FIVES

Technology Pathways to decarbonization and Productivity Improvements

SEAISI - November 2022

STEELMAKING – AN ENERGY INTENSIVE PROCESS

World Energy Outlook by the
International Energy Agency

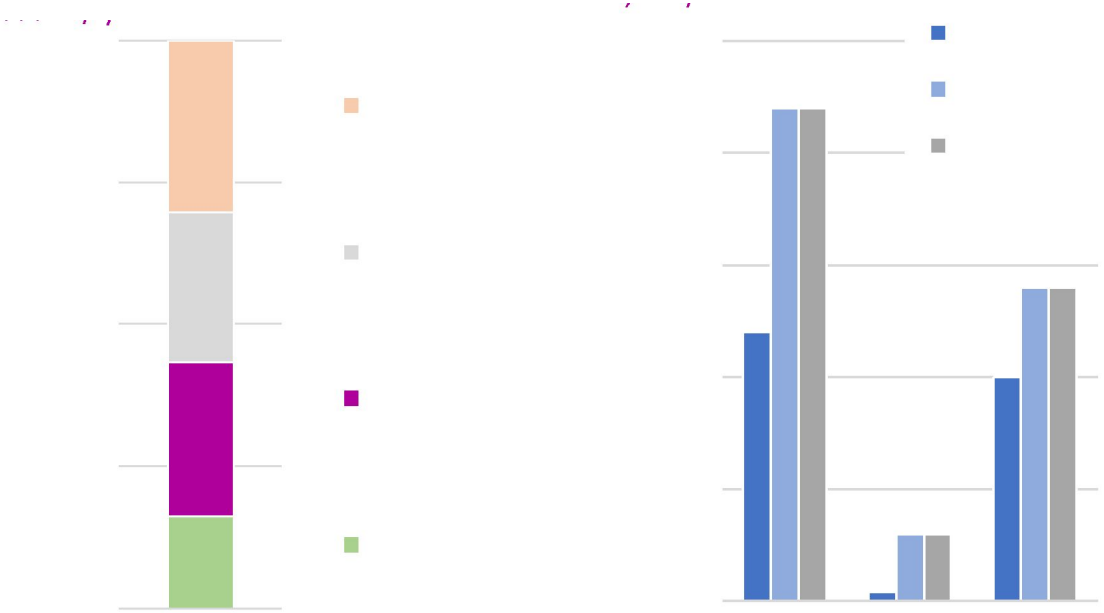


Fig. 1: Yearly CO2 emissions industry breakdown and type of steelmaking processes [IEA]

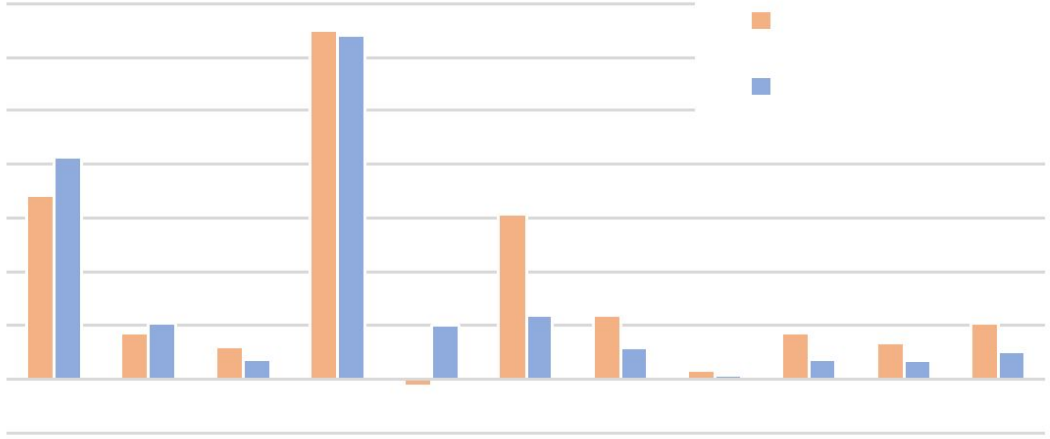


Fig. 2 : Energy consumption and CO2 emissions per plant [EUR. 1]

STEELMAKING PROCESS ROUTES

Process routes and scenarios are region-specific but follow the same mega-trend:

Existing BF-BOF process route (''Commercial'') to be replaced by:

- Scrap-EAF
- DRI-EAF (NG then H_2)
- SR-BOF with CCUS

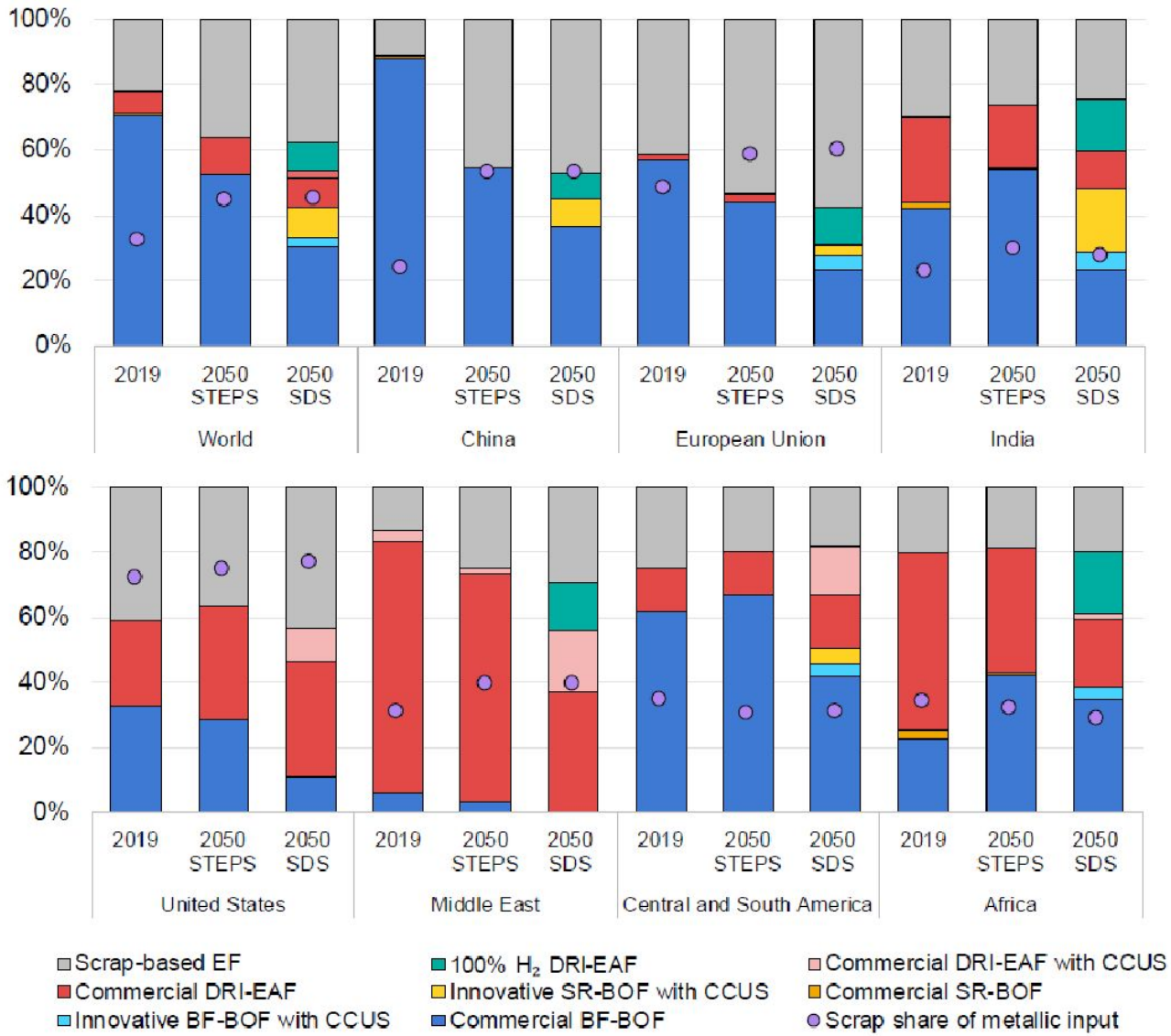
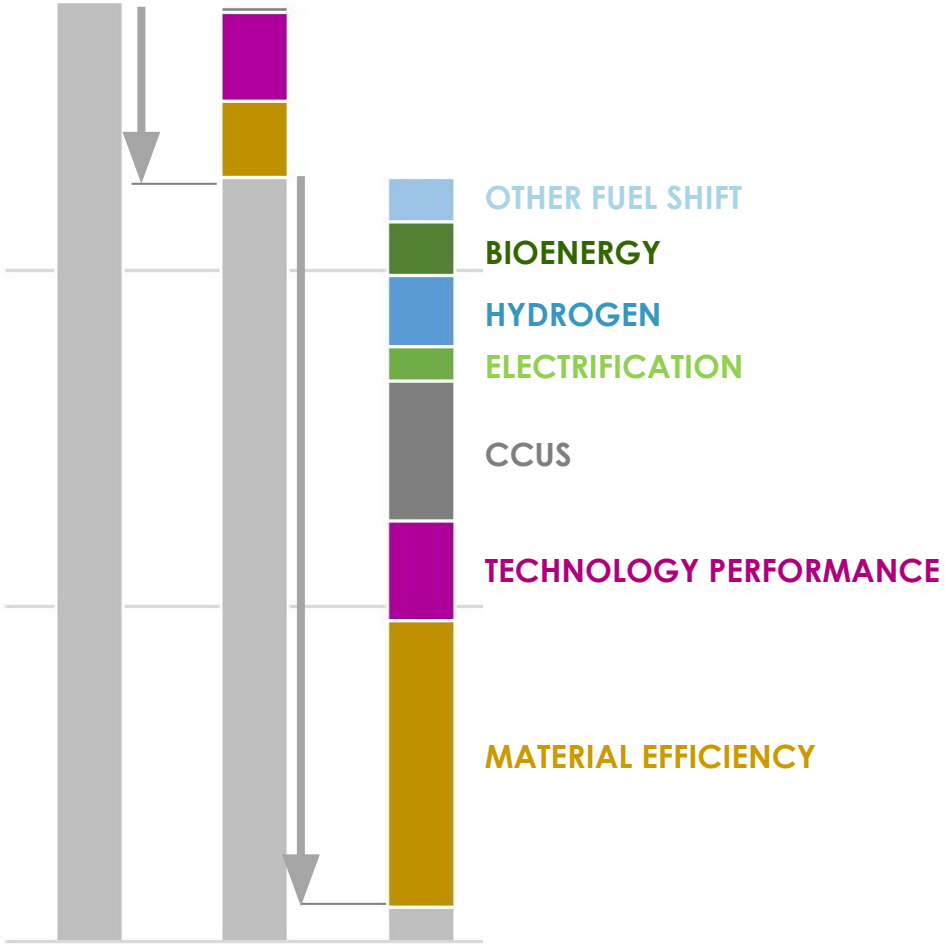


Fig. 3: Crude steel production by process route and scenario in major steel producing regions [IEA]

STEPS: Stated Policies Scenarios (Slight decrease of CO2)

SDS: Sustainable Development Scenarios (to reach IEA target)

IEA TECHNOLOGY ROADMAP



IEA introduced to G20 summit technology roadmap defined with key actors[1] of steel industry.

Due to investment timeline, technologies availability & maturity, CO2 emission decrease will be done in two main steps:

Before 2030 □ 10%

2030 – 2050 □ 40%

Material efficiency (40%), **Technology performance** (21%) and **CCUS** (16%) are the **main existing levers to decrease CO2** emissions until 2050.

