Use of torrefied biomass by the steel industry: the TORERO project

European Bioenergy Future 2022

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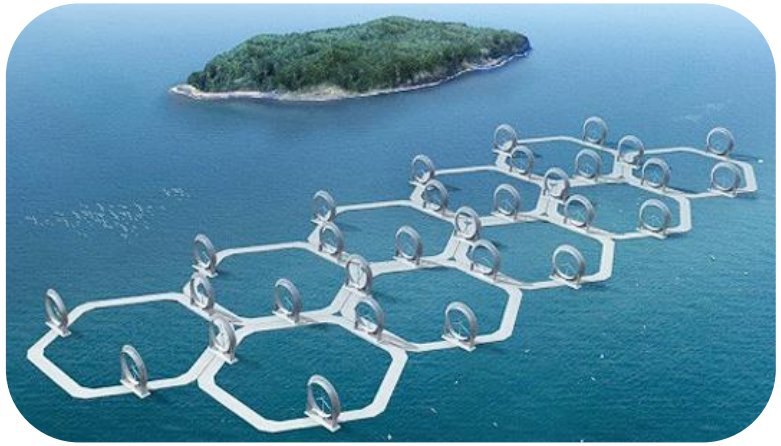
What is common about all of these plausible futures?



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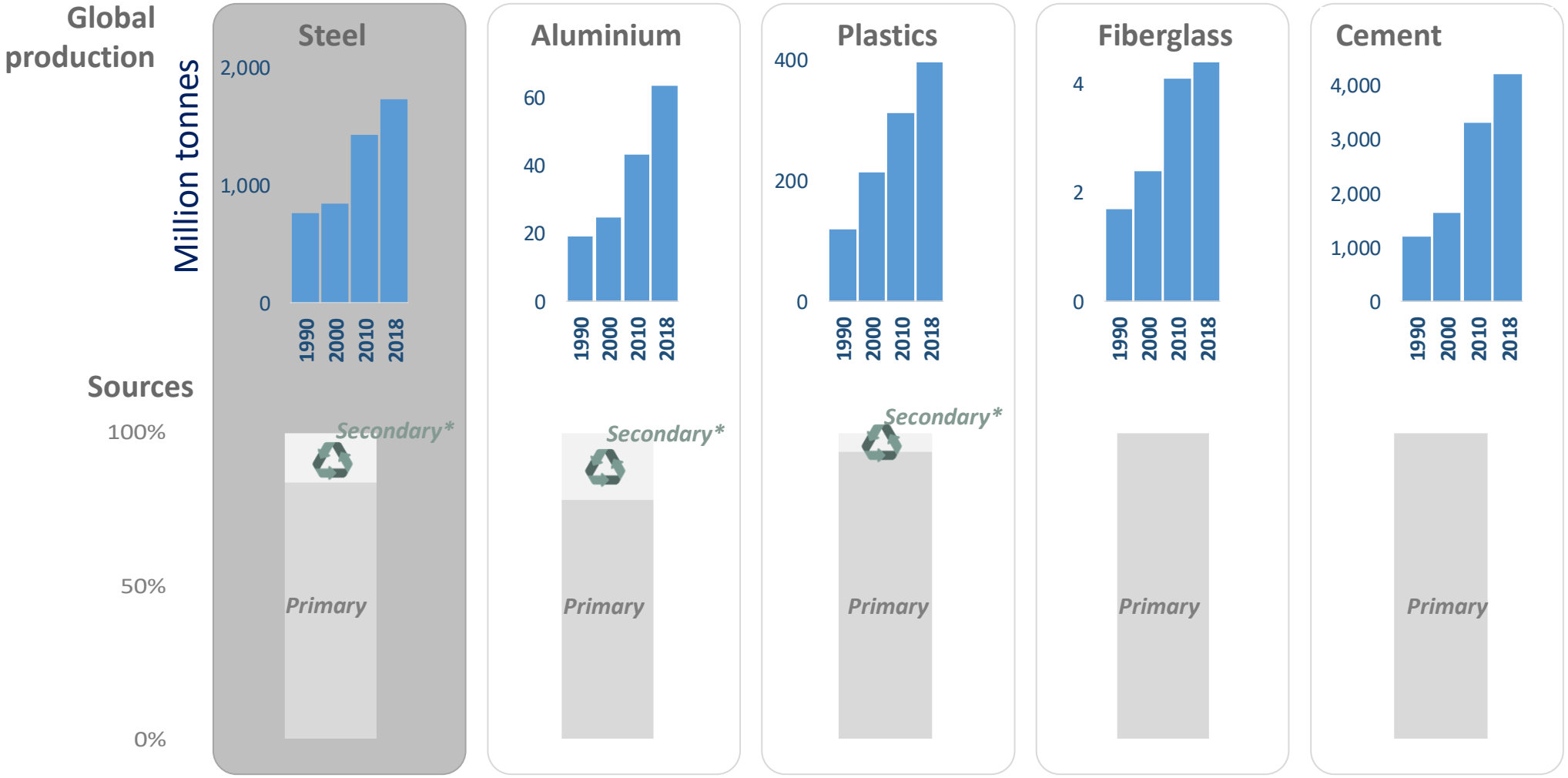
Materials: global consumption for most materials has tripled since 1990; material production today relies heavily on primary sources



* Defined as end of life material recycled to make same material again

Sources: WSA, World Aluminium, Plastics Europe, ArcelorMittal Corporate Strategy analysis

