This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952936.

Innovation as key for the energy transition

RE4Industry Final Event

Olgu Birgi
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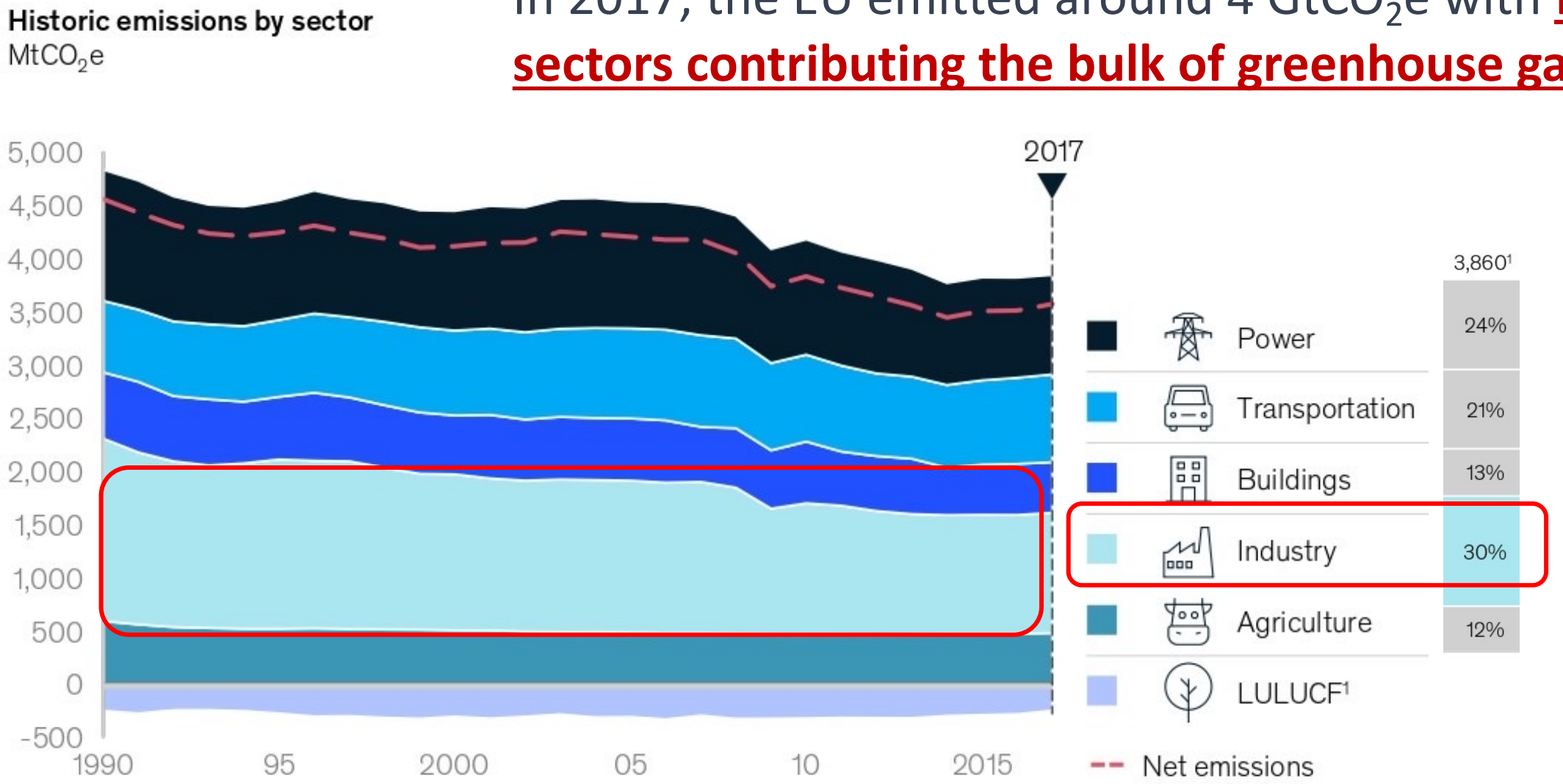
June the 20th, 2023

www.re4industry.eu

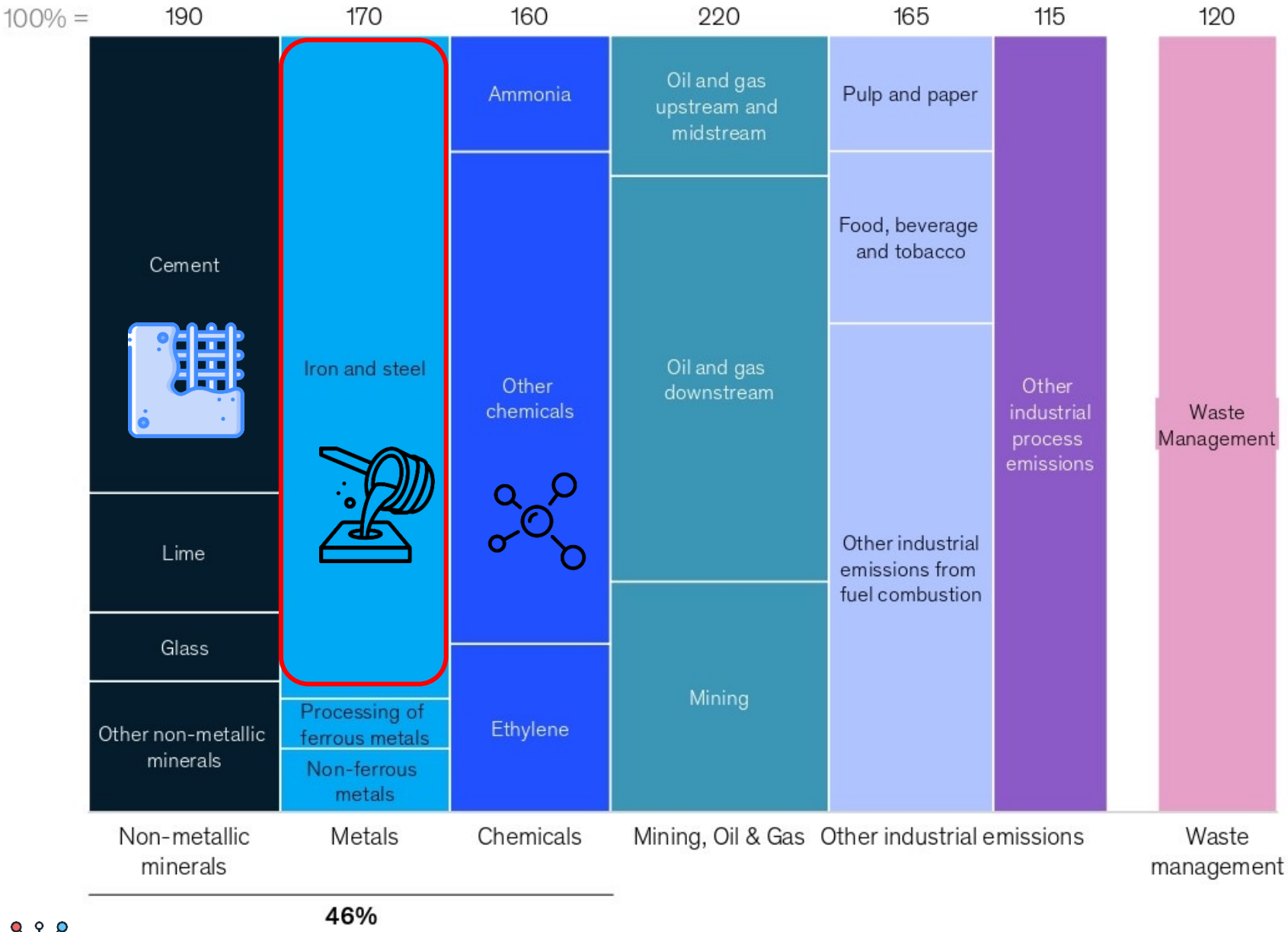
Context: the bulk of Europe's emissions are generated by five sectors

In 2017, the EU emitted around 4 $GtCO_2e$ with **five sectors contributing the bulk of greenhouse gases**



d'Aprile, P., et al. "How the European Union could achieve net-zero emissions at net-zero cost." McKinsey & Company: Chicago, IL, USA (2020)

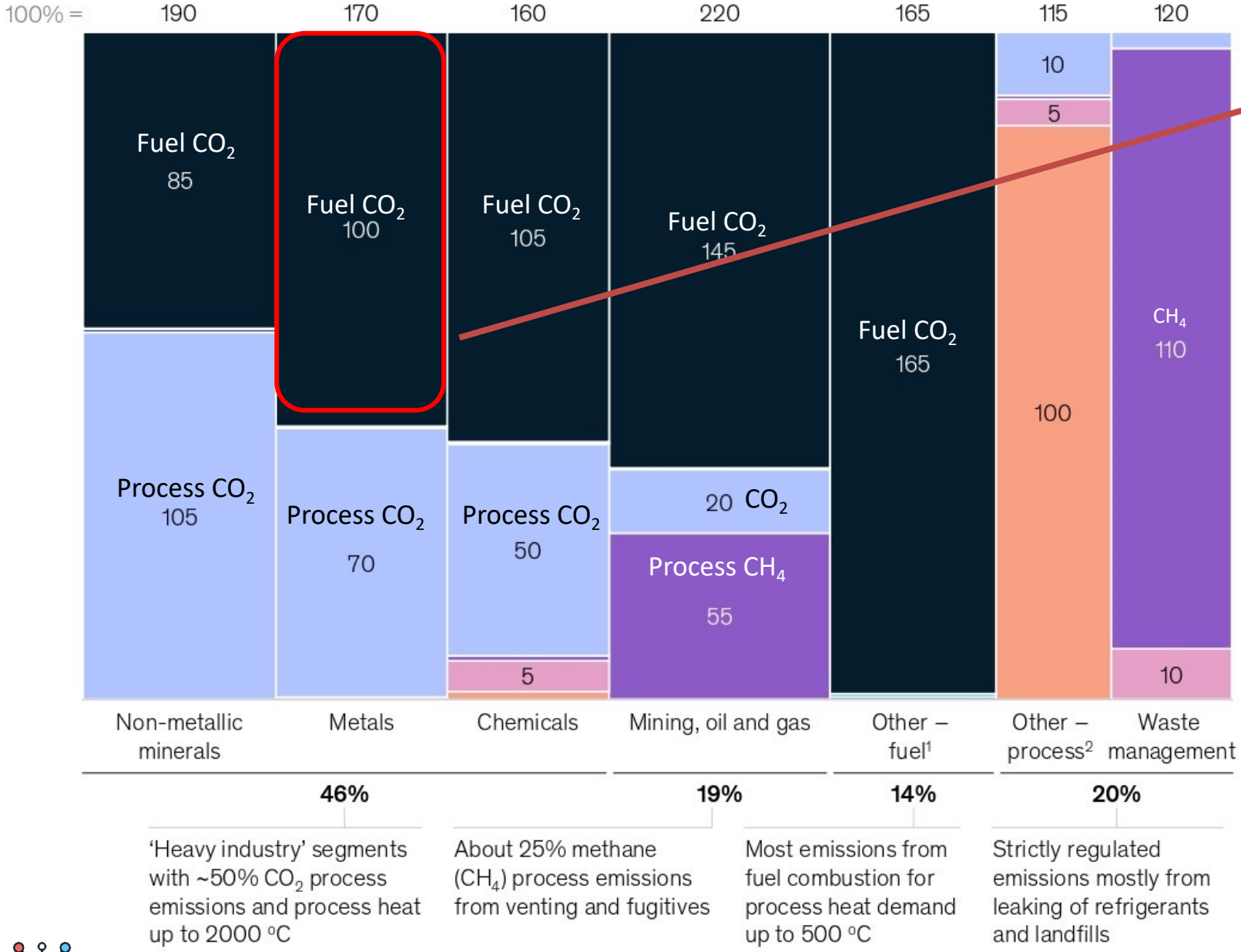
Emission by subsector in $MtCO_2e$, 2017