The contribution of other technologies, such as **Hydrogen, Bioenergy and Electrification** will increase after 2030.

[1]: Steelmakers, Technology institutes, States Institutes, Worldsteel, Equipment suppliers, Steel associations.

CO_2 STRATEGY FOR REHEATING

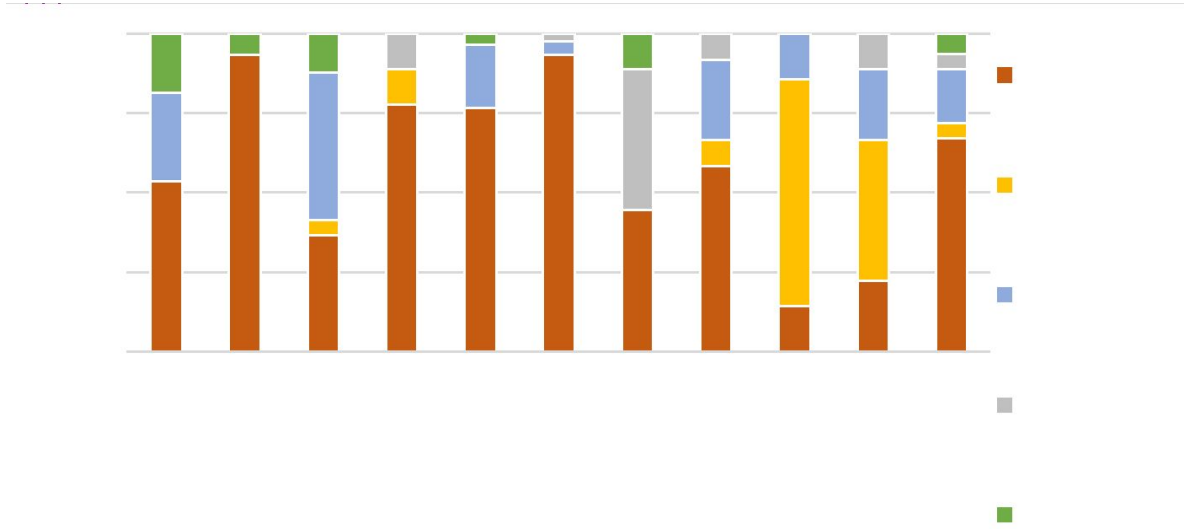
FUEL SCENARIO:

Depend on **integrated plants** **94%**

Only mills **6%**

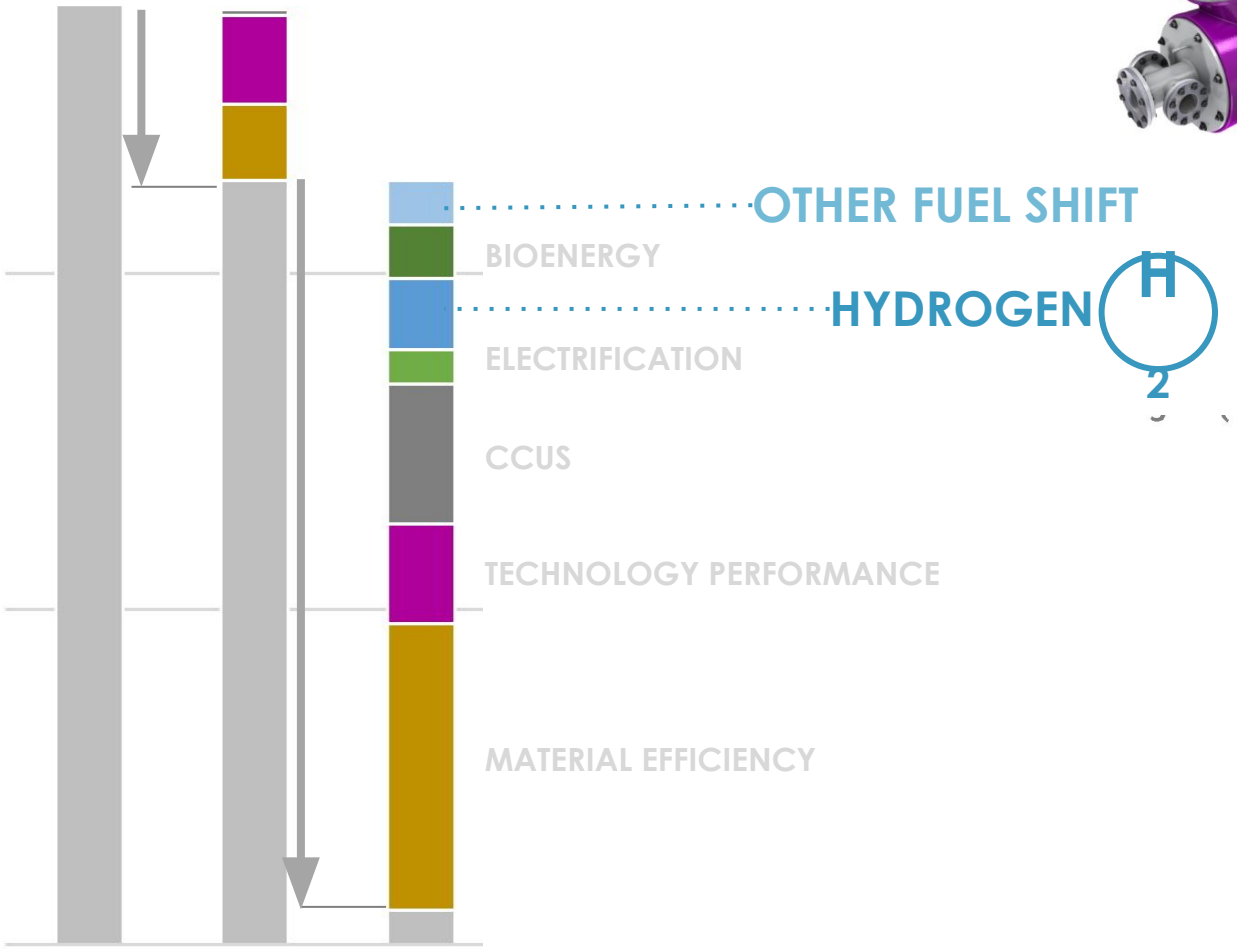
WAYS TO REDUCE CO_2 EMISSIONS

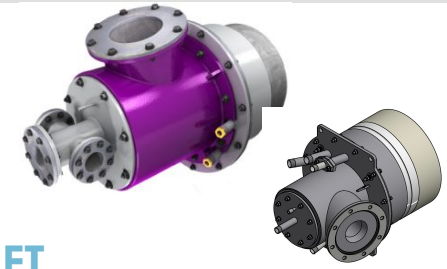
1. Improve efficiency
2. Reduce N2 in air **oxy-combustion**
3. Bio-fuel **H_2**



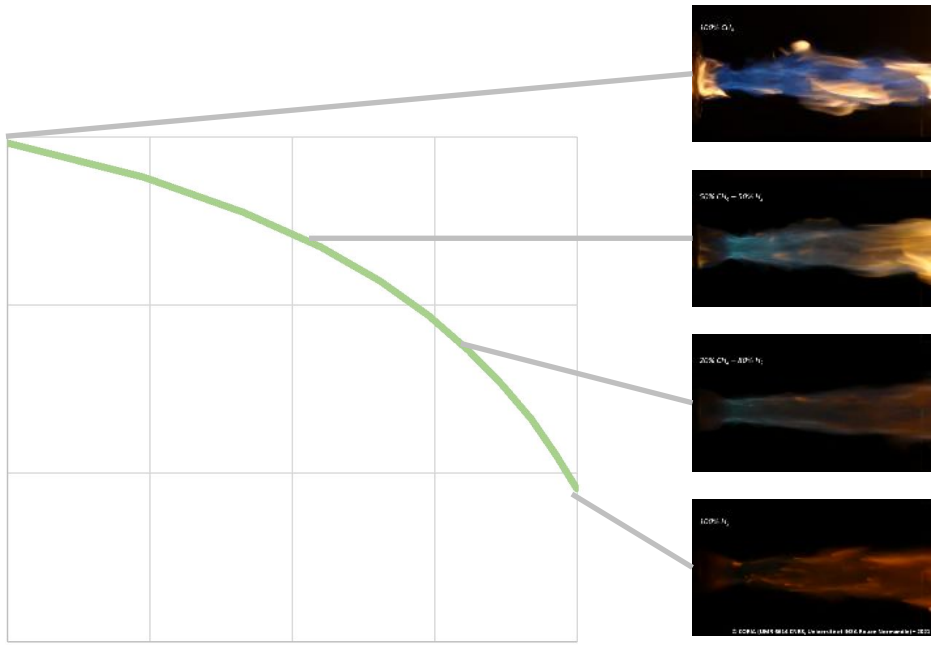
Hot Strip Mills breakdown per plant type – 2020 [FIVES]

TECHNOLOGY PATHWAYS TO DECARBONIZATION

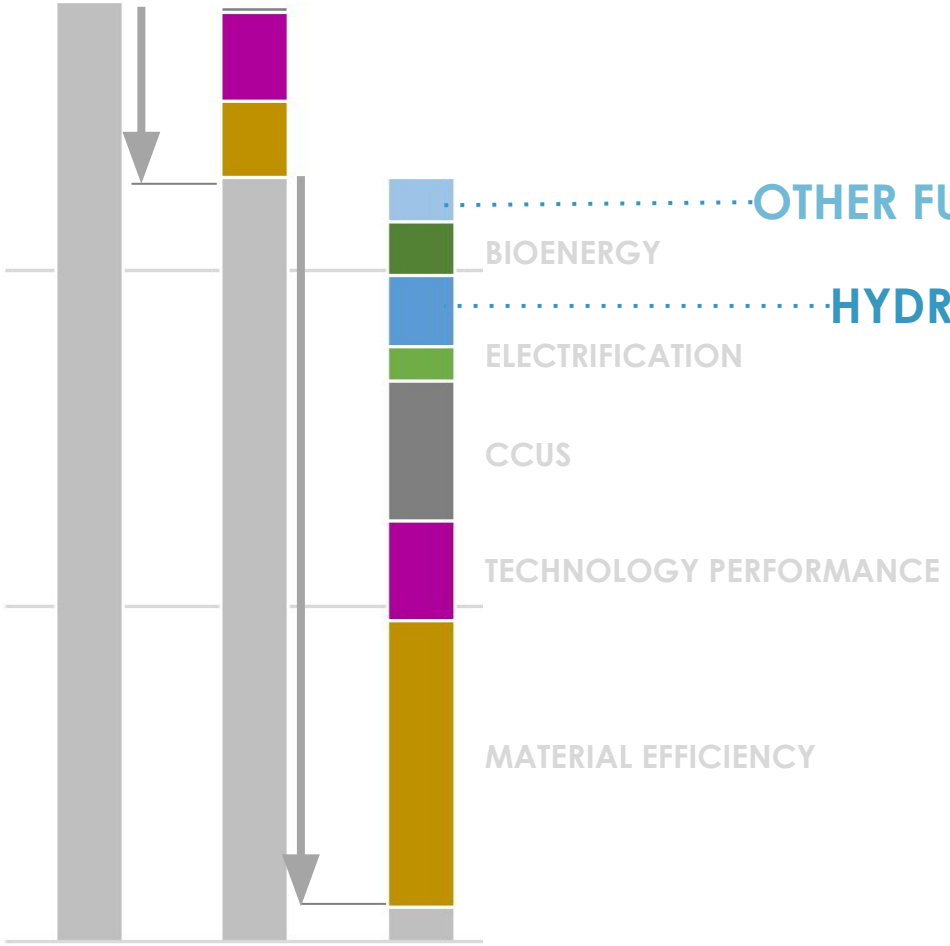


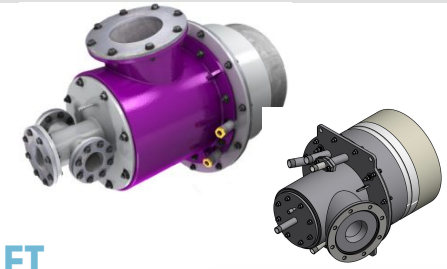


Combustion systems



TECHNOLOGY PATHWAYS TO DECARBONIZATION





Combustion systems

New Generation AdvanTek® CWF/MWF for Slab reheating and DFR (Non oxidizing sections) burners for Strip heating