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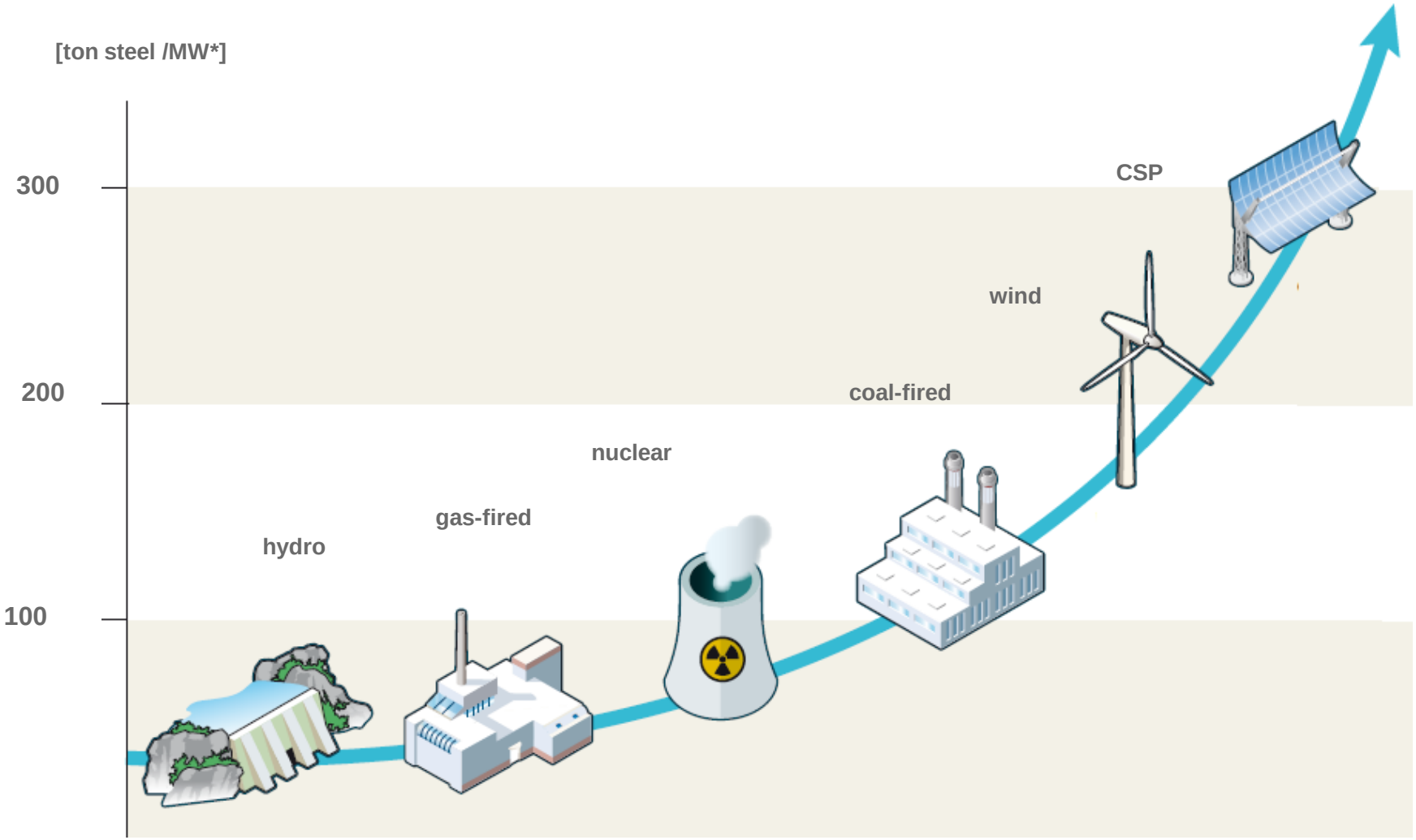
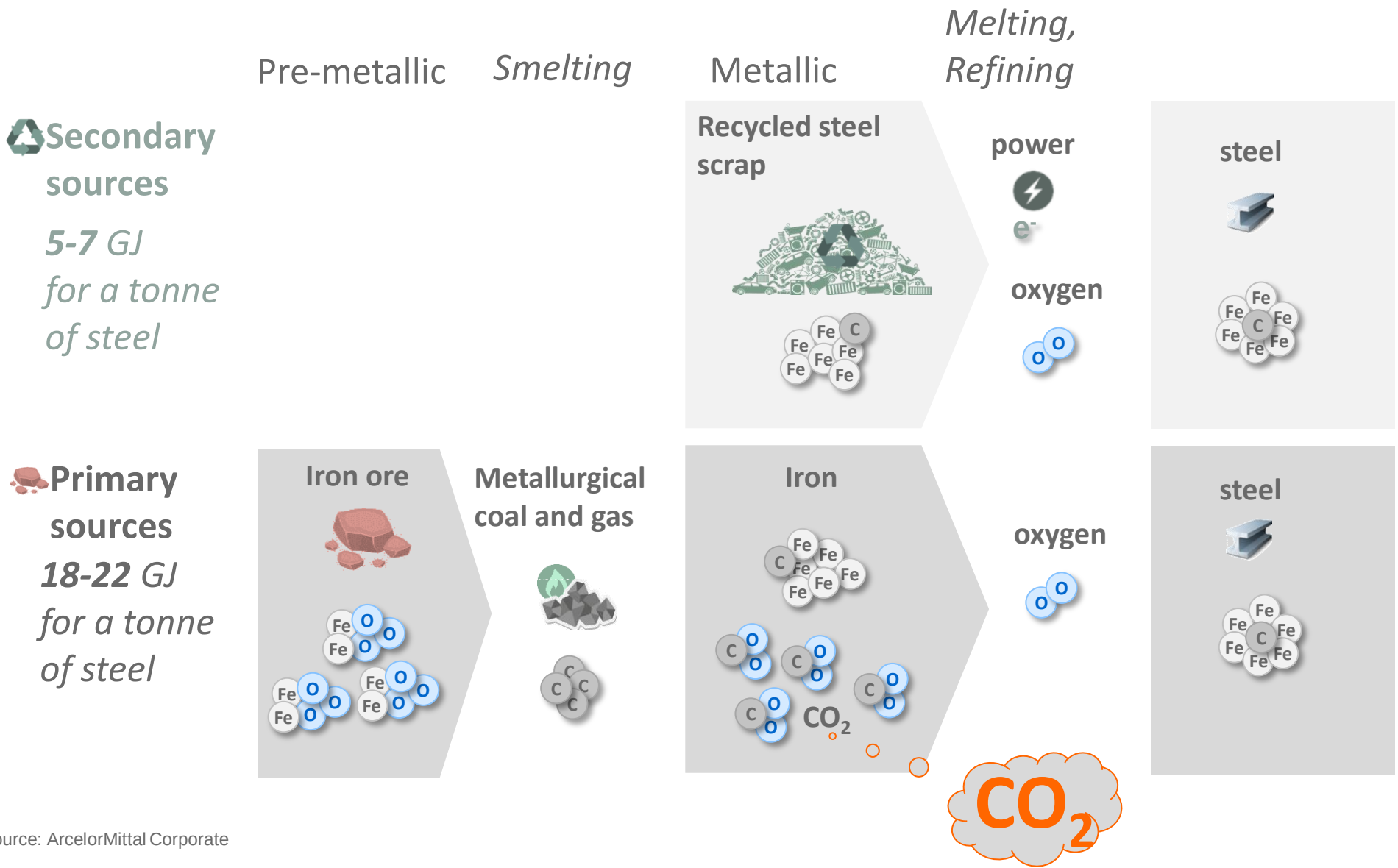
Energy transition: Sustainable energy production increases the need for materials
Steel intensity in modern society is further increasing



