# Representing Industrial decarbonization Options in TIMES Belgium model

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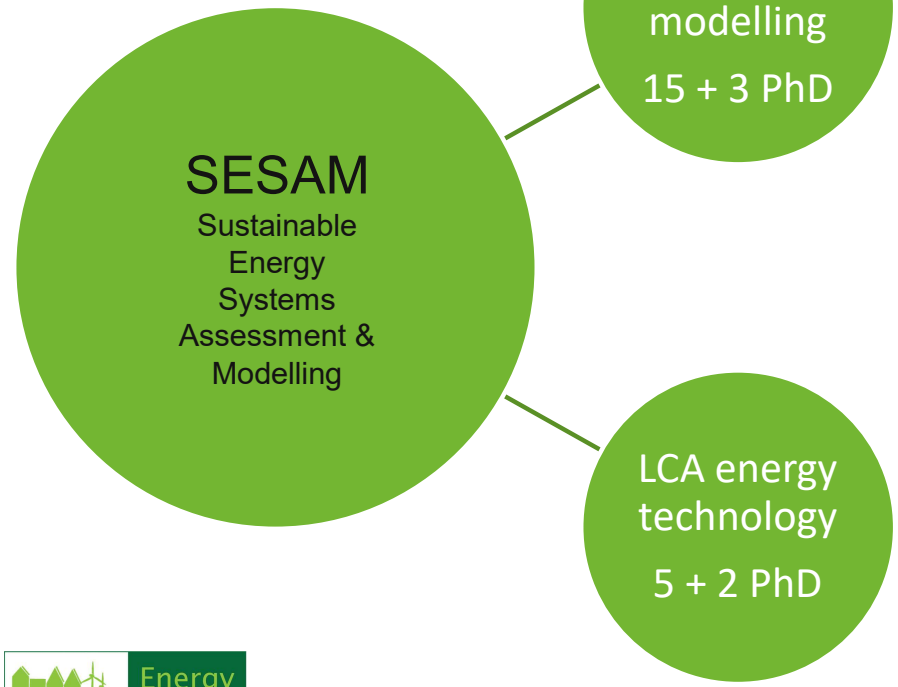
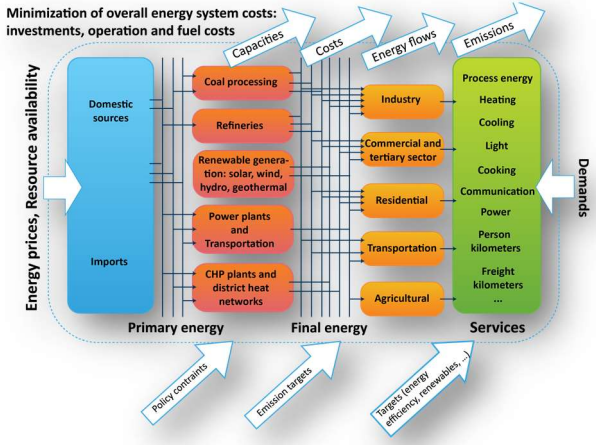
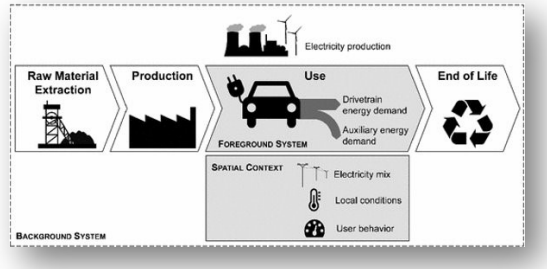
# SESAM@VITO-EnergyVille




- Techno-economic model development
- Long term system scenarios
- Focus on pathways to net-zero 2050




- LCA analysis for new energy technologies
- Integrate LCA with other sustainability assessment methods/tools