- Basic products like **cement, glass, steel, and plastics require high temperatures**
- These **hard-to-abate emissions pose a significant challenge to achieving emissions reductions in heavy industry**

d'Aprile, P., et al. "How the European Union could achieve net-zero emissions at net-zero cost." McKinsey & Company: Chicago, IL, USA (2020)

Emissions are split between fuel combustion emissions and process emissions



- **Half of industrial emissions come from fuel combustion for process heat**
- **Solutions must target both fuel combustion** and process emissions to effectively address industrial emissions

d'Aprile, P., et al. "How the European Union could achieve net-zero emissions at net-zero cost." McKinsey & Company: Chicago, IL, USA (2020)

SHORT-TERM VISION

2030

LONG-TERM VISION

2050

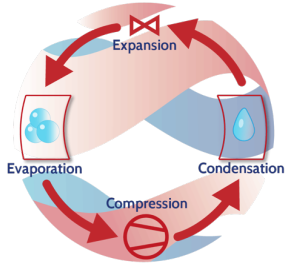
Vision

RE4iNDUSTRY

Renewable technologies within the scope of 2030

1. Heat

Solar thermal



Heat pumps

Geothermal

Biomass

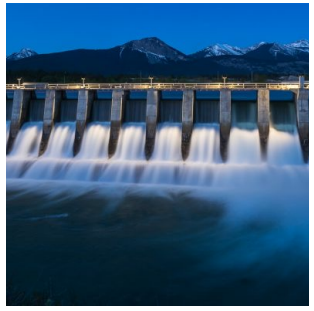
Biofuels

Green hydrogen

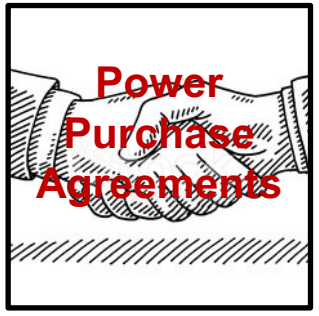
2. Electricity

Photovoltaics

Wind



Hydraulic



Renewable PPAs

(preliminary) **Findings**

Electrification will be key thanks to the gradual **decrease of renewable power price** and the **conversion of natural-gas-dependent processes**

Industrial **processes** that are **not** readily **eligible for electrification** will still be needing **a form of renewable heat**

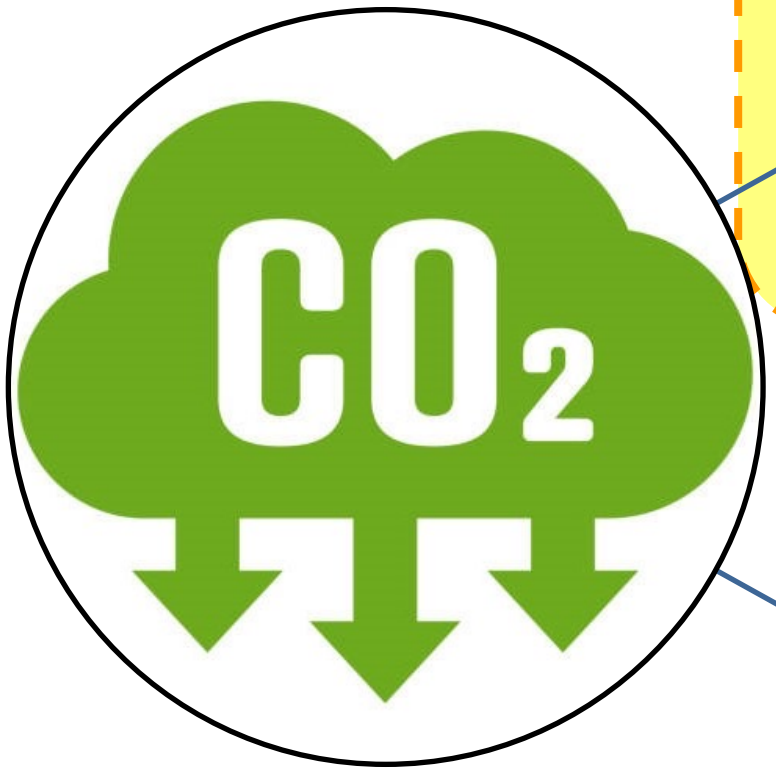
From **concentrating solar power** and **heat pumps to geothermal energy** to supply a **broad range of temperatures needed**

Biomass will be a **key element in the decarbonisation** of not only **conventional combustion systems** but also as a **biofuels feedstock**

Biomethane can allow a **straightforward transition** from using fossil-based natural gas to **renewable gas**

Green hydrogen production technologies will require to **increase** their **maturity** and **availability** all over Europe

Renewable technologies within the scope of -2050-



General innovations

- CCS
- New cement chemistries
- Alternative materials
- New chemical production methods

Sector specific

- Steel
- Ceramics
- Chemicals and Fertilizers
- Glass
- Non-ferrous metals
- Cement and Lime

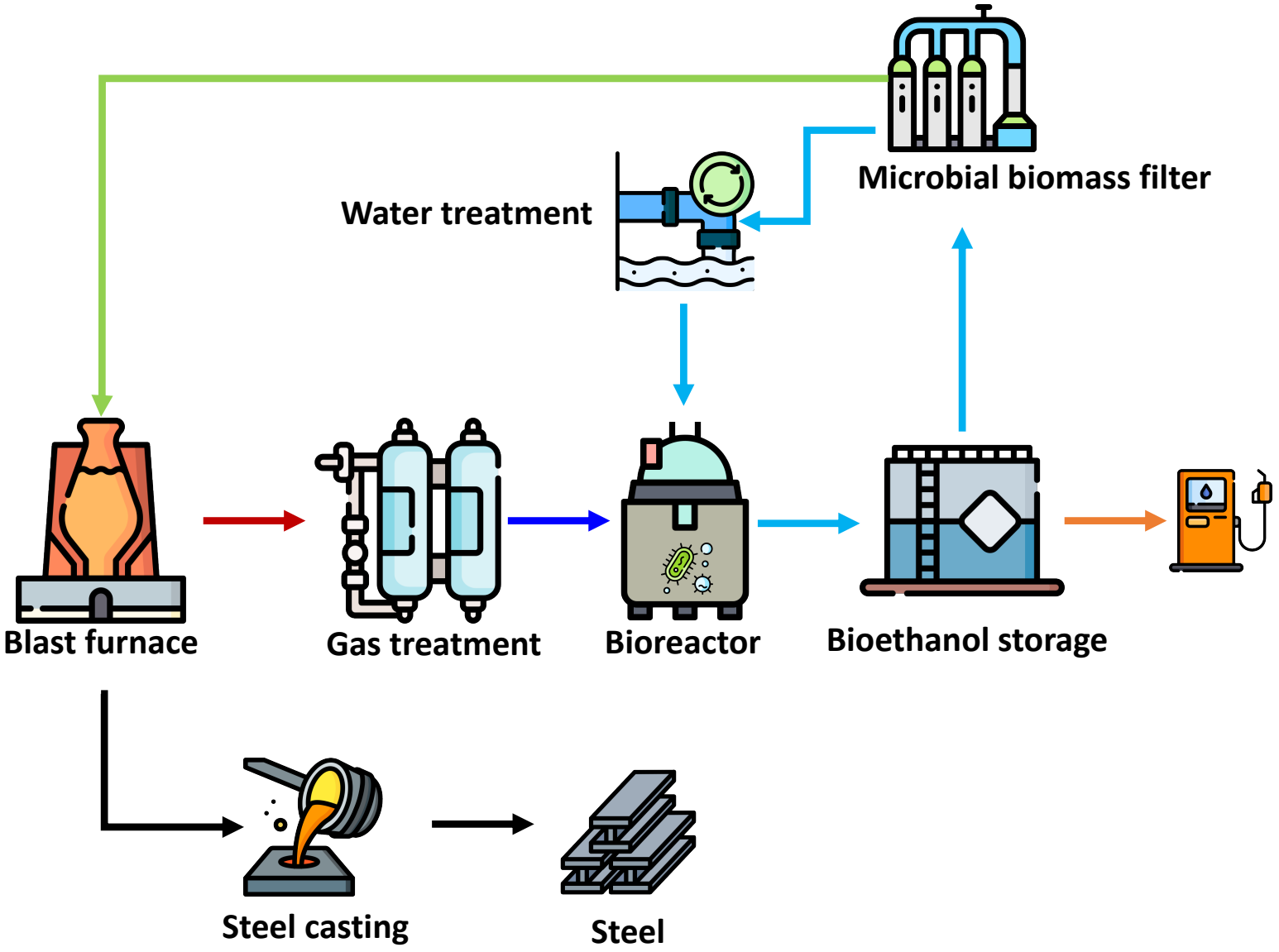
Renewable technologies within the scope of -2050-

Time frame: 2020-2035 / Achievable emissions reductions: 20%

Current developments	Technologies achieving maturity	Key R&D areas to enable future technologies (2050)
• Efficiency improves continuously, with most industrial processes undergoing incremental improvements • **A growing number of processes shift towards electricity** • Material efficiency, longevity, and re-use are recognized as key strategies • **Heavy R&D investments are directed into technologies that will be important in subsequent phases (*e.g.*, CCS)**	• **Electrification** • Material efficiency • Energy efficiency • Increased re-use and recycling (circular economy)	• **CCUS** • **Zero-carbon hydrogen production** • **Hydrogen and renewable gases use** • Novel chemical catalysts and separations • New cement chemistries

Adapted from Rissman, et al. (2020), Applied Energy

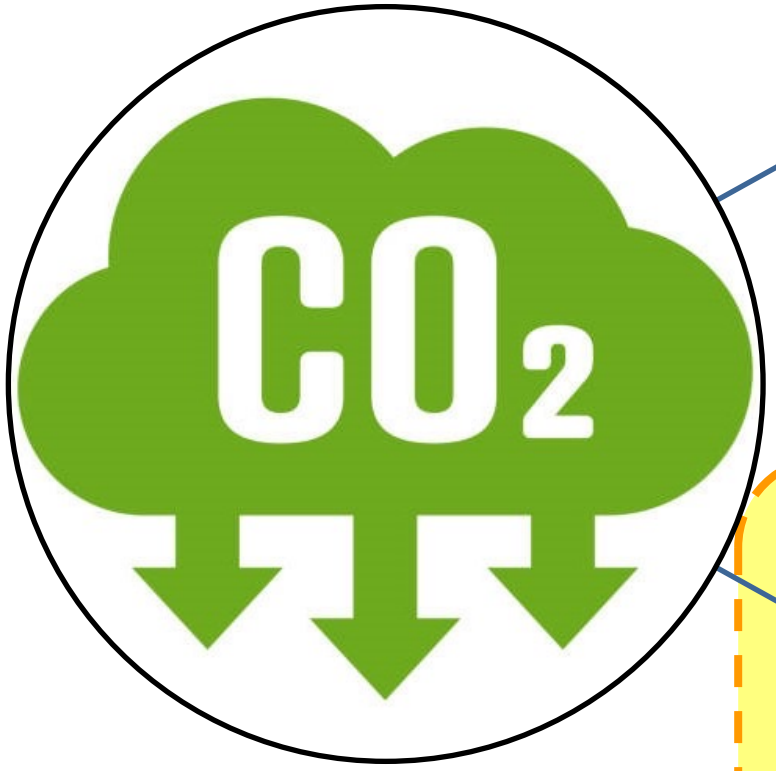
Industrialisation of CO_2 bioconversion into fuels