** steel consumptions per installed MW capacity*

As with virtually all materials, producing steel from primary sources requires significant energy, today's main source of CO_2 emissions



Source: ArcelorMittal Corporate

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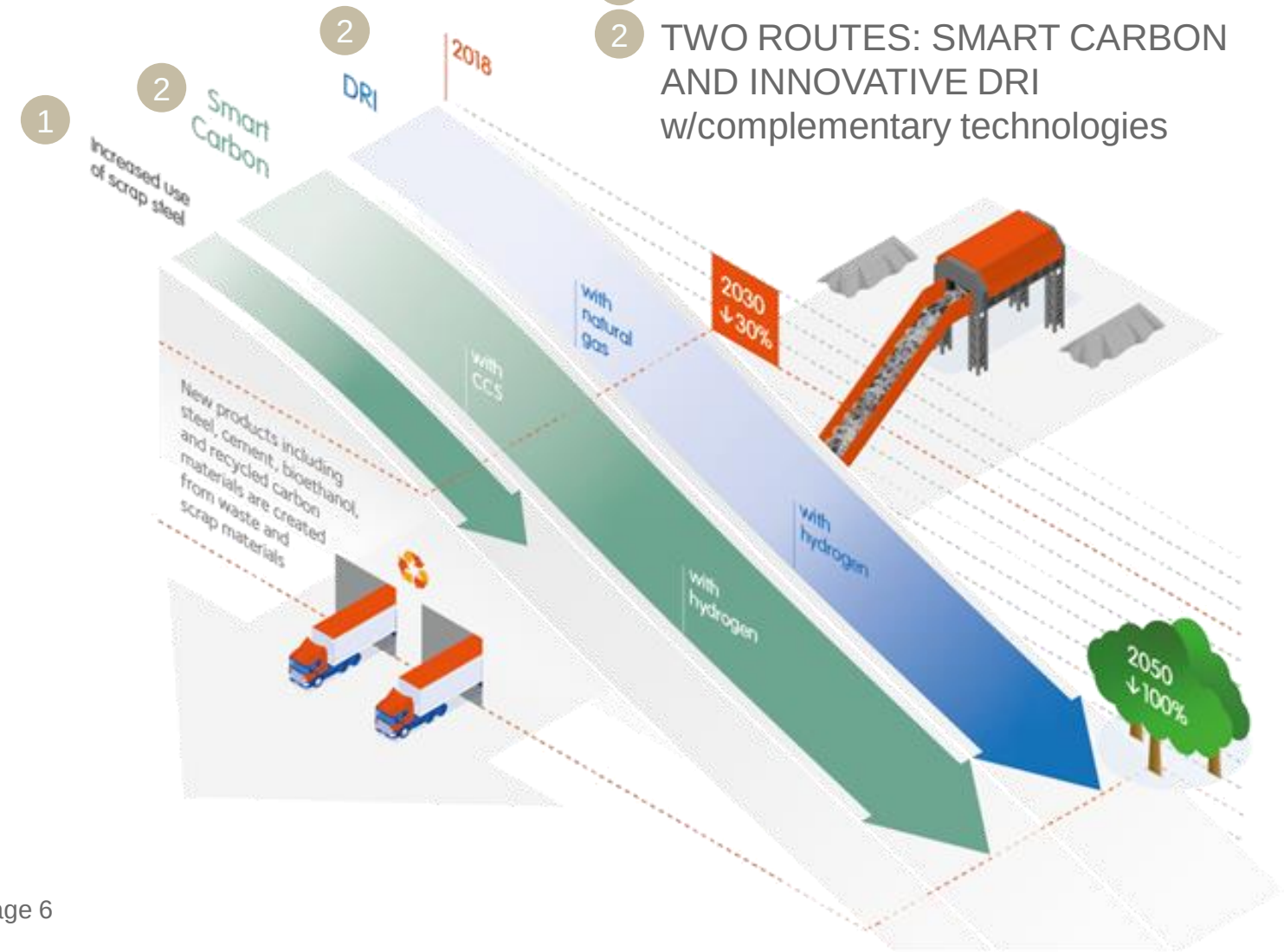
ArcelorMittal roadmap to low-emissions steelmaking