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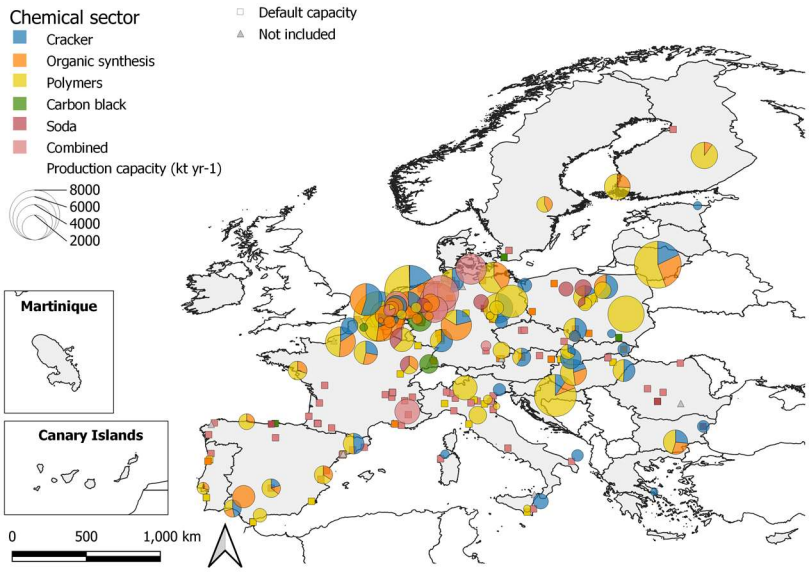
# Agenda

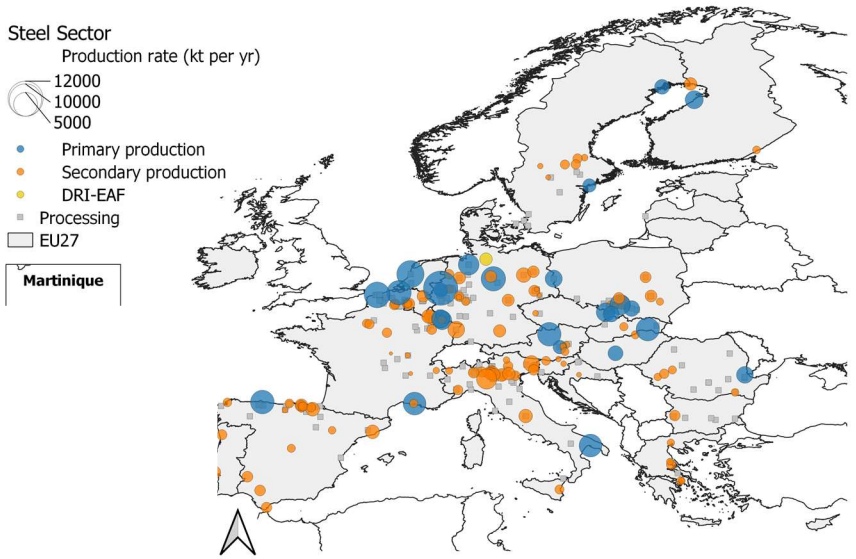
- Industrial energy consumption and CO2 emission in Belgium
- Industry representation within TIMES-BE model
- Improved modeling of industrial sector
- Various decarbonizing options
- Indicative results
- Discussion