- **CO_2 bioconversion into fuels is possible**, as demonstrated by examples such as the Steelanol project within the steel sector
- The Steelanol project operates a plant in Ghent, Belgium, with the goal of **producing 80 million liters of bioethanol**
- The bioethanol produced by the Steelanol plant will be used as a **low carbon alternative fuel in the transport sector**
- This decarbonization initiative has received funding from various sources, including the EU, and is expected to **prevent the emission of approximately 130k tonnes of CO_2 per year**

Drawing based on the scheme by: Perathoner, et al. "Reuse of CO_2 in energy intensive process industries." Chemical Communications (2021)

Renewable technologies within the scope of -2050-



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Suitable RE combination options for Energy Intensive Industries

Sector	Renewable power for process electrification		Renewable heat and its sources				CCUS technologies	
	Heat and mechanical	Electrochem. processes (excluding H_2)	Biomass combustion (and biofuels feedstock)	Other RE (Geotherm. & Conc. solar)	Green H_2 (electrolysis/ gasification)	Biomethane (anaerobic digestion)	Carbon Capture and Storage	Carbon Capture and Utilisation
Steel								
Chemicals								
Fertilizers								
Cement								
Lime								
Refining								
Ceramics								
Paper								
Glass								
Non-Fe metals								
Alloys								

Sector already applies the technology on a large scale (it can be expanded in some cases)

High potential

Medium potential

Limited or no significant application foreseen

Possible application but no main route or wide scale application

Table adapted from: *Tomas W, Gauri K, Isobel R. Industrial Value Chain – Abridge Towards a Carbon Neutral Europe. 2018*

(partial) **Conclusions**

Energy intensive industries' **decarbonisation will occur** through a progressive use of an **energy mix** that allows European industrial sectors to **remain competitive** in a global scale

Each industrial sector will require **specific renewable energy solutions**, especially those **top greenhouse gas emitting** industries

RE4Industry has also been conceived as an **initial point of discussion** to be shared with potential decision makers to favor a **transition of Energy intensive industries to full decarbonisation**

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www.linkedin.com/company/re4industry

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952936. The information and views set out on this presentation are those of the authors and do not necessarily reflect the official opinion of the European Union. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the following information.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952936.

Success cases examples from Energy Intensive Industries (EIIs)

Anatoli Rontogianni, **CERTH, Greece**

20.06.2023, Brussels

www.re4industry.eu

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[A] CERTH profile & RE4Industry project overview

[B] Success cases prologue

i. Steel Industry

ii. Glass Industry

[C] Success cases examples from EIIs

1. ArcelorMittal Ghent steel plant
2. Ebroacero S.A. steel industry
3. Verallia S.A. Spain glass industry

[D] Re4Industry Interactive map

[E] Conclusions

[A]

CERTH-CPERI

Chemical Process & Energy Resources Institute

- ✓ **Mission:**
  - ✓ High quality scientific research
  - ✓ Emphasis on Research – Development – Innovation (R&D&I)
  - ✓ Strong collaboration with the global industry
  - ✓ Innovative synergies with universities and research institutes in Greece and abroad
  - ✓ **Annual Turnover: ~** 25 M€ (> 30 % bilateral industrial research contracts; > 60 % competitive research projects;
  - ✓ < 10 % government institutional funding) –Listed among **top 20 EU Research Centers** with **the highest participation in Horizon 2020 / No1 in Greece**

RE4INDUSTRY

RE4Industry: 100% Renewable Energies for Energy Intensive Industries (EIIs)

- **11 partners from 6 countries (AT, BE, DE, ES, GR, NL)**
- **Total EU contribution: € 2 999 500 (total cost) -Starting date: 1st September 2020 - Duration: 36 months**

[A]

Overview

The 2023 **Net-Zero Industry Act** repeats the EU's commitment to reaching net-zero emissions by 2050 and, as a stepping stone, slashing emissions by 55% on 1990 levels by 2030 (Fit for 55 package)

Energy Intensive Industries (EIIs) are expected to play an important role in energy transition as they represent 24% of the final energy consumption, but **a clear long-term vision and strategy is required** in order to remain **competitive** while contributing to the **decarbonization** targets of the EU.

1 Technologies that reduce the CO_2 emission of current processes:

- ✓ **energy efficiency measures;**
- ✓ **electrification, using electricity from renewable energy sources;**
- ✓ **deep geothermal energy;**
- ✓ **biomass;**
- ✓ **low-carbon hydrogen or other synthetic fuels;**
- ✓ **Carbon Capture and Storage (CCS)**

2 New production pathways with a lower CO_2 footprint:

- **Carbon Capture and Utilizations;**
- **Process Intensification;**
- **Circular economy**

RE4INDUSTRY

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[B]

Success cases prologue

Re4Industry focus cases

RE4Industry associated with cases that have successfully implemented or are investigating through demonstration projects integration of various forms of renewable energy sourcing in the productive processes on an Energy Intensive Industry (EIIs):

Biomass, Biogas and Biomethane

Electrification

Geothermal Heat

Green H_2

Heat Pumps

Power Purchase Agreements (PPAs) for renewable electricity

Solar Heat

Others

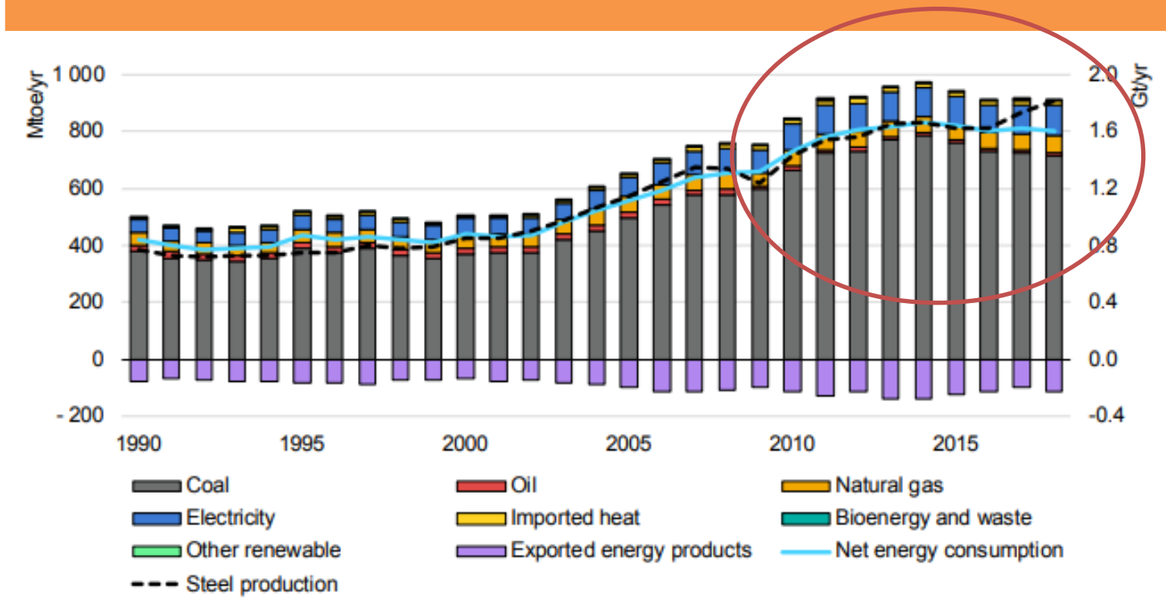
Re4Industry is primarily targeting success cases from the following Energy Intensive Industries sectors:

- ❑ Non-ferrous metals
- ❑ Steel
- ❑ Cement & Lime
- ❑ Chemicals & Fertilizers
- ❑ Ceramics
- ❑ Glass

Steel industry

The European sector is under pressure due to its CO_2 emissions produced by its high energy and resource intensive processes.

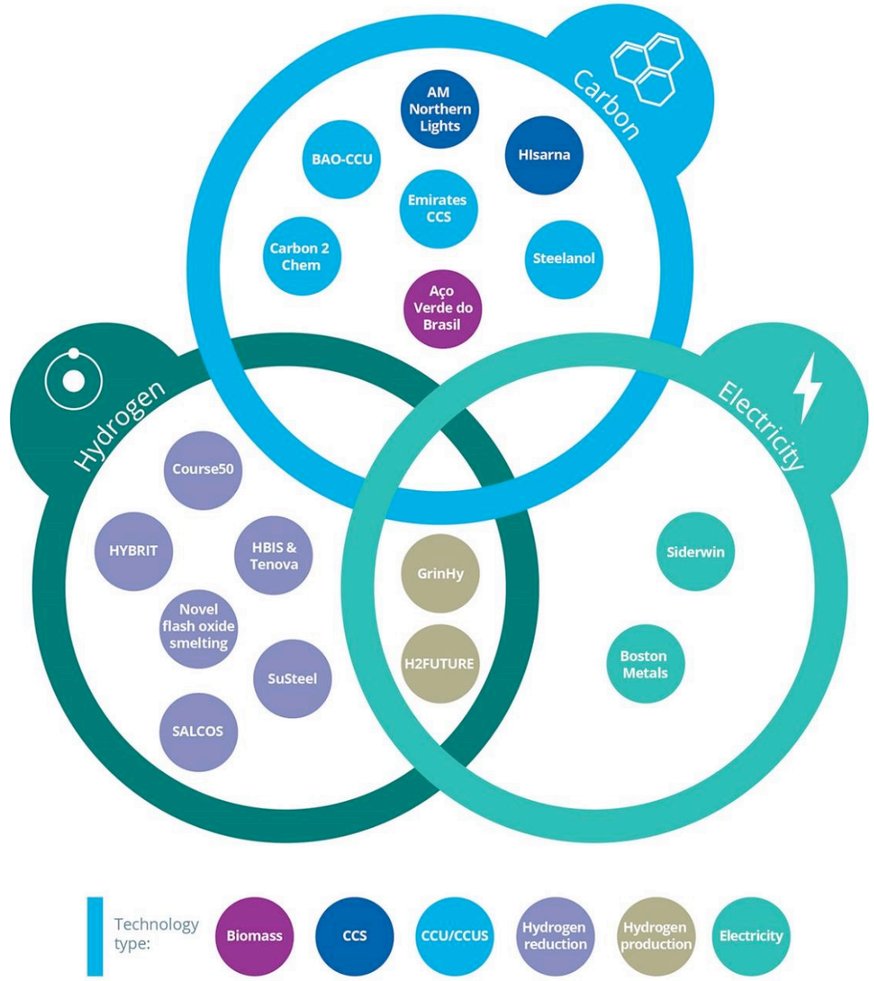
The sector contributes to approximately 5% of total European CO_2 emissions and to 22% of total EU industrial emissions.



Final energy consumption in the steel industry6 worldwide
(Gt = gigatonne; Mtoe = million tonnes of oil equivalent)

Increasing needs in steel product corresponding in increasing needs of carbonization solutions

Innovations in the steel industry by technology type.



Steel industry decarbonisation

Primary route	Secondary route
✓ Methods such as coke dry quenching and optimizing pellet ratios, as well as Blast Furnace equipment like top gas recovery turbines ✓ Replacing coke with natural gas can also significantly cut CO_2 in primary steel making ✓ Injecting hydrogen or ammonia into the BF to partly replace pulverized coal	➢ Making savings on the electricity used to power the Electric Arc Furnace ➢ Shifting the electricity mix towards renewables
The recycling ratio of steel is very high in the industry, close to 95%, making steel the most recycled material. While the high recycling ratio is mainly for economic reasons, it provides other environmental benefits that include less energy use and fewer carbon emissions	

cornerstone of the circular economy.