1. INCREASE USE OF SCRAP
2. TWO ROUTES: SMART CARBON AND INNOVATIVE DRI w/complementary technologies



Smart Carbon includes:

- Carbalyst
- Torero
- IGAR
- 3D - carbon capture

DRI includes:

- ArcelorMittal Hamburg hydrogen project

New Group target of a 25% reduction in CO_2e emissions intensity by 2030 (scope 1 and 2)

Europe target increased to 35% reduction in CO_2e emissions intensity by 2030 (scopes 1 and 2)

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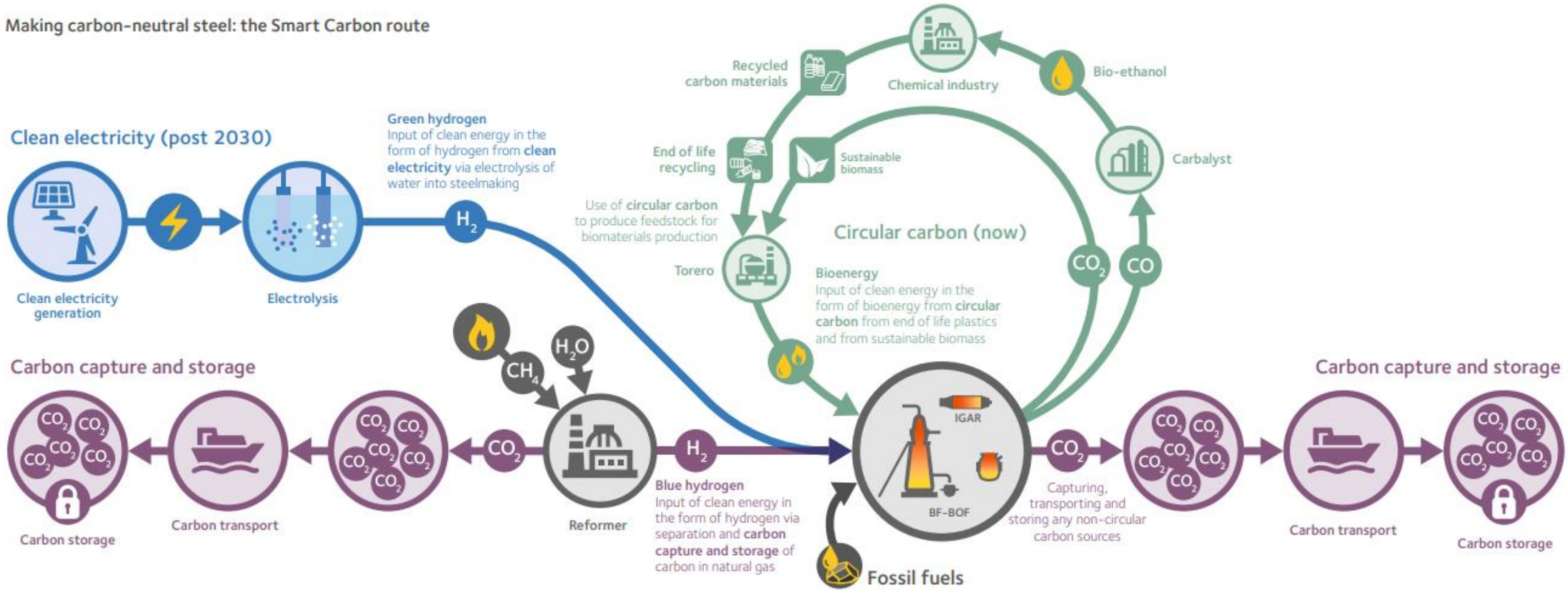
Our roadmap: Smart Carbon technologies