# Belgium is an industry hotspot

## Chemical




## Steel

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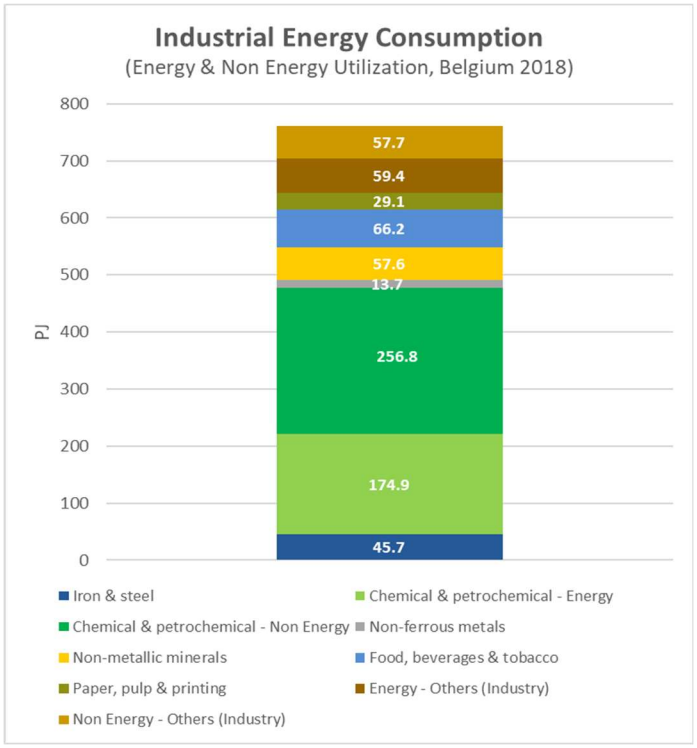
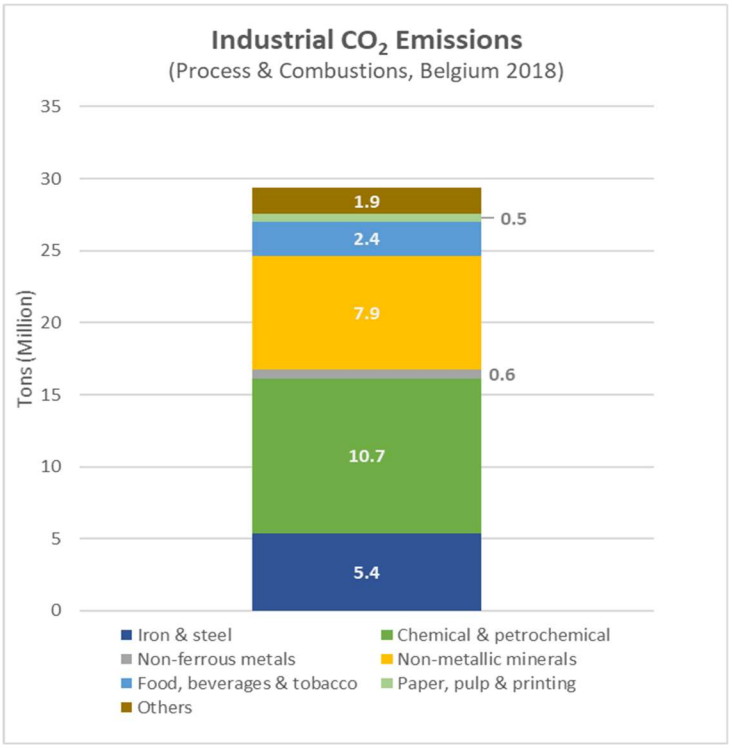
Source: AidRES project, 2021