- Multi-fuel combustion for gradual fuel shift acc.availabilities
- Hybrid hydrogen fuels or full hydrogen combustion
- Lower fuel consumption with higher combustion efficiency and heat recovery with high air preheating (up to 600°C)
- Ultra-low NOx emissions

CO_2 STRATEGY FOR STRIP PROCESSING LINES

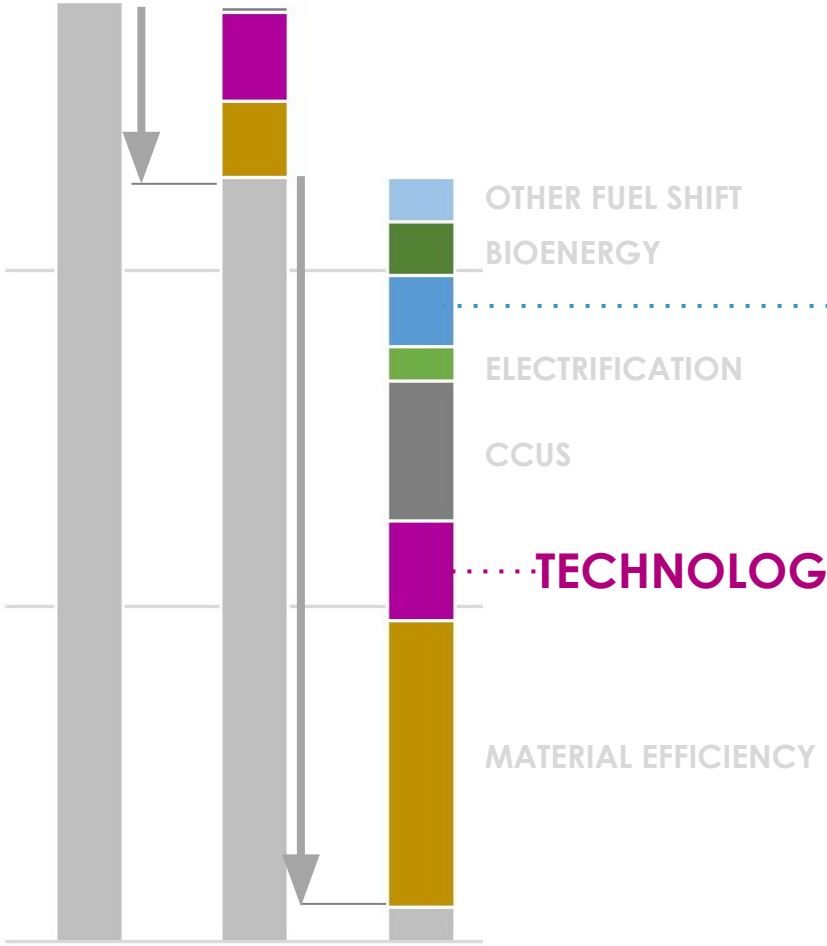
FUEL ENERGY SCENARIO:

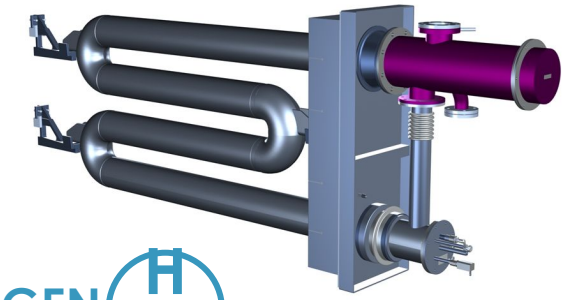
Most of the time not linked with integrated plant. **Stand alone scenario**

WAYS TO REDUCE CO_2 EMISSIONS

1. Improve efficiency
2. Electrification
3. H_2

TECHNOLOGY PATHWAYS TO DECARBONIZATION





Combustion systems

High efficiency AdvanTek® Radiant tube recuperative burners for strip annealing

- Lower energy consumption with higher efficiency and heat recovery
- Ultra-Low NOx emissions
- Compatible with greener fuels

STRIP PROCESSING LINE ELECTRIFICATION

TECHNICAL SOLUTIONS:

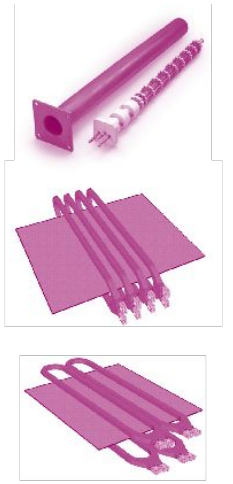
CO_2: □ 90% (renewable)