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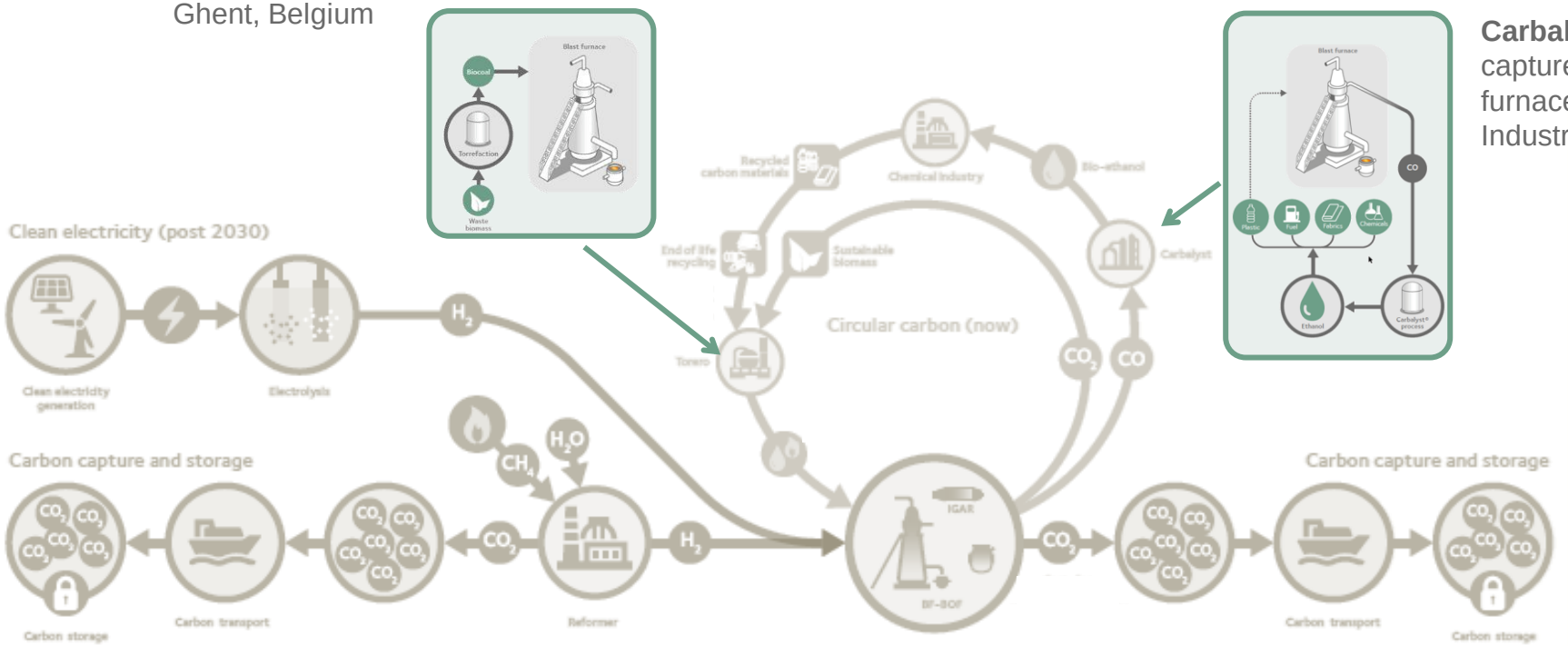
Our roadmap: Smart Carbon technologies

Torero
converts waste wood into bio-coal, replacing the coal currently injected as a reductant. Large-scale demo plant in Ghent, Belgium



Carbalyst (Steelanol)
captures carbon off-gases from the blast furnace and converts into ethanol
Industrial demo plant in Ghent, Belgium

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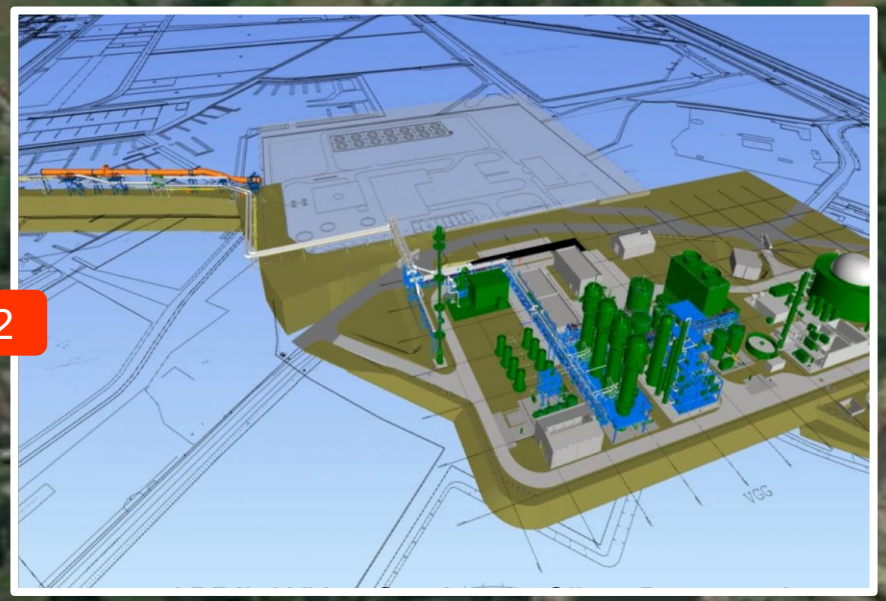
Torero and Steelanol: converting waste wood into advanced bio-fuel

1

2



- Investment cost is **210 Meuro**
- **90 000 Nm³** waste gas/h from BF
- ₊180 000 ton waste wood (type B) is converted to **75 000 biocoal**
- Production of **80 million liter of biofuel**
- Start production **2023**

Waste collection

Torrefaction

Waste wood

Bio Coal

45 % Powder coal

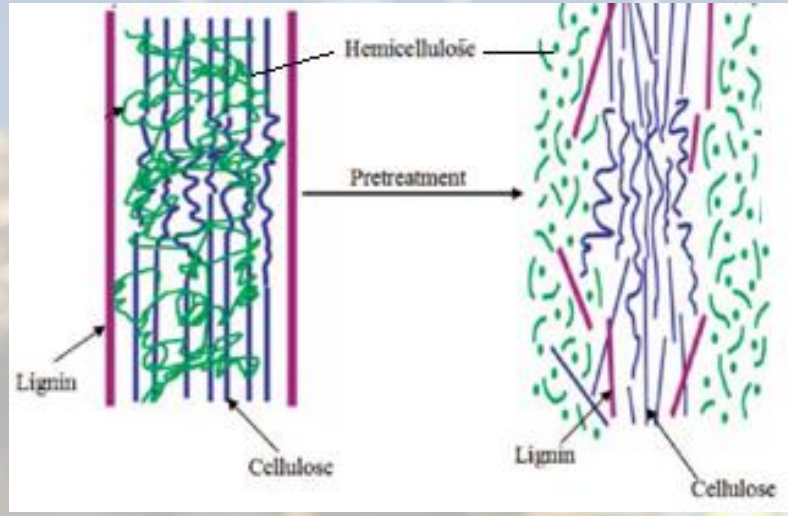
5 %

50 % Cokes

Blast furnace

Torrefaction process

- A biomass pre-treatment at a temperature of 250-320° C in absence of O_2, leading to removal of moisture and volatiles
- Similar thermal degradation process as charcoal