# Belgium Industry: Energy Consumption and CO2 Emission

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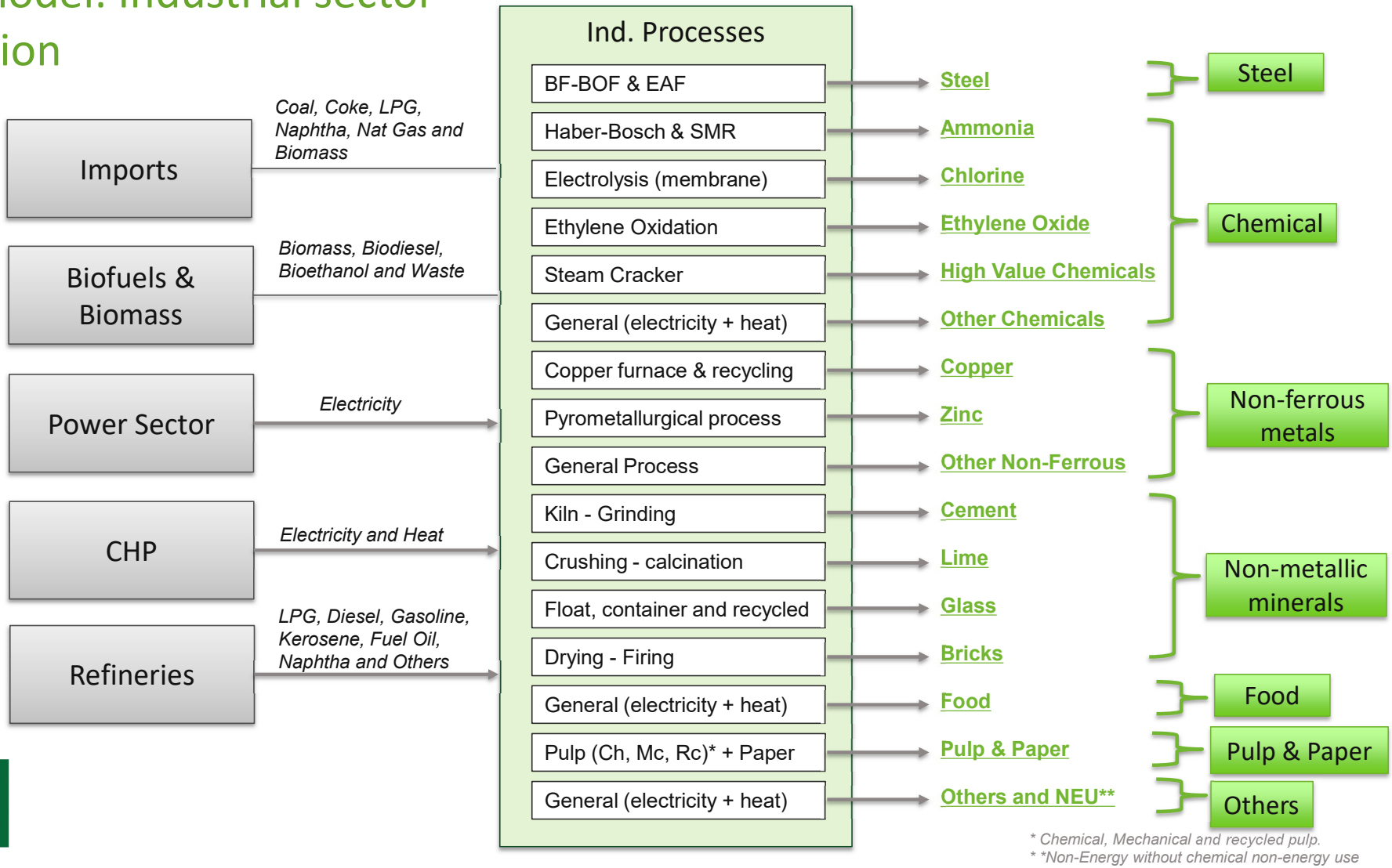
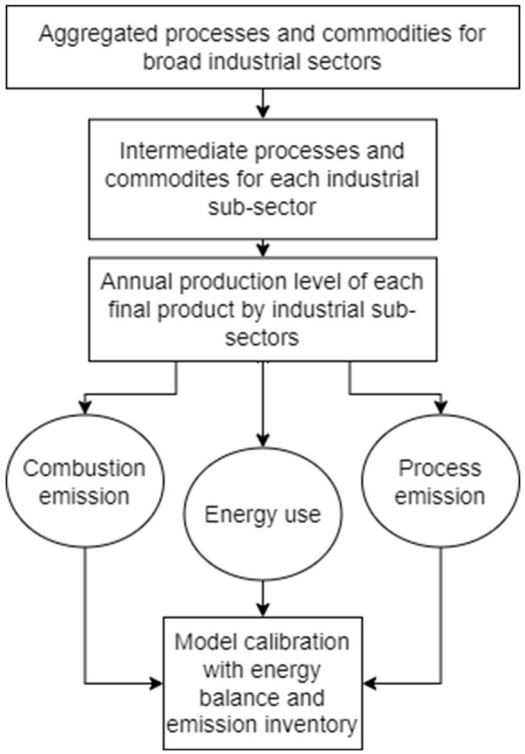
# TIMES-BE model: Industrial sector representation



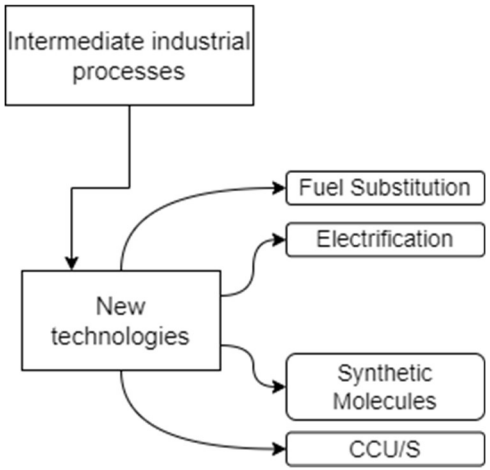

* Chemical, Mechanical and recycled pulp.
* *Non-Energy without chemical non-energy use