[B]

Glass industries

Overview of glass industry

- Glass still represents one of the largest used materials in manufacturing, building and consuming processes, significantly enabling light-weighting products, superior quality glazing and is **high recyclable** .
- Glass manufacturing industry is an energy intensive process due to the need for heating the raw materials to high temperature in order to melt, form, coat and anneling glass containers, fibers or flat glass slides (around 1600 ₀C).
- mainly fuelled by natural gas, comprehending near 75% of their energy requirements

➢ **A switch to biomethane is technically possible**

Enablers and barriers to decarbonize glass industry

- **Proven and financially viable technologies**
- **Increasing lifespan of equipment**
- **Regulations encouraging energy efficiency in downstream sectors**
- **Commitment by top management to an environmental policy or climate change strategy**
- **Stable energy efficiency and carbon regulatory framework**
- **Replacement of obsolete equipment**
- **Strong recycling infrastructure**

- **Long payback periods and high costs**
- **High and fluctuating energy prices**
- **Uneven playing field with overseas competition**
- **Retrofit capability**
- **Lack of capital**
- **Chemical and process efficiency limitations**
- **Low demand risk**

[B]

Glass industries Decarbonisation

Novel technologies

- **Energy efficiency improvements in terms of fuel furnace consumptions**
- **Waste heat recovery to pre-heat combustion air and raw materials, or electricity co-generation**

Cobustion innovations

- Oxyfuel combustions
- **Introduction of liquid biofuels (biodiesel)**

Reduce combustion emissions

- **Electric Arc Furnaces rather than gas fired furnaces**
- Hybrid furnaces running on multiple fuels and electricity
- **Study of the feasibility of hydrogen to run glass furnaces**

Circularity

- **Increased cullet uses to produce new glass (waste to material)**
- Calcined raw materials as CaO to substitute carbonates reducing CO2 emissions

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[C]

Steel Industry

Belgium:ArcelorMittal Ghent
Spain:Ebroacero S.A.

ArcelorMittal Ghent steel plant

[C]

ArcelorMittal is the leading steel and mining company around the world,

It is the leader in all major global steel markets, including automotive, construction, engineering, household appliances and packaging.

The RE technology already applied at ArcelorMittal Ghent steel plant is currently based on both solar and wind energy

More than 45,000 MWh of wind power per year
=
CO_2 emissions avoidance is 11,225 tons of CO_2 per year.

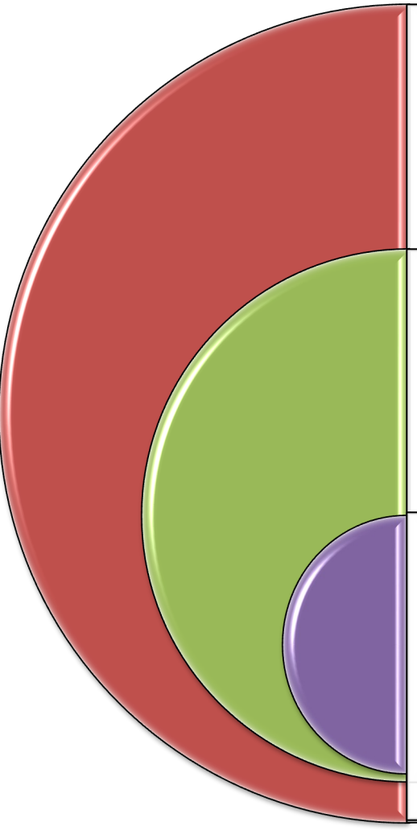
The biggest solar energy producer in Belgium, with an approximate energy production of 10,000 MWh per year.

RE4Industry success cases

ArcelorMittal Ghent steel plant

[C]

ArcelorMittal Belgium[1] has been selected as one of the success cases in the RE4Industry Project owing to the industry's huge efforts to reduce CO_2 related emissions by utilizing Renewable Energy Sources (RES) in their basic production line and Carbon Capture and Utilization (CCU) technologies.



Carbon2Value project :

A cost effective CCU technology that captures & separates CO_2 from waste gases, for transport & storage/ reuse

Torero project:

A 2.5 million-tonnes direct reduced iron plant and electric arc furnace facility at its Ghent site will operate alongside Ghent's state-of-the-art partially waste wood and plastic fired blast furnace.

The project is expected to reduce Ghent's annual CO2 emissions by 225,000 tonnes

Carbalyst/Steelanol

Is a group of technologies, which allows the production of basic chemicals, such as bioethanol,

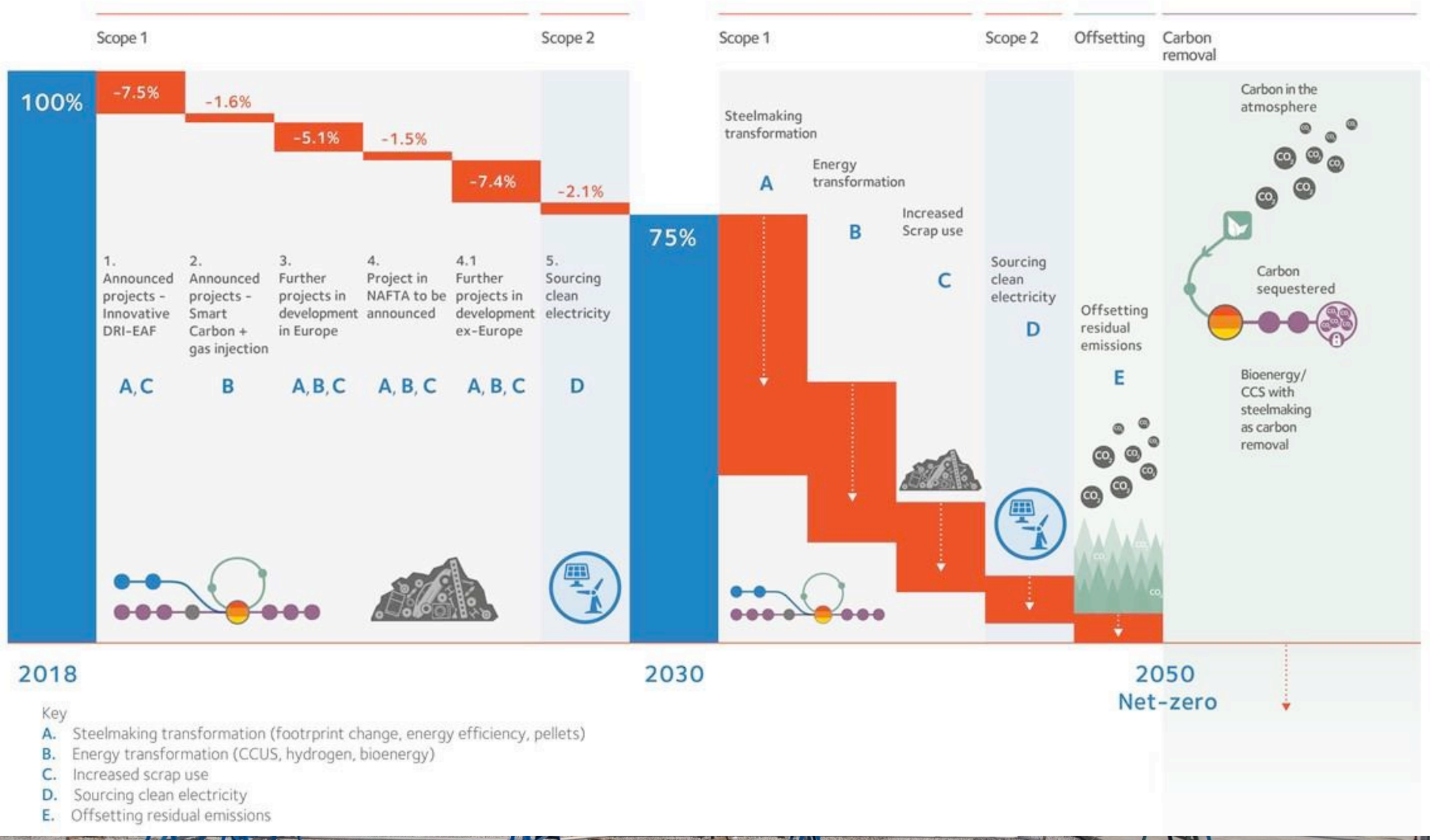
by utilizing steelmaking waste gases.

Promotes CCU by converting biologically waste gases captured from blast furnaces into bioethanol; bioethanol can be re-used as chemical feedstock or blended for use as a liquid fuel.

Target: Reduce CO_2 emission by 3.9 Mt/y by 2030

ArcelorMittal Ghent steel plant

[C]



[C]

Synergies for a sustainable future

ArcelorMittal Ghent steel plant

- ArcelorMittal with Fluxus and North Sea Port have started preparing a feasibility study for the Ghent Carbon Hub project, **an open-access CO_2 storage and liquefaction hub in the Ghent** part of North Sea Port. (capacity to process 6 million tonnes of CO_2 annually**, equivalent to around 15% of industrial CO_2 emissions in Belgium)**

- Is starting a new initiative called SMART Steelmaking with Alternative Reductants" in Collaboration with Vanheede Environment Group, Ghent University and CRM group. **This project is an cutting-edge process to chemically recover end-of-life plastics and other waste in order to reduce CO_2 emissions.** With the help of SMART project, ArcelorMittal can replace fossil carbon-containing reductants, such as coal, with circular waste-based reductants.

- A pilot project to employ bio-coal as a high-quality partial replacement for fossil coal is being launched by ArcelorMittal Ghent. The bio-coal is being responsibly sourced from Dutch company Perpetual Next that uses its proprietary high temperature torrefaction technique to manufacture it.

- Finally, leading global resources company BHP, Mitsubishi Heavy Industries Engineering (MHIENG), and Mitsubishi Development Pty Ltd are working together on MHIENG's carbon capture technology with ArcelorMitta targeting in **evaluate the separation and capture of CO_2 from the off gases.**

[C]

Ebroacero S.A. steel industry

Ebroacero S.A. is a steel industry located in Zaragoza, Spain. This company was born in 1963, and from the beginnings their activity has been focused on the manufacture of moulded steel parts and alloy foundries for all types of industrial applications.

The Spanish steel industry is at the lead in environmental performance, which has been addressed from several forefronts.

Particularly, the efficiency of raw materials utilisation, the water and energy consumption, so as the reduction of CO_2 emissions and process waste valorisation, have been key strategic lines in the sector to improve its environmental impact and process sustainability.

Main action undertaken by Ebroacero S.A in 2021 was the agreement with *Solarfarm* for the installation of **photovoltaic solar cell** technology for further procurement of fossil fuels use reduction.

Target: Reduce CO2 emissions. by 46,81 ton/year

Ebroacero S.A. steel industry

Average annual power consumption orbits 5.000.000 kWh/year, photovoltaic may guarantee near **207.254 kWh/year** produced by RE, which represents 4-5% of overall power consumptions.

This amount will be entirely consumed by their own facilities whilst no surplus will be sold to the grid.

Project economics:

- **Investment: 150.000€**
- **Return of investment: 6years**

Challenges

- **The factory's large age**
- **The adaptation of the roofs prior to the installation of the plates would entail a high cost**

[C]

Spain:
Verallia S.A.

glass industry

RE4INDUSTRY

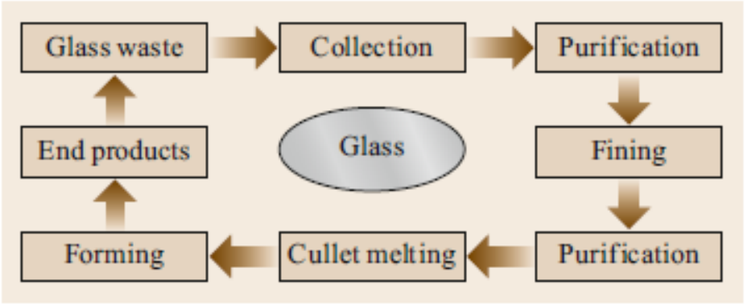
Verallia S.A. Spain glass industry

[C]

In 2020, Verallia Spain S.A, the Spanish subsidiary of the top glass manufacturing company decided to implement innovations in its processes to enhance corporative decarbonisation strategies in their facilities located in Zaragoza.