Wood chips Wood(pellets) Torrefied wood Charcoal Coal Coke

TORERO PLANT

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Torero: March 2021

Torero: June 2021


arentis.com
JLG
460SJ

Torero today

Roll **out** at AM steel plants

ArcelorMittal Ghent, Belgium

"Torero": At ArcelorMittal Ghent, we are constructing an industrial-scale demonstration plant that converts waste wood into bio-coal through a process called torrefaction. This source of waste wood is considered hazardous material if burnt in an incinerator as it emits harmful gasses. However, in a blast furnace no such pollutants can be formed. At the Ghent plant, two reactors will each produce 40,000 tonnes of bio-coal annually that can be used in the blast furnace as a substitute for coal. Construction of the €50m project started in 2018: reactor #1 is expected to start production in 2022 and reactor #2 in 2024.

Expanding our Torero technology across our operations in Europe would allow us to reach 1 million tonnes of coal substitute by 2030, reducing our CO_2 footprint by up to 3 million tonnes. We expect the technology to permit the use of municipal sludges, agricultural residues and plastic waste as inputs and the creation of biofuels and biogases as outputs in addition to bio-coal.

CO_2 savings: up to 3 million tonnes (when expanded across operations)

Expected completion date: 2022 (reactor 1) & 2024 (reactor 2)

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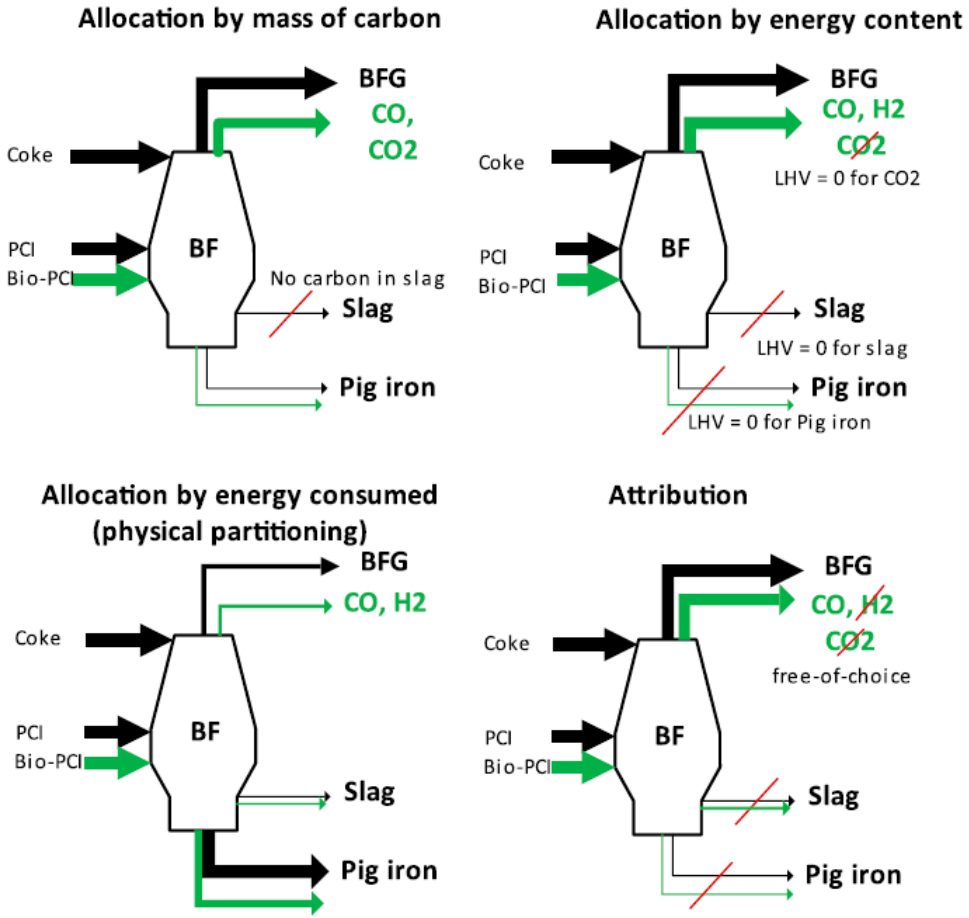
Roll **out** at AM steel plants

- Technical potential for emissions reductions in a reference integrated steel mill in Europe:
  - Replacement of 10% of fossil PCI with biocoal, which is possible without affecting the blast furnace operation, would lead to emission reductions of 2.5–3.5% for any product (e.g., electricity or ethanol) made from the CO and H2 in the BFG.
  - Theoretical replacement of 100% of the fossil PCI with biochar and a 99% capture rate from the BFG would lead to ~21–24% emissions reduction



Carbon allocation by mass (top-left panel), by energy content (top-right panel), and by physical partitioning (bottom-left panel) versus free-choice carbon attribution (bottom-right panel).