# Improved modeling of Industry Sector in TIMES-BE model

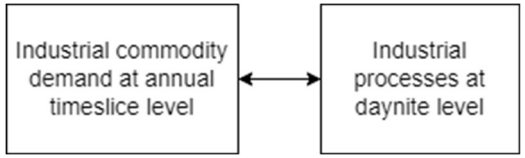
## Technological detailing




## Decarbonization options




## Flexibility



# Decarbonization options for Industry

| Sector | Fuel Substitution | Electrification | Molecules | CCU/S |
|---|---|---|---|---|
| Iron & Steel | BF - H2 Injections<br>EAF (ELC+Biomas) | MOE<br>EAF (100% ELC) | H-DRI | BF/BOF + CCU/S<br>NG-DRI + CCU/S<br>Amine absorption |
| Ammonia | | | Haber–Bosch (H2) | Pyrolysis<br>SMR+CCUS |
| High Value Chemicals | | Electro plastics | MTO<br>MTA | Advanced steam crackers & CCS |
| Other Chemicals | | Heat pumps<br>Electric steam boilers<br>Electrode Steam boilers<br>Electric heaters | Hydrogen boilers<br>Hydrogen heaters | |
| Cement | Waste and biomass | Plasma heaters | H2 substitution of fuel in Kiln | Amine absorption<br>CCS-oxy fuel<br>MEA |
| Glass | Green methane | 100% electric<br>Electric boosting | H2 heaters | Amine absorption |

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# Decarbonization options for Industry

| Sector | Fuel Substitution | Electrification | Molecules | CCU/S |
|---|---|---|---|---|
| Brick | Green CH4 | Microwave heaters<br>Microwave-assisted gas firing (MAGF) | H2 heaters | Amine absorption |
| Lime | Waste and biomass | Plasma heaters | H2 substitution of fuel in Kiln | Amine absorption |
| Other non-metallic minerals | | Electric tunnel kiln | H2 -based high temperature heat | Amine absorption |
| Copper | | | H2 anode furnace | |
| Zink | Biogas burners | Electric burners | | Amine absorption |
| Other non-ferrous metals | Biogas burners | Electric heaters | H2 based heaters | Amine absorption |
| Food | | Electric boilers<br>Heat pump<br>Electric heaters | H2 boilers | |
| Pulp and Paper | | Electric boilers<br>Heat pump<br>Electric heaters | | |