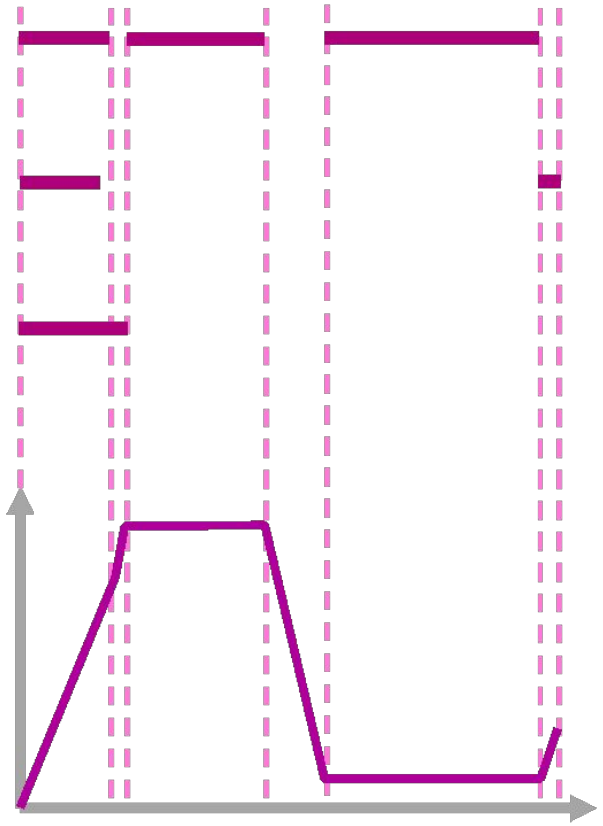
Industrial solutions:

- **Electric Radiant Tube**
- **Induction (LGF, ETF)**

Annealing cycle:

- **Standard grades: GEN 1, 2 & 3**
- **Ultra short annealing**
- **To be combined with ultra fast cooling technologies Wet FlashCooling®**