Verallia has been working in the following areas:

- **Strengthening the circularity of glass packaging**
- **Significantly reducing the CO_2 emissions of Verallia's operations**



- Verallia has identified the potential of **liquid biofuels** to substitute at least partially non-renewable fossil sources.

Emission reduction goals.

Verallia S.A. Spain glass industry

Action	Description of action	Proposed goals	SDGs
Strengthening the circularity of glass packaging	Glass is one of the most sustainable materials. The circular economy focuses 3 areas: -Increasing glass collection -Optimising cullet use -Developing the reuse of its packaging	Verallia will pursue the following goals between now and 2025: -Increase the glass packaging European collection rate of 90% in 2030. -Increase the use of external cullet in their worldwide production processes to reach 59% by 2025. -Trial at least one bottle reuse pilot project in France.	
Significantly reducing the CO2 emissions of Verallia's operations	Verallia's bottle and jar production process entails substantial energy consumption and CO2 emissions. Main impacts are found in furnaces energy efficiency and recycled cullet use	Verallia aims to reduce its CO2 emissions (Scopes 1 and 2) by 46% from 2019 to 2025 With regard to its products, Verallia aims to achieve a 3% reduction in the weight of our non-returnable standard bottles and jars by 2025.	

Verallia S.A. Spain glass industry

[C]

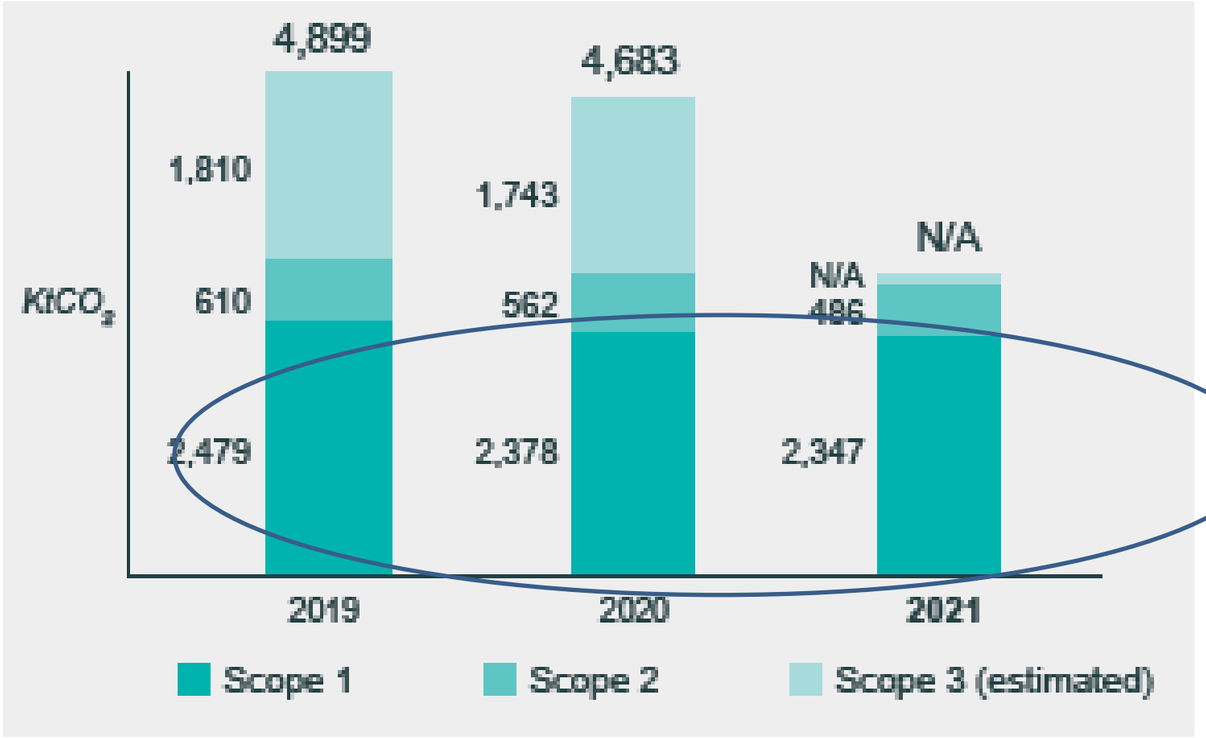
Undergone and ongoing 3 actions for scopes #1 & #2, related to energy consumption

Action #1: Optimise the energy consumption of Verallia's industrial facilities

- Reduction of emissions from melting by reducing fuel oil consumption
- Conversion of the installations to replace heavy fuel oil with liquefied natural gas, • Improvement of existing industrial facilities
- Elimination of all energy losses
- Use of flue gas heat .

Action #2: Develop and invest in low-carbon furnaces

- Installation of electric furnaces at certain sites - The project aims to reduce CO2 emissions at the site by 50%.
- **Prioritising the transition to the hybrid furnaceproduction, applicable to all sites**
- **Relying on transition technologies: the "super-boosted" furnace and the oxy-combustion furnace**



Verallia S.A. Spain glass industry

[C]

Scopes 1 and 2

Action #3: Develop renewable or decarbonised energy
- **Towards "greener" electricity**
- **Electricity generation on sites**
- Preparing for the use of green hydrogen
- **Biofuel co-firing implementation in furnaces**

The goal is to supply the equivalent of three furnaces with 100% biofuels by 2030.

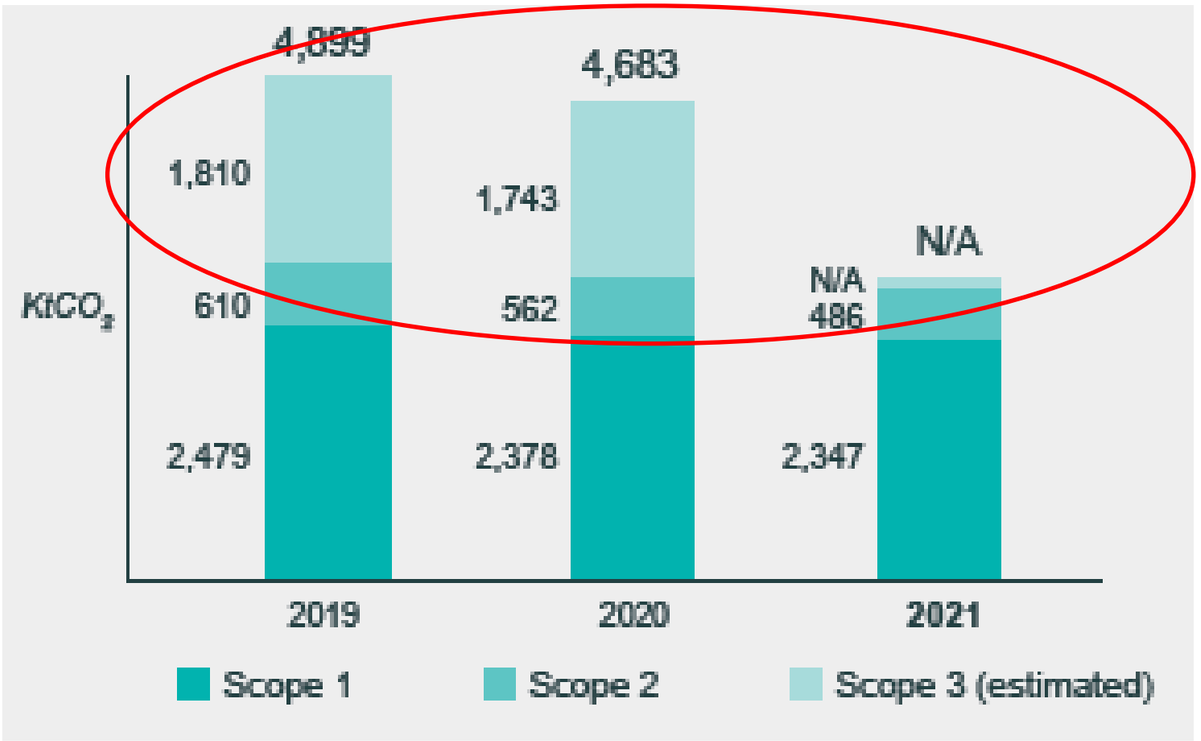
Scope 3 actions related to energy consumption

The significant reduction in Scope 3 emissions between 2020 and 2019 is linked to two main elements:

- **the raw material emission factors per supplier assessment**

and

- **the reduction in the use of virgin raw materials.**



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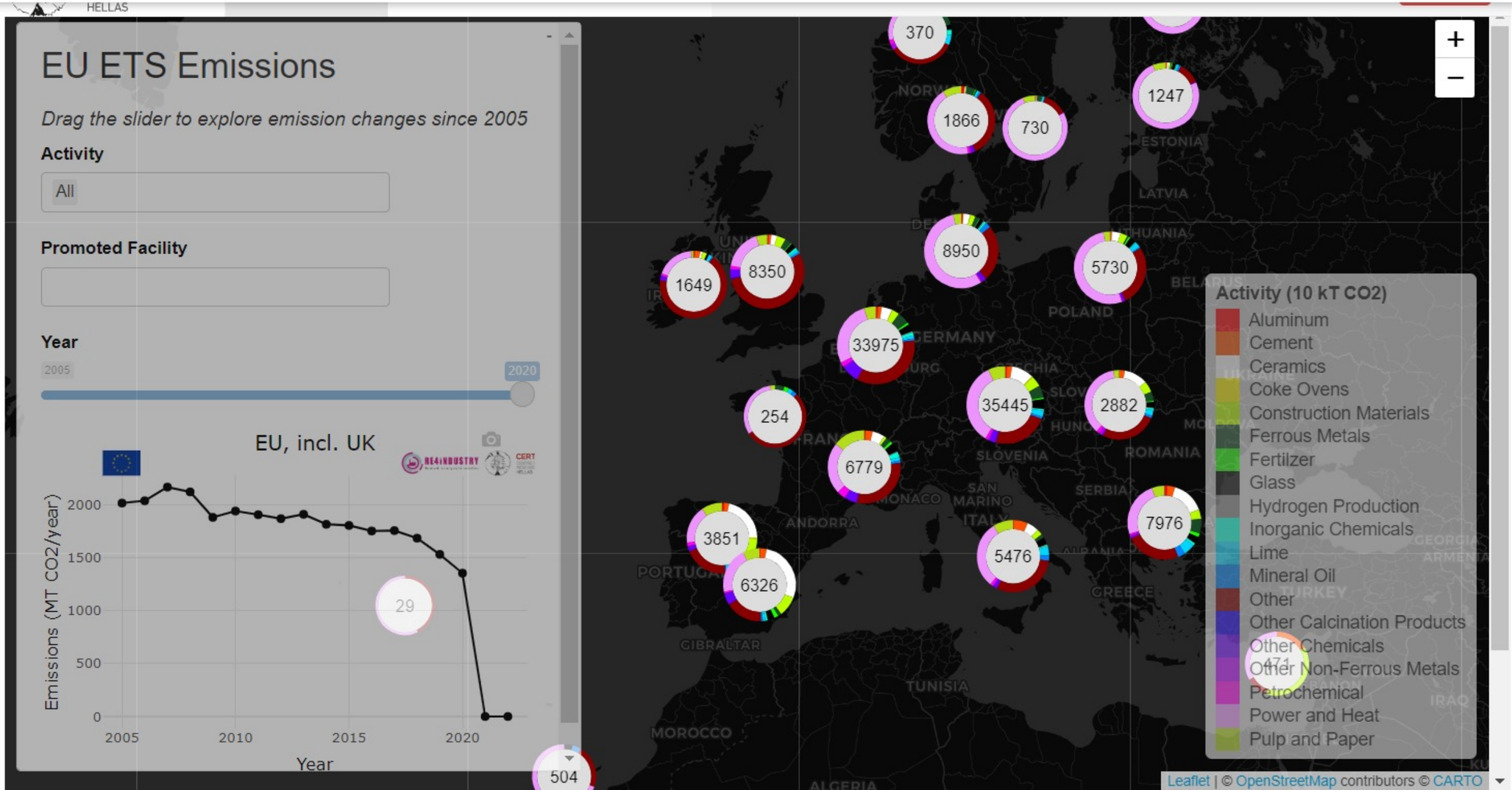
[D]