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Feedstock investigation

- Climate change mitigating policy and high energy prices because of high prices for the traditional energy carriers (gas, fuel, …) increased the appetite for biomass.
- The demand for waste wood is strongly increased as is reflected by the strong rise of the EUWID index for the German market. The price levels completely shifted.
- Alternatives need to be investigated

Wood

SRF

RDF

SLF

PUR

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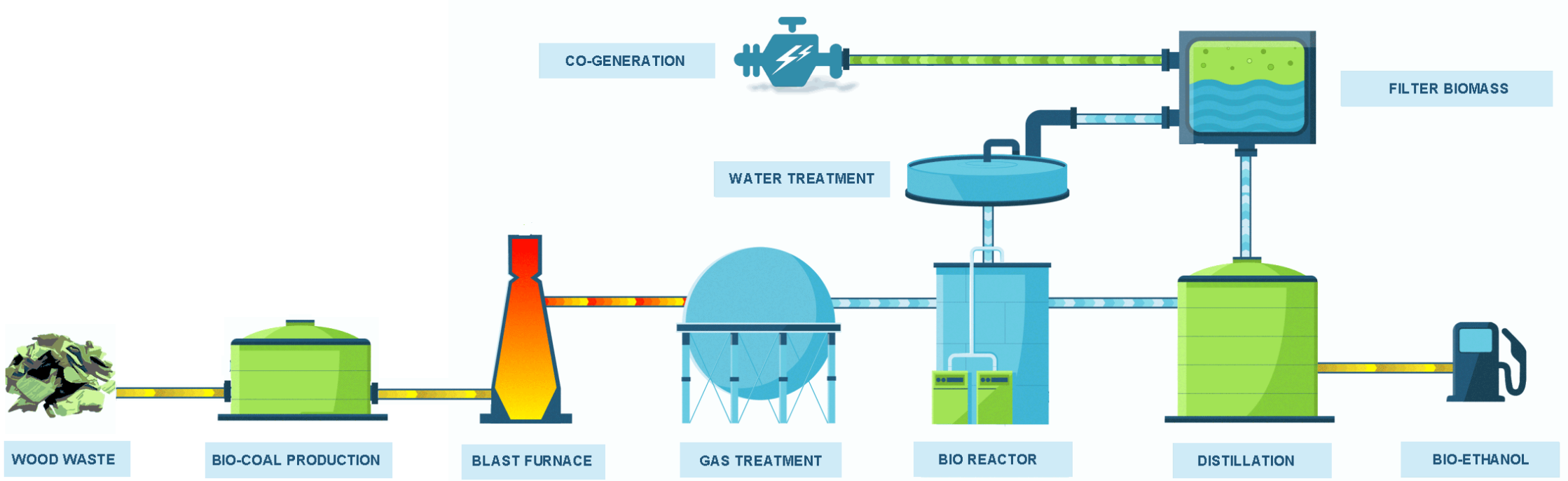
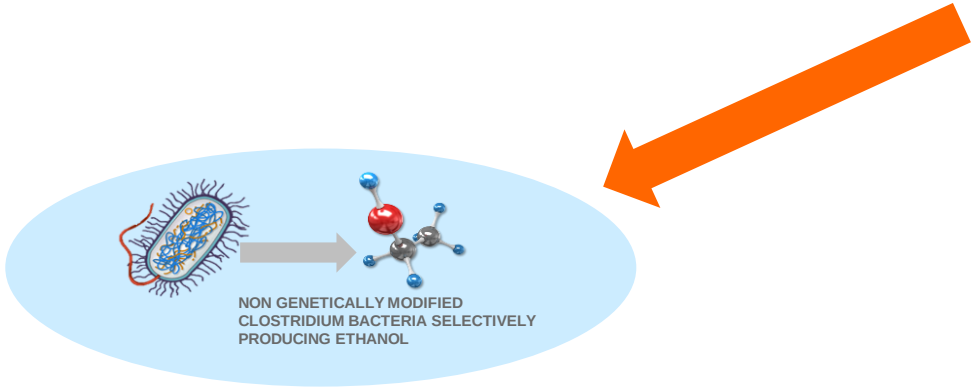
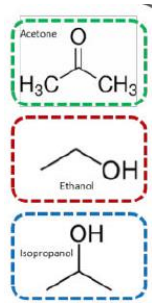
Torero and Steelanol: converting waste wood into advanced bio-fuel







