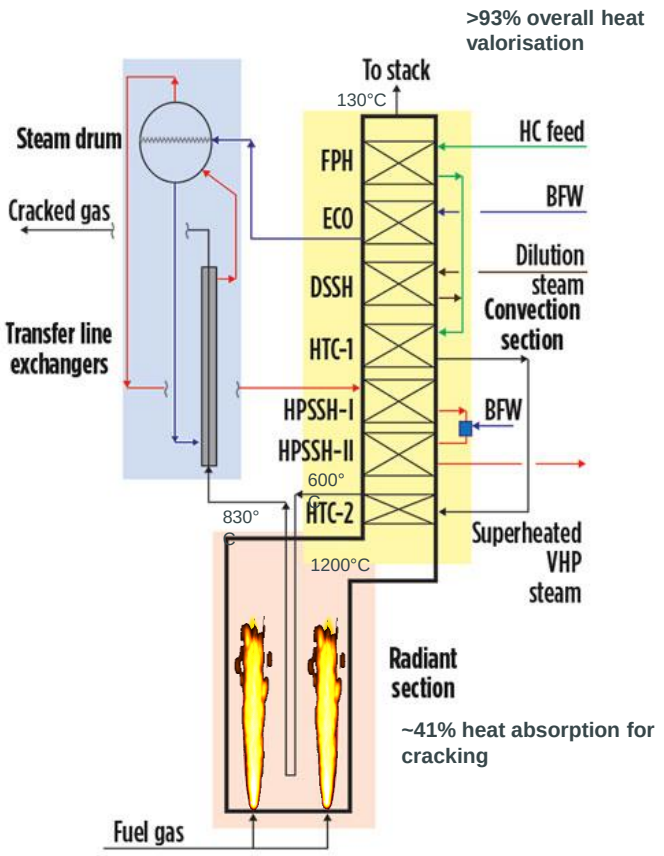
Pathways-to-Decarbonize-Refining-Report.pdf (ogci.com)

The “Cracker of the Future” consortium (COF)

Initiative of the Trilateral region

The Netherlands, Flanders & North Rhein WestFalen

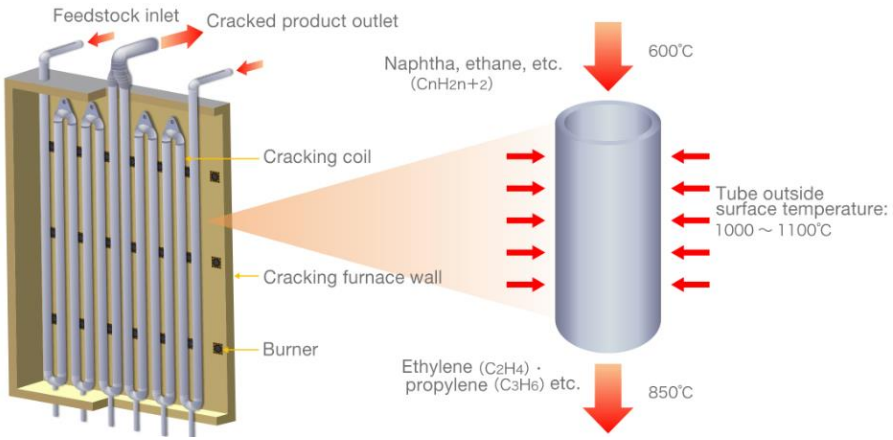
To assess direct electrification of furnaces



- **Europe:**
  - **40 steamcrackers**
  - Capacity: 22 Mta ethylene (‘19)
  - 31 Mta CO_2 [1.43 t CO_2/t ethylene]
  - Energy need (naphtha based): 27 GJ or 7.5 MWh per ton ethylene = 171 TWh/y