RE4Industry EIIs map tool

→Re4industry.eu→re4industry platform → EIIs interactive map

RE4INDUSTRY

HOMEPAGE | RE4INDUSTRY | RE4INDUSTRY PLATFORM | NETWORKS | DOCUMENTS | NEWS & EVENTS | SYNERGIES | NFT



[D]

GLASS

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

Interactive Map | Country | Activity | Installation | Manual

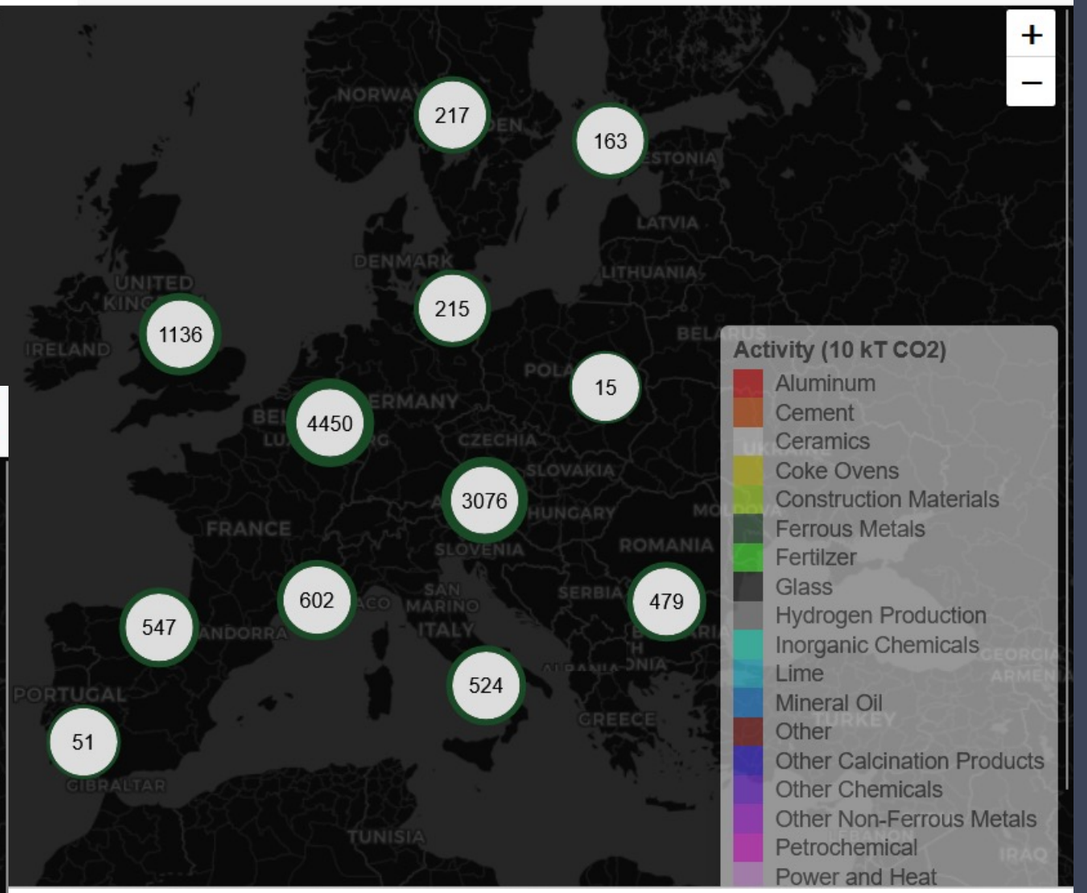
EU ETS Emissions

Drag the slider to explore emission changes since 2005

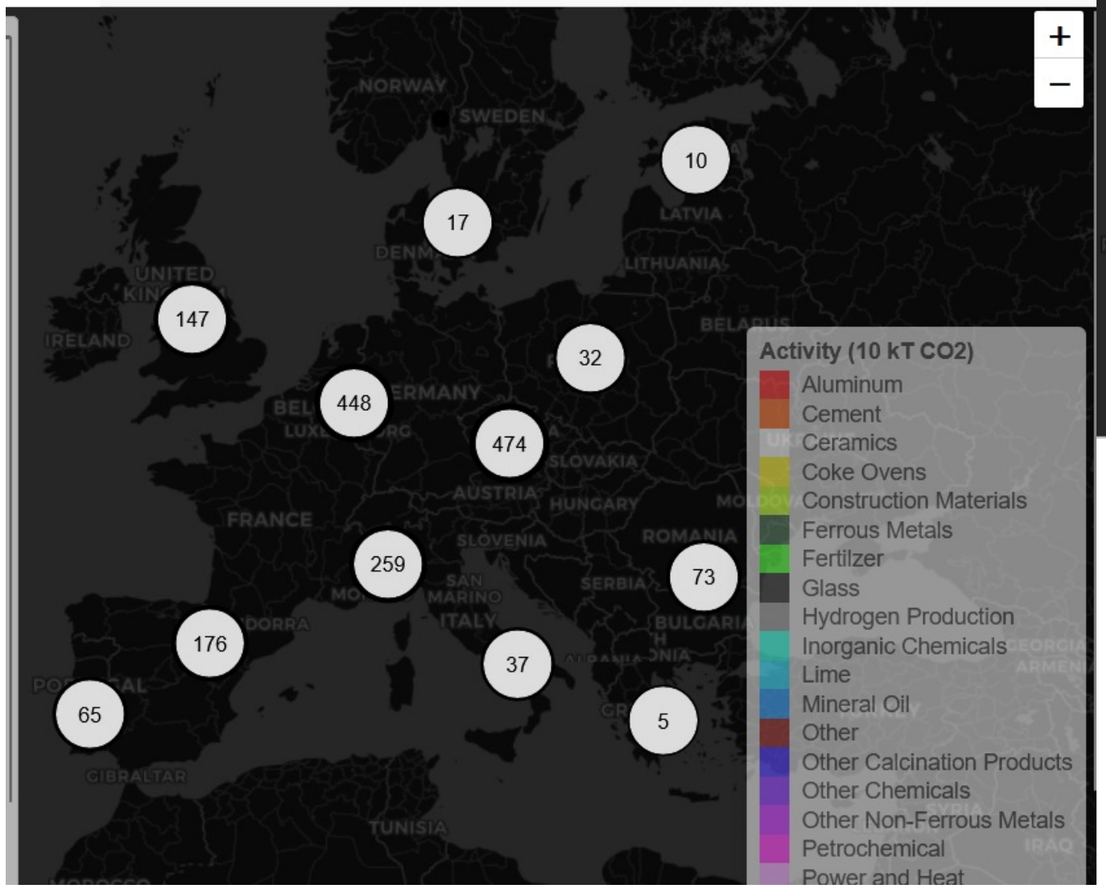
Activity

Ferrous Metals

Promoted Facility



allation | Manual



RE4Industry EIIs map tool

Agenda

[A] CERTH profile & RE4Industry project overview

[B] Success cases prologue

i. Steel Industry

ii. Glass Industry

[C] Success cases examples from EIIs

1. ArcelorMittal Ghent steel plant

2. Verallia S.A. Spain glass industry

[D] Re4Industry Interactive map

[E] Conclusions

- **Regarding the emissions related to the electricity, one potential measure is the use of electricity produced from sun and wind sources .**

- **CCS & CCU technologies is crucial for CO_2 intensive industries to reach net zero emissions, particularly in hard-to-abate sectors with processes that naturally generate CO_2 emissions**

- **Emissions produced from fuel's combustion could be avoided by switching the fuel mix with fuels that are not contributing to the carbon footprint**

Concluding,

The zero-carbon transition of heavy industry is not only feasible but also beneficial for the companies, by ensuring their long-term competitiveness in a world that is inevitably moving towards a climate-safe future

[E]

RE4INDUSTRY
Renewable energies for industries

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CERTH
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RETROFEED

Implementation of a Smart RETROfitting Framework in the Process Industry towards its Operation with Variable, Biobased and Circular FEEDstock

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869939.

RETROFEED: Implementation of a **smart RETROfitting framework** in the process industry towards its operation **with variable, biobased and circular FEEDstock**

TOTAL COST
15,468,861.25 €

DURATION
48 months
End: October 2023

CONSORTIUM
18 partners

Main objective

RETROFEED main objective is to:

enable the use of an increasingly **variable, bio-based and circular feedstock** in process industries through the **retrofitting of core equipment** and the implementation of an **advanced monitoring and control system** and providing support to the plant operators by means of a **DSS** covering the production chain.

This approach is demonstrated in **five Resource and Energy Intensive Industries - REIIs**

AGROCHEMICAL	ALUMINIUM	CEMENT	CERAMIC	STEEL

IMPACT

22%

+ RESOURCE EFFICIENCY

19%

+ ENERGY EFFICIENCY

9.4 M euro

COSTS SAVINGS

135 kton CO_2

REDUCTION GHG EMISSIONS

Demos

Fertiberia

CORE EQUIPMENT – PHOSPHOROUS REACTOR

Retrofitting actions

- ✓ New design of a in-line reactor for alternative phosphorus sources

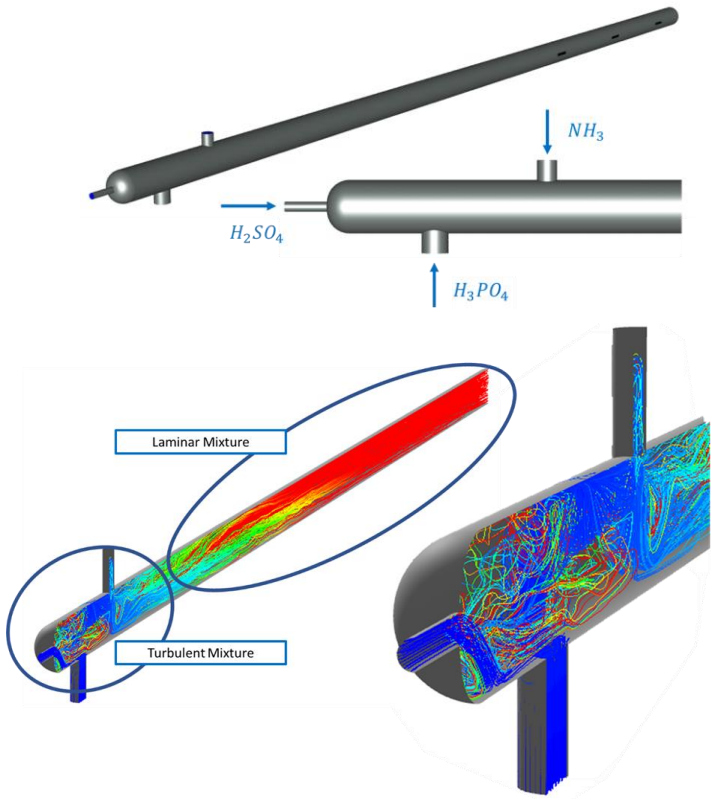
Goals

- ✓ Replace 10% of the currently used phosphorous sources
- ✓ Recover valuable raw materials from wastes
- ✓ Reduction of cost
- ✓ M&C system improvement