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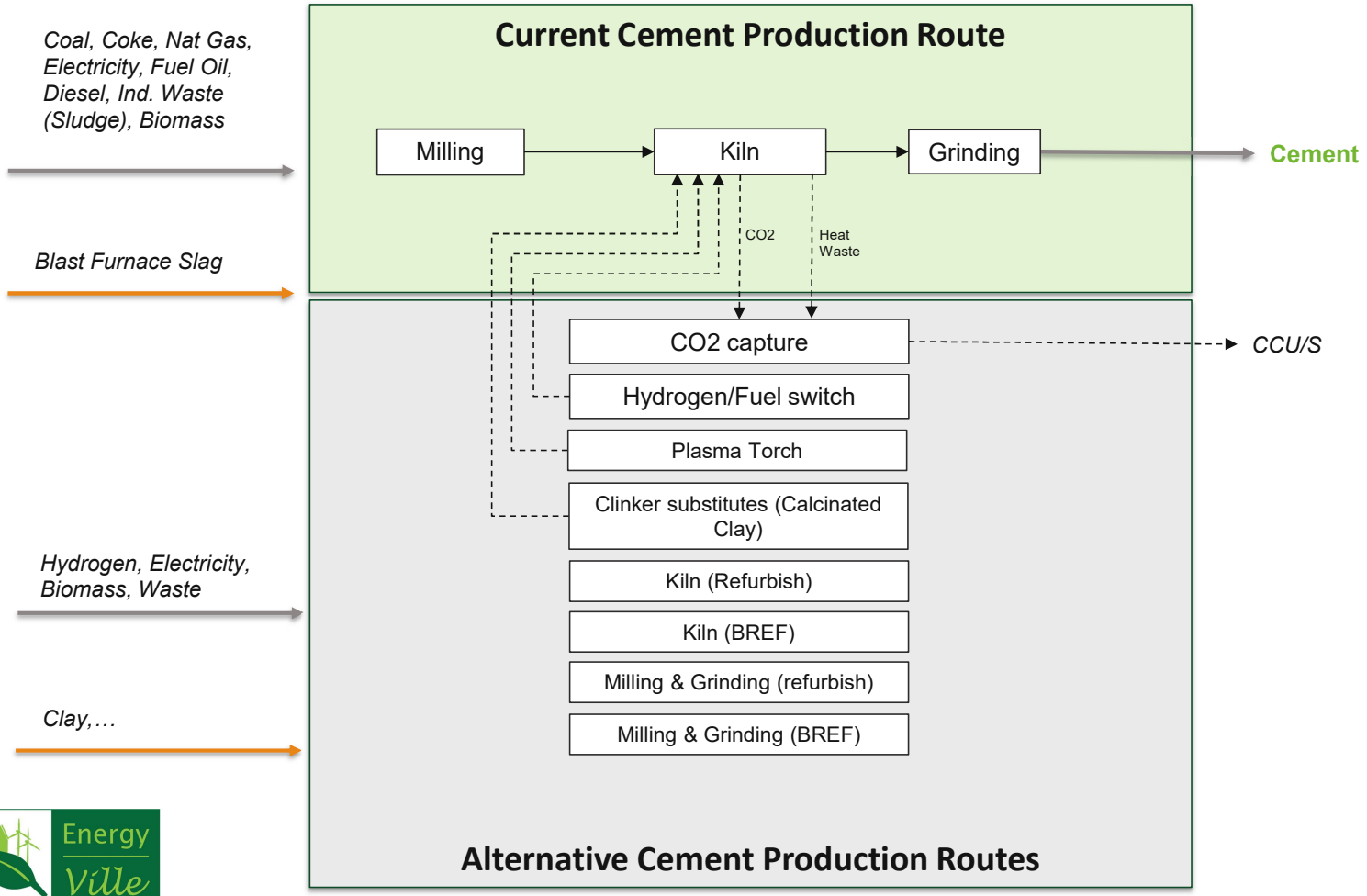
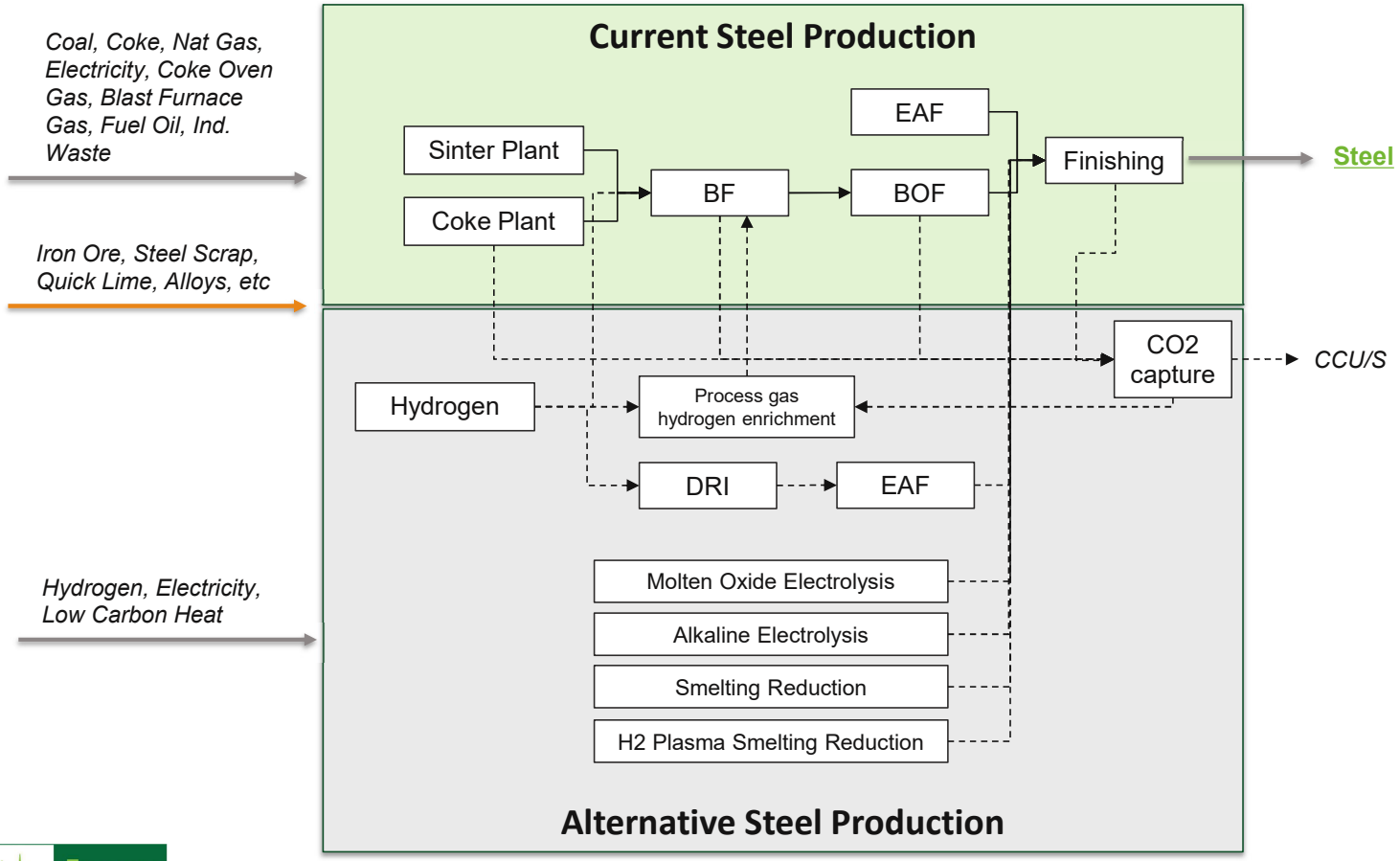
# Example: Cement production routes in TIMES-BE model