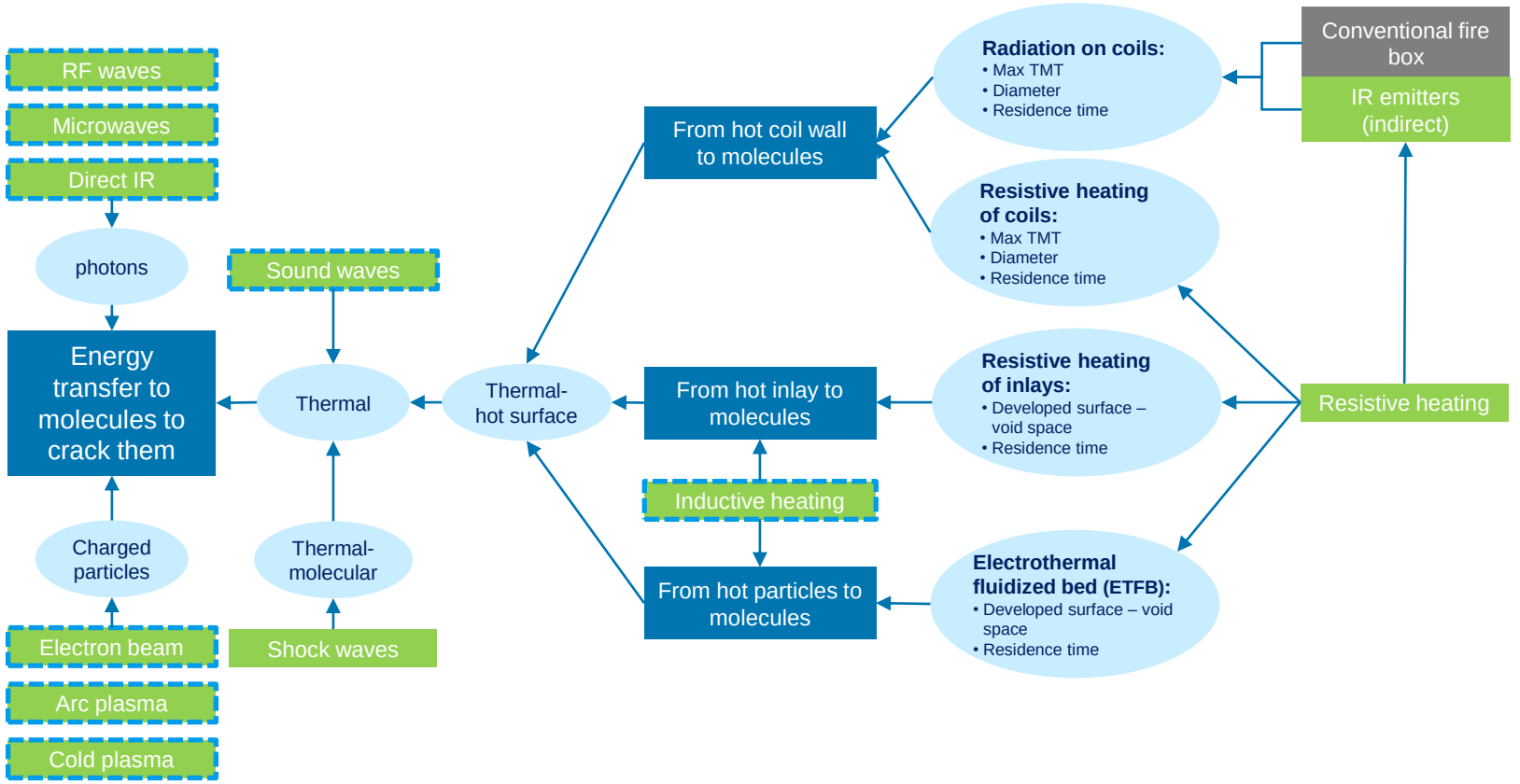
→ Energy need: **171 TWh/y** or ~20 GW

- This additional 171 TWh/y corresponds to 2x the power consumption of Belgium (83 TWh/y)



The COF's technology perspective on electric heating

Assessment: sound technical options – no proof-of-concept yet – new experienced technology partners identified!



Physical concept deemed not scalable for steamcracking

Thanks

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