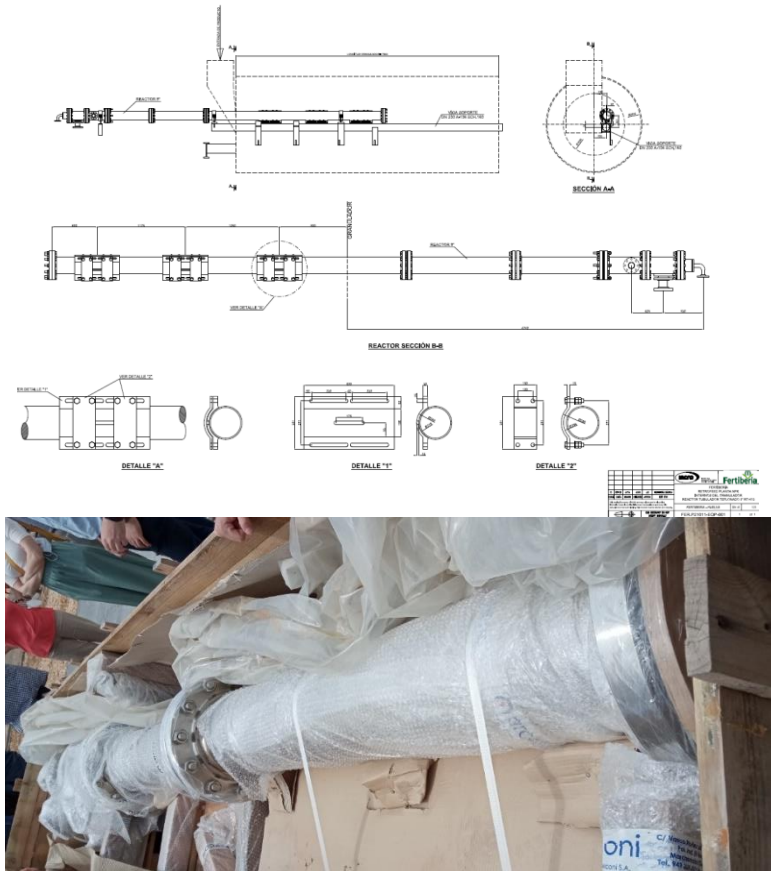
Demos Fertiberia

CORE EQUIPMENT – PHOSPHOROUS REACTOR

Pilot plant



Digital twin



New reactor

CORE EQUIPMENT – ROTARY KILN

Retrofitting actions

- ✓ Multi-fuel burner design
- ✓ Image based combustion diagnosis tool
- ✓ Alternative fuels properties determination
- ✓ Real time clinker optical characterization

Goals

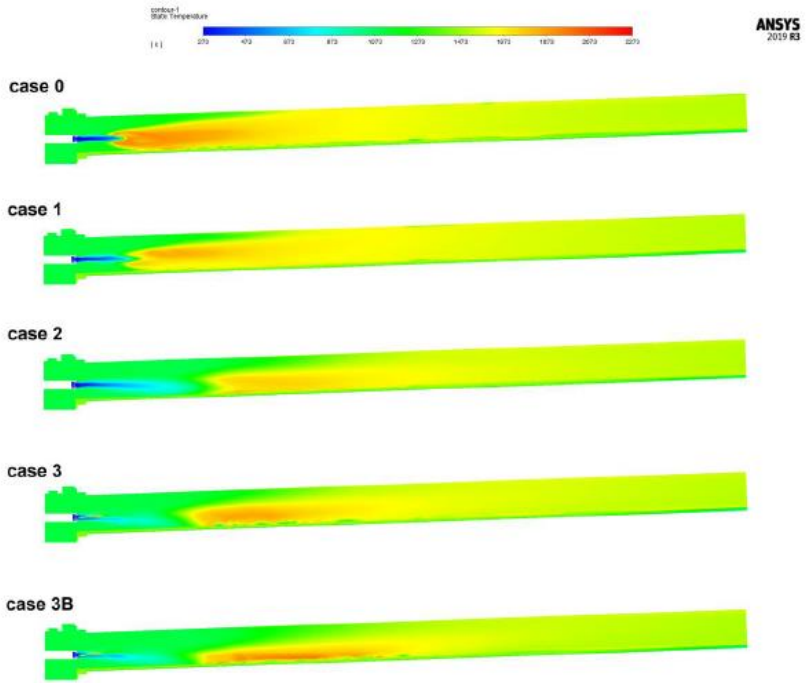
- ✓ CO_2 emissions reduction
- ✓ Replacement of fossil fuel close to 100%
- ✓ Increment in energy efficiency
- ✓ M&C improvement

Demos

SECIL

Dá forma às ideias

CORE EQUIPMENT – ROTARY KILN



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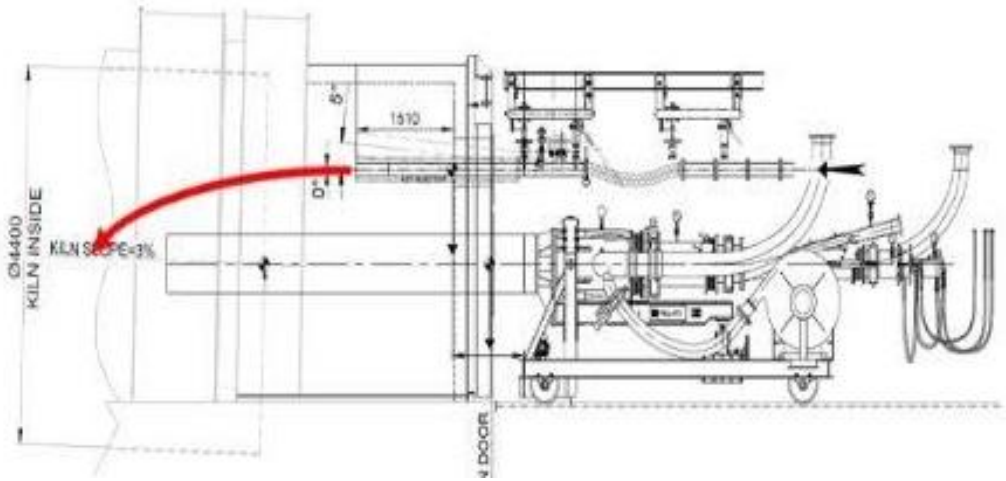
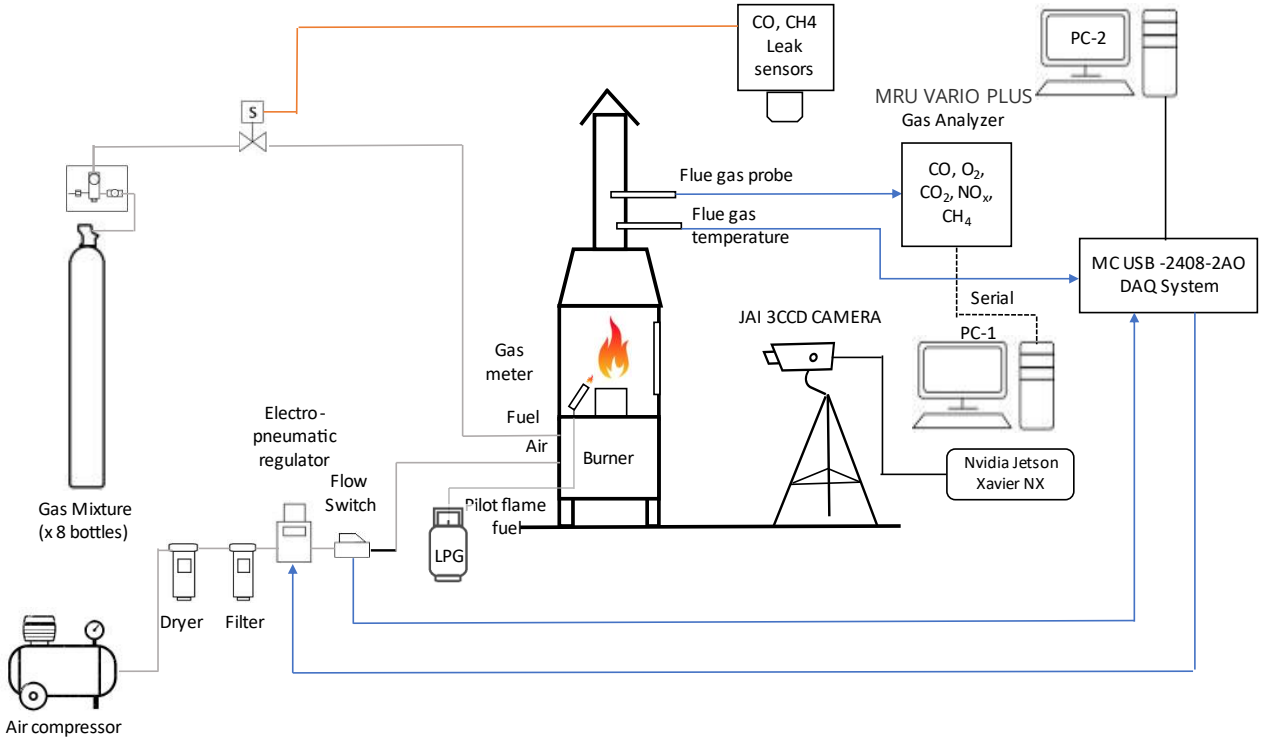
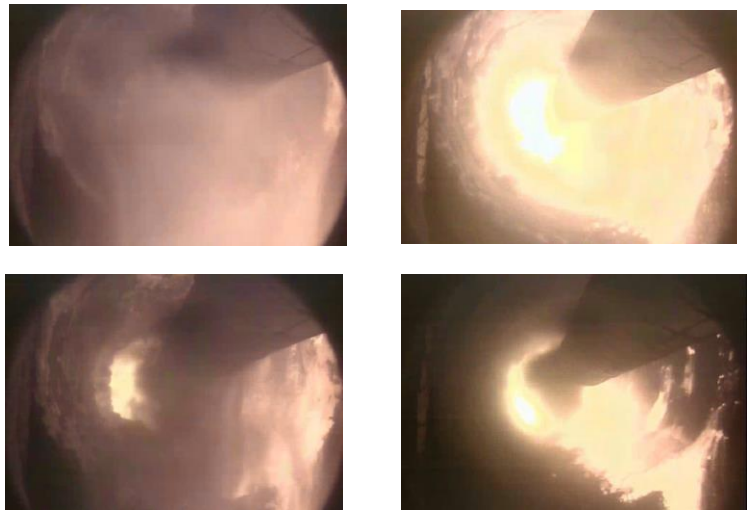