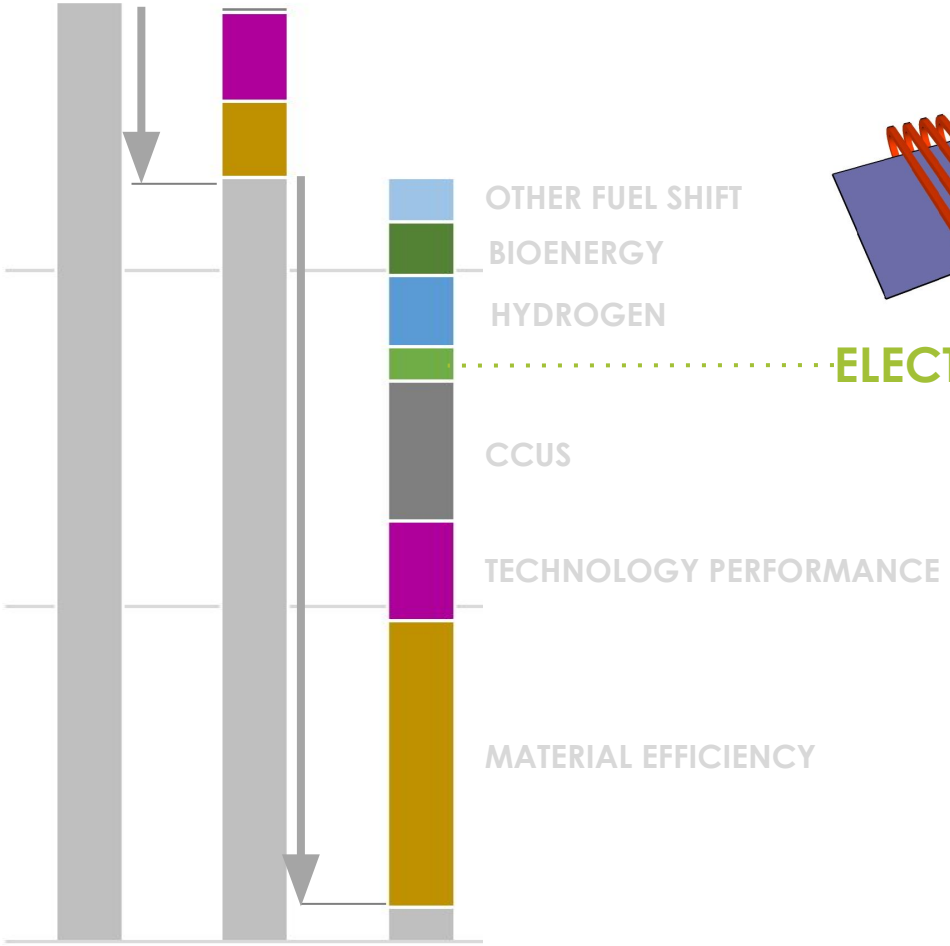




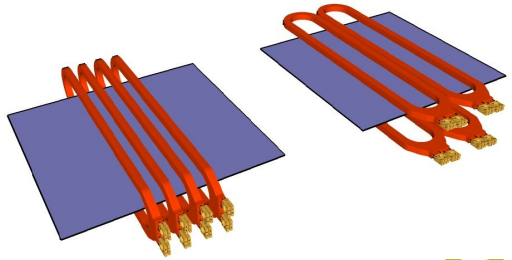
Typical use of Induction and ERT

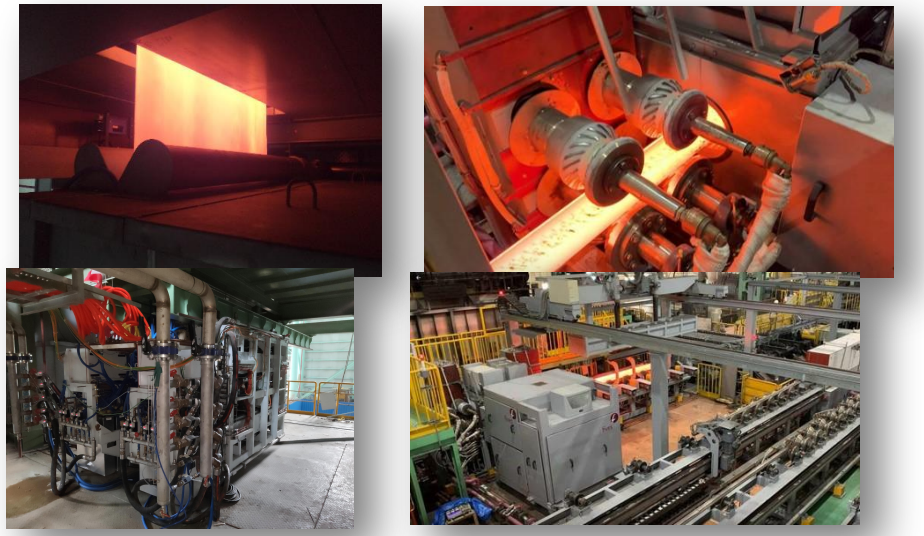
CAL, HDG

TECHNOLOGY PATHWAYS TO DECARBONIZATION



Innovative Induction heating technologies

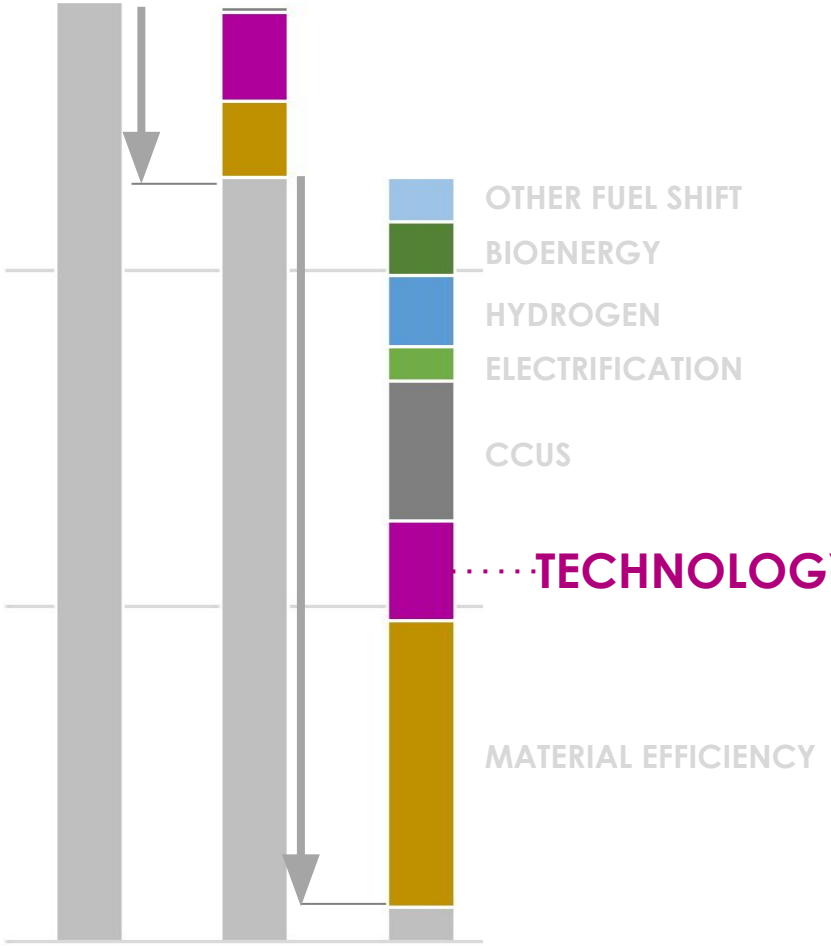




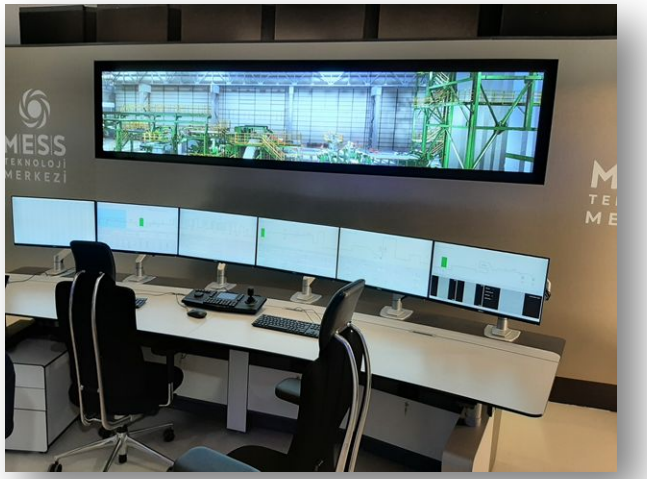
High power electric induction heating

- Excellent heating efficiency for any grades and any annealing temperature including non-magnetic materials
- Compact electrical heating solution: replaces in a short space a long gas fired heating chamber
- Ultra-low emissions