# Example: Steel production routes in TIMES-BE model



# Initial observations from the model run

- We run a scenario with CO2 price of 80 €/ton in 2020 and 350 €/ton in 2050
- Industrial CO2 emission is about 2.6 Mt in 2050 compared to 24.6 Mt in 2020
- Decarbonization technologies are being picked up by the model for certain sub-sectors in 2050
- Choice of electricity is seen in sectors like pulp and paper (heat pump), food (heat pump), fiber-glass (electric boosting), lime (plasma kiln), zinc (electric burners), other chemical (CHP)
- Hydrogen based heating for bricks, hollow glass, and lime sector
- Substantial amount of CO2 capture, mainly to capture process related CO2 emissions. Total CO2 capture in 2050 is 12.56 Mt
- Chemical, cement and lime contributes to most of the captured CO2

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# Developing Input data related to improved industry sector modeling

- Many industrial decarbonization technologies have low technological readiness level (TRL)
- Compiling realistic data e.g., costs, life, efficiency, start-year for these technologies are challenging
- Converting an aggregated process into sub-processes needs realistic input data (e.g., input to output ratio for material and energy consumption, emission factors, other attributes)
- We rely on industry and consultancy reports, research articles and stakeholder consultations
- We closely work with industry partners in Belgium in multiple projects to develop these technological assumption

# Lessons learned from improved modeling of industry

- Technological improvements of low TRL technologies should be regularly tracked for updates of data
- Model outputs should be examined for sensitivities of low TRL technology parameters
- Modeling intermediate processes allows decarbonizing a certain sub-process
- It allows effective tracking of process and combustion related emission
- It also allows flexibility to be linked to a specific intermediate process
- Modeling final commodity demands allows validating realistic commodity prices from model output
- Modeling of flexibility for industrial processes impacts largely on model run-time

# Future Work

- Further validation and refinement of data for low TRL decarbonization options (On going)
- Prioritize certain industrial processes to be modeled as flexible (On going)
- Parametric runs for various CO2 prices and Net Zero GHG emission scenario (End of the year)

# Thank You

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