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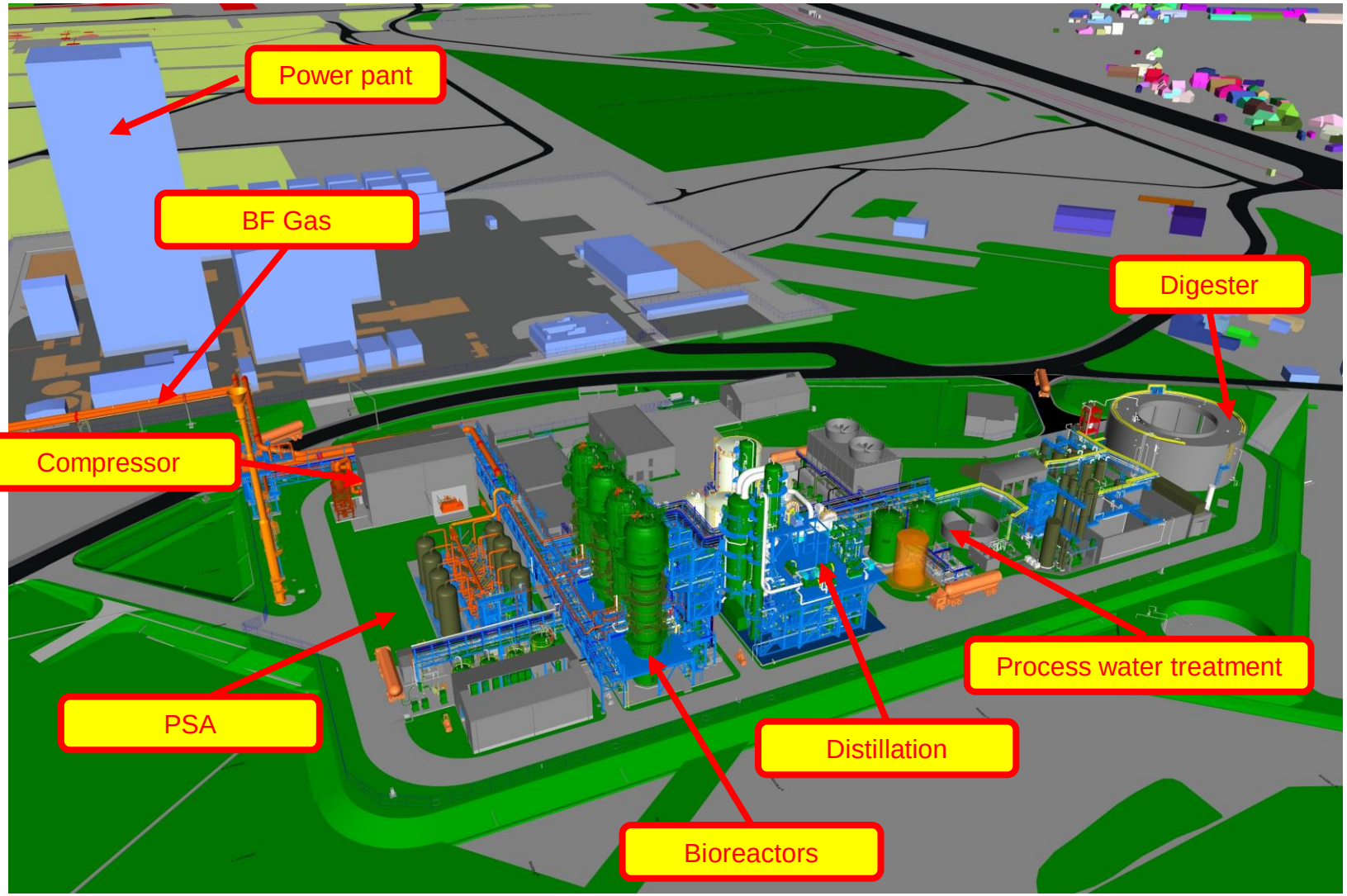
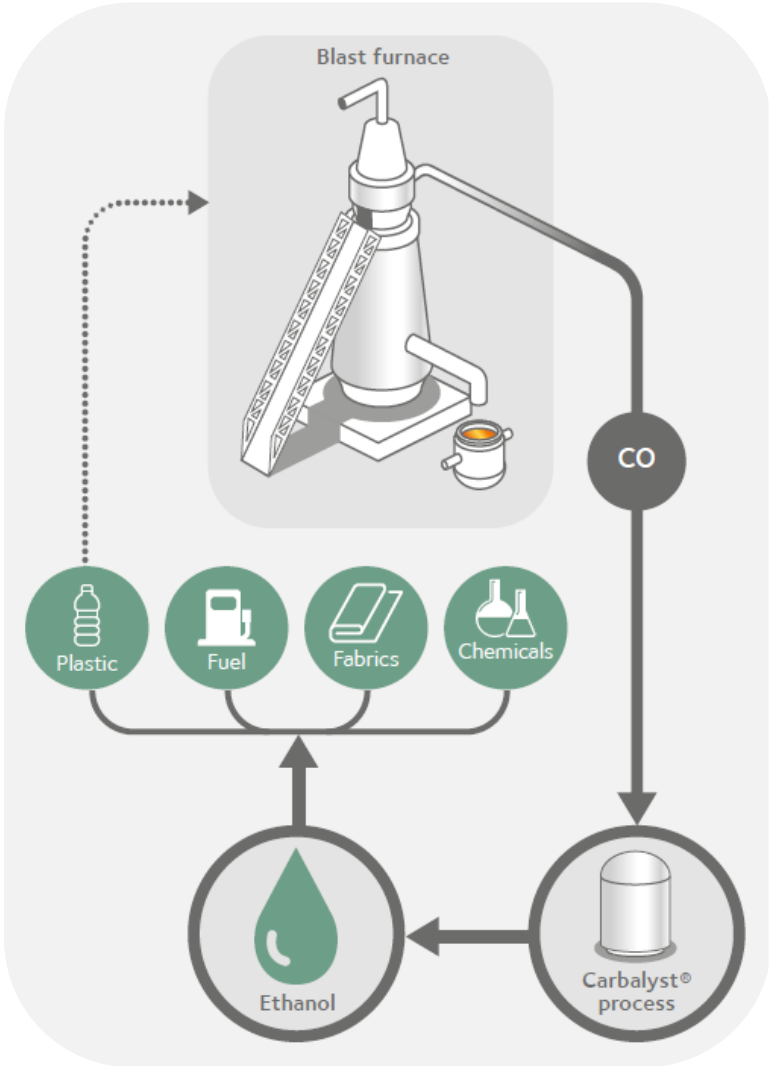
Carbalyst (Steelanol): : industrial Scalable Bio-Technology enables to convert by-product gas into valuable chemicals with high energy efficiency





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Steelanol: January 2019

Steelanol: September 2020

Steelanol: December 2020

Steelanol: September 2021

Steelanol: today

Acknowledgement

This work is part of the project:

- *“TORERO (TORefying wood with Ethanol as a Renewable Output: large-scale demonstration)”. The project receives funding from the European Union Horizon 2020 program. Torero relates to work programme topic LCE-19-2016-2017 “Demonstration of the most promising advanced biofuel pathways”*
- *“MUSIC (Market Uptake Support for Intermediate Bioenergy Carriers) . The project receives funding from the European Union Horizon 2020 program. MUSIC relates to work programme topic LC-SC3-RES-28-2018-2019-2020 “Building a low-carbon, climate resilient future: secure, clean and efficient energy.”*

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Thank you for your attention !

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