TECHNOLOGY PATHWAYS TO DECARBONIZATION



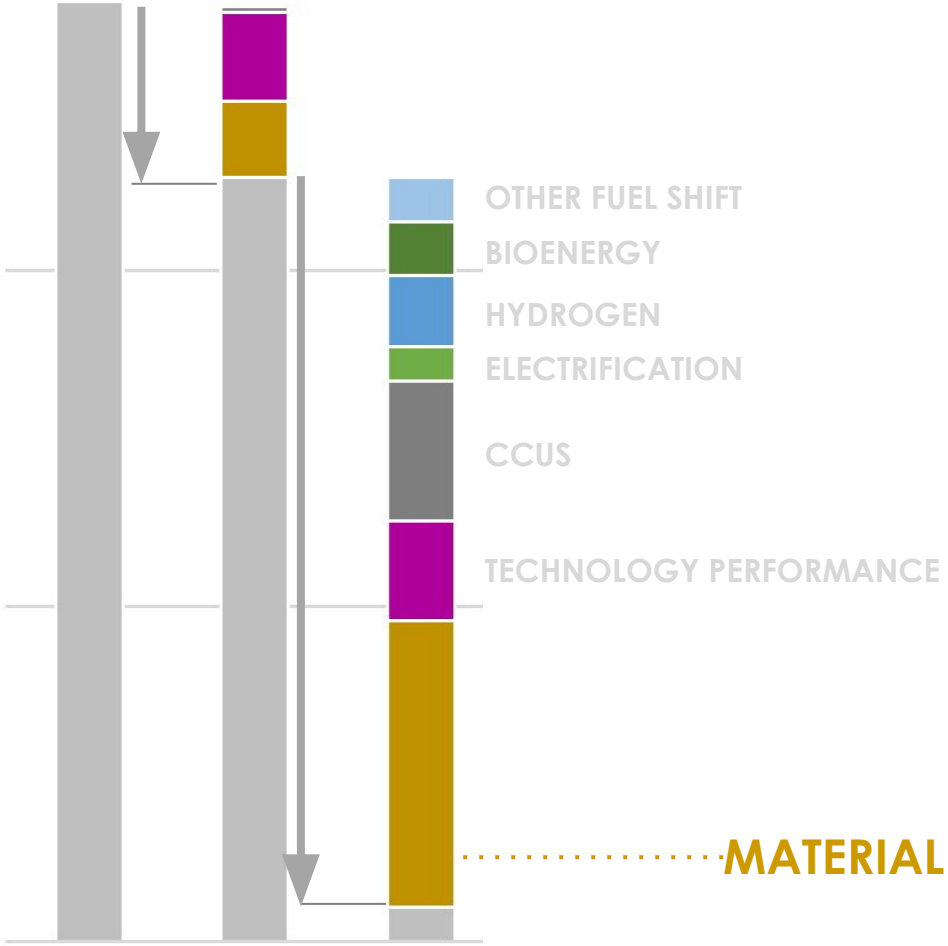
Digital Smart Manufacturing Systems



VIRTUO®: L2 Furnace Thermal performance optimizer

SMARTLINE: L2.5 Automatic pilot for HDG Line. Line Cost & Productivity optimizer.

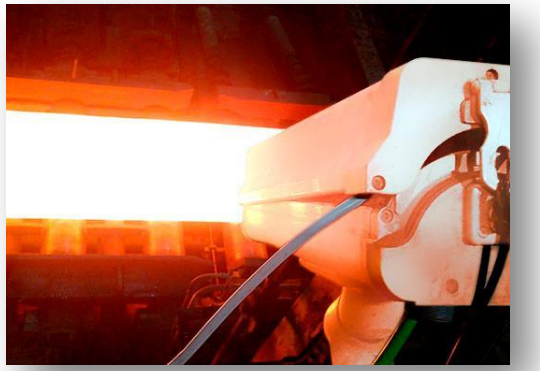
TECHNOLOGY PATHWAYS TO DECARBONIZATION

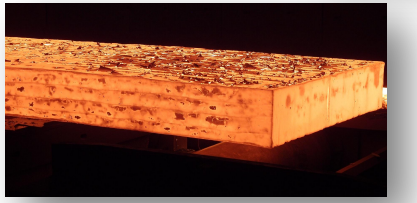


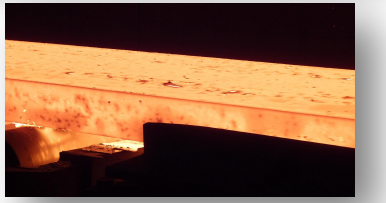
Smart Digital solutions to reduce Material Losses

Virtuo-Optiscale®: Smart technology to increase the productivity and prime quality yield of slab reheating

- Reduced material losses due to oxide scale in the range of 10 to 30%.
- Improved product surface quality
- Energy usage gain



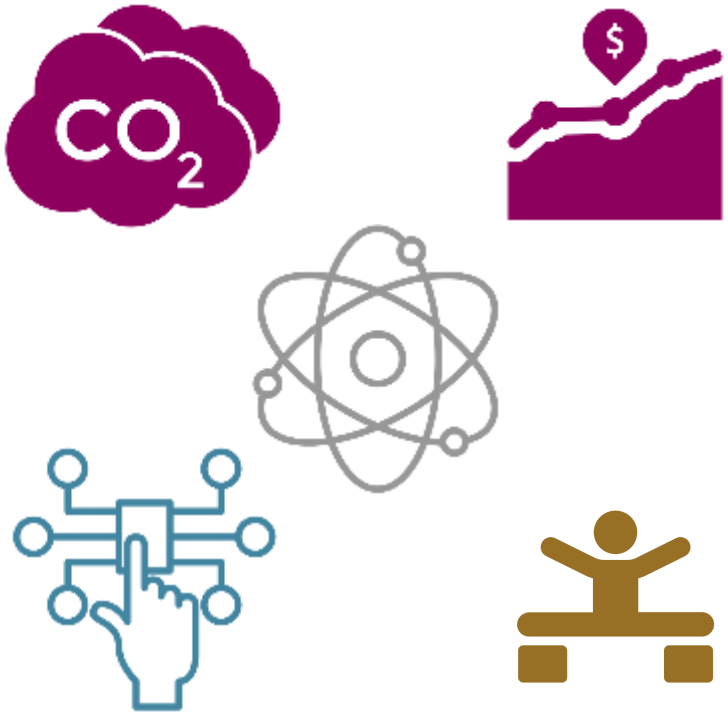




CHALLENGES FOR STEELMAKERS

CO_2 EMISSION REDUCTION :

Upstream transformation as first step and then Downstream transformation.



COMPETITIVENESS:

As steel demand will most probably slowly decrease, market will stay highly competitive.

DIGITALIZATION :

Mastering the processes in order to achieve CO2 emission targets to produce better quality with higher yield through digital solutions

FLEXIBILITY:

Toward volatile markets, adaptation to unsteady demand and supplies

Fives, at the Forefront of Low-Carbon Transition

Commitment to reduce the environmental footprint of the company and its clients

- Control its direct impacts by taking action at its sites
- Design technologies combining energy and operational performance

80%
Industrial sites of Fives are complied with ISO 14 001, Environmental Management System

4
Fives solutions are labelled «Solar Impulse Efficient Solution»

Vincent POT

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Fives Stein

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