New burner

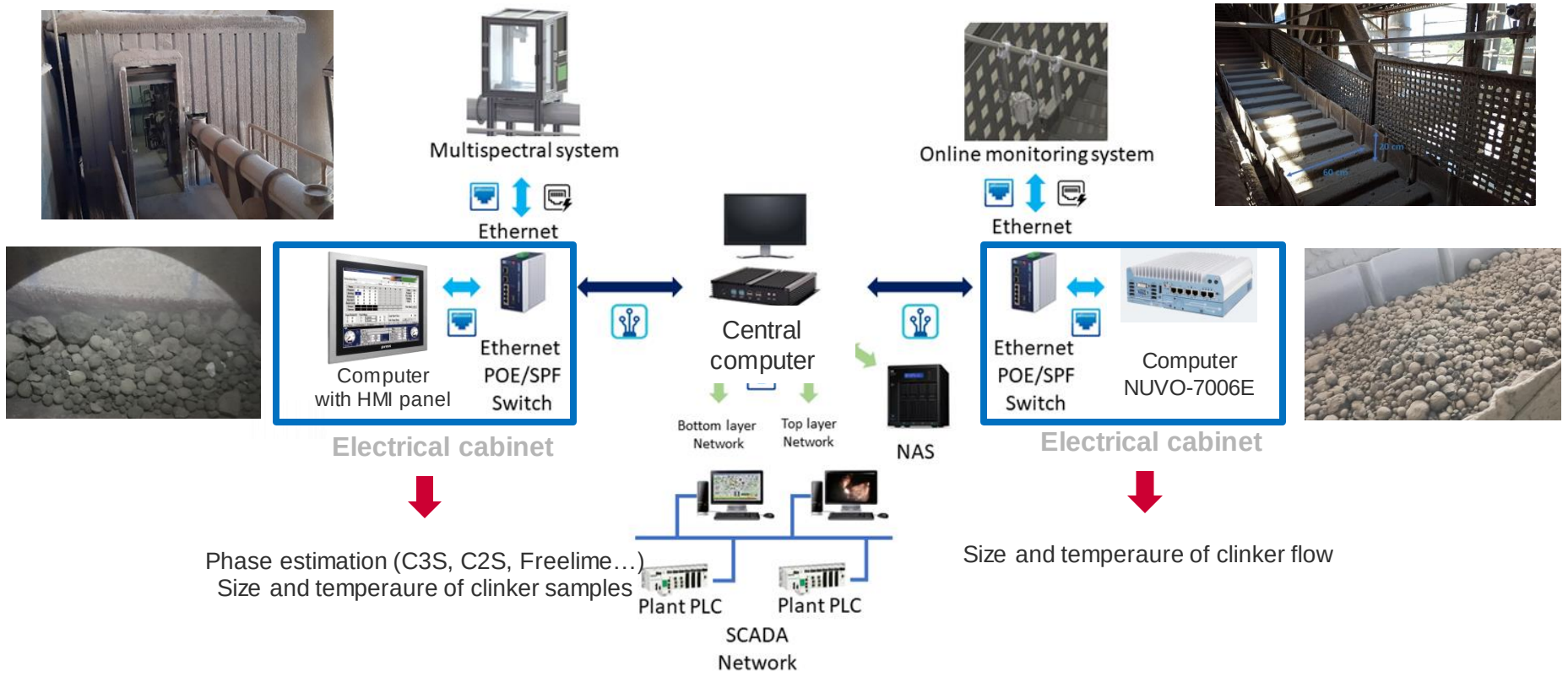
CORE EQUIPMENT – ROTARY KILN





New image based combustion diagnosis tool

CORE EQUIPMENT – ROTARY KILN



Alternative fuels properties determination and real time clinker optical characterization

CORE EQUIPMENT – MELTING FURNACE

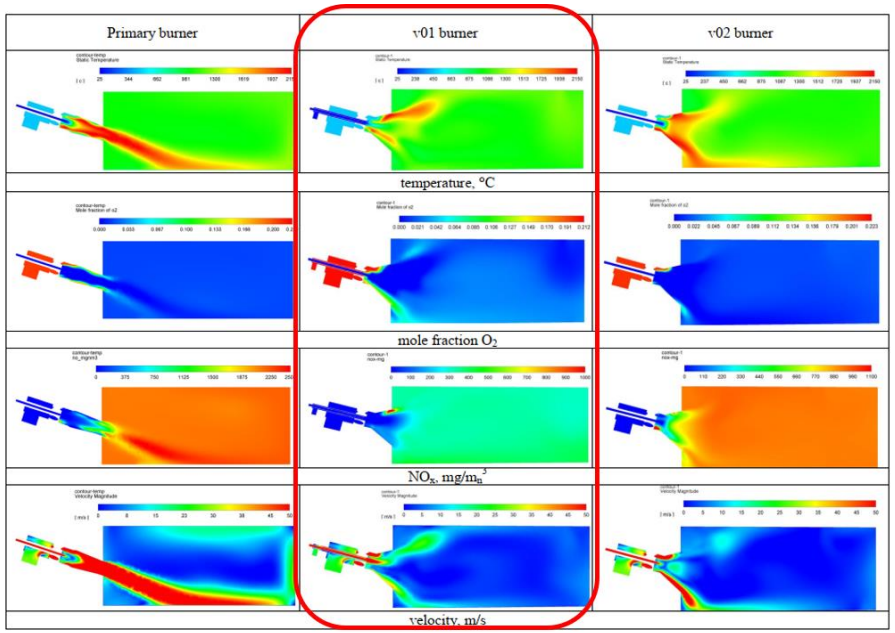
Retrofitting actions

- ✓ Delacquering system
- ✓ O_2 injection system
- ✓ New burner head design
- ✓ O_2 and TOC analyzers

Goals

- ✓ 50% increment in the amount of scrap
- ✓ Reduction of the energy consumption 15 times
- ✓ More efficient combustion
- ✓ Reduction of the GHG emissions
- ✓ Improved M&C system

CORE EQUIPMENT – MELTING FURNACE



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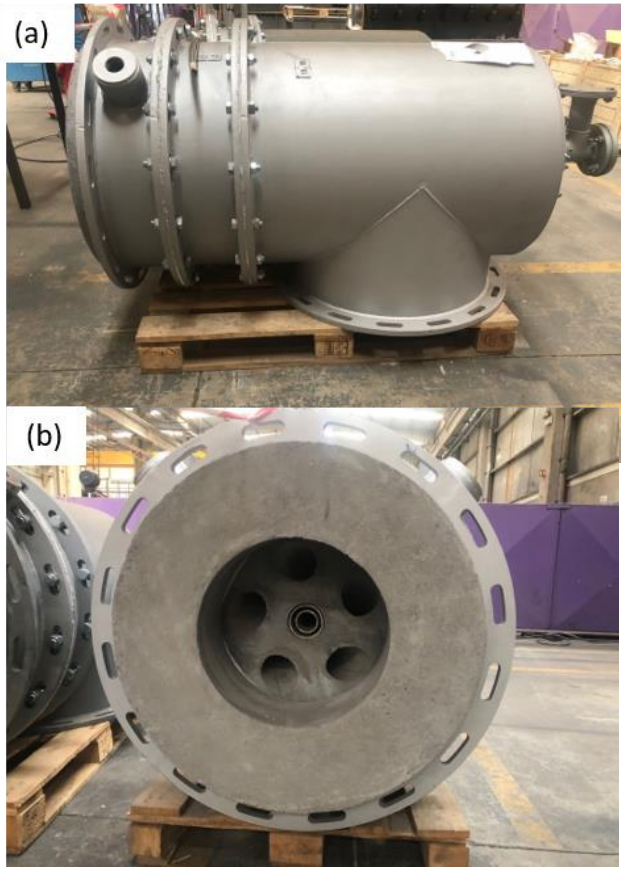


New burner head

O_2 injection system

CORE EQUIPMENT – MELTING FURNACE

Delacquering system

O_2 analyzer

CORE EQUIPMENT – FRITS FURNACE

TORRECID

Retrofitting actions

- ✓ Feeding system enhancement
- ✓ Redesign of the flue gases recovery system
- ✓ Implementation of new sensors
- ✓ Smart control

Goals

- ✓ Energy and material savings
- ✓ Optimization use of fuel and combustion air
- ✓ Reduction of material waste
- ✓ Improved M&C system

CORE EQUIPMENT – ELECTRICAL ARC FURNACE

PITTINI

TenarisSilcotub

Retrofitting actions FENO

- ✓ Burner modification for feeding biochar and plastic grains
- ✓ Injection system

Retrofitting actions SILCOTUB

- ✓ Feeding injection system

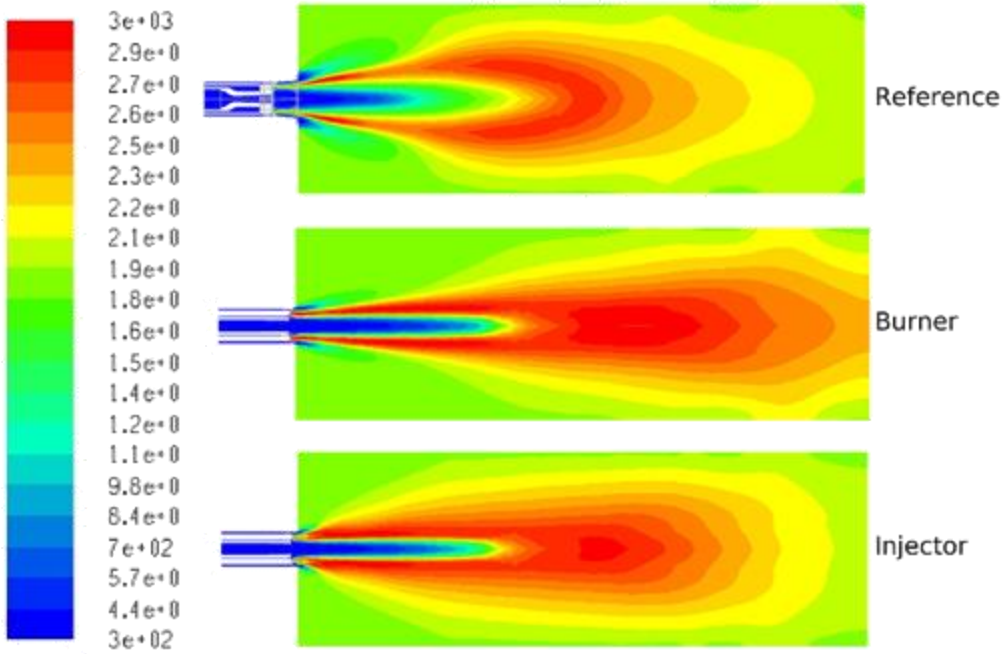
Goals

- ✓ Reduction of GHG emissions
- ✓ Use of alternative feedstock
- ✓ M&C system improvement

CORE EQUIPMENT – ELECTRICAL ARC FURNACE

PITTINI

TenarisSilcotub



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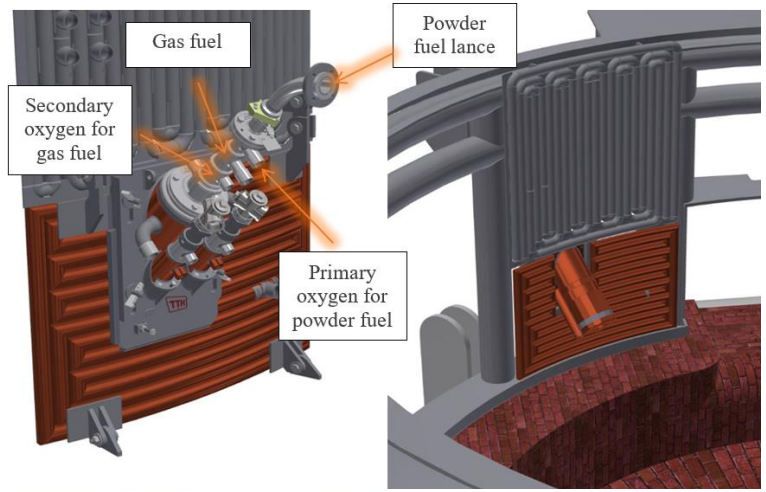
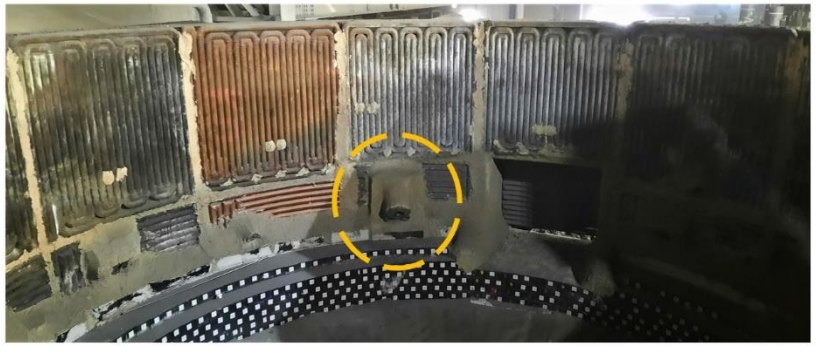




New burner/injector

Retrofeed
smart retrofitting in process industry

CORE EQUIPMENT – ELECTRICAL ARC FURNACE

PITTINI

TenarisSilcotub

Electric Arc Furnace

Flame of the new burner using the AM

Flame generated by CH_4 and O_2 without the use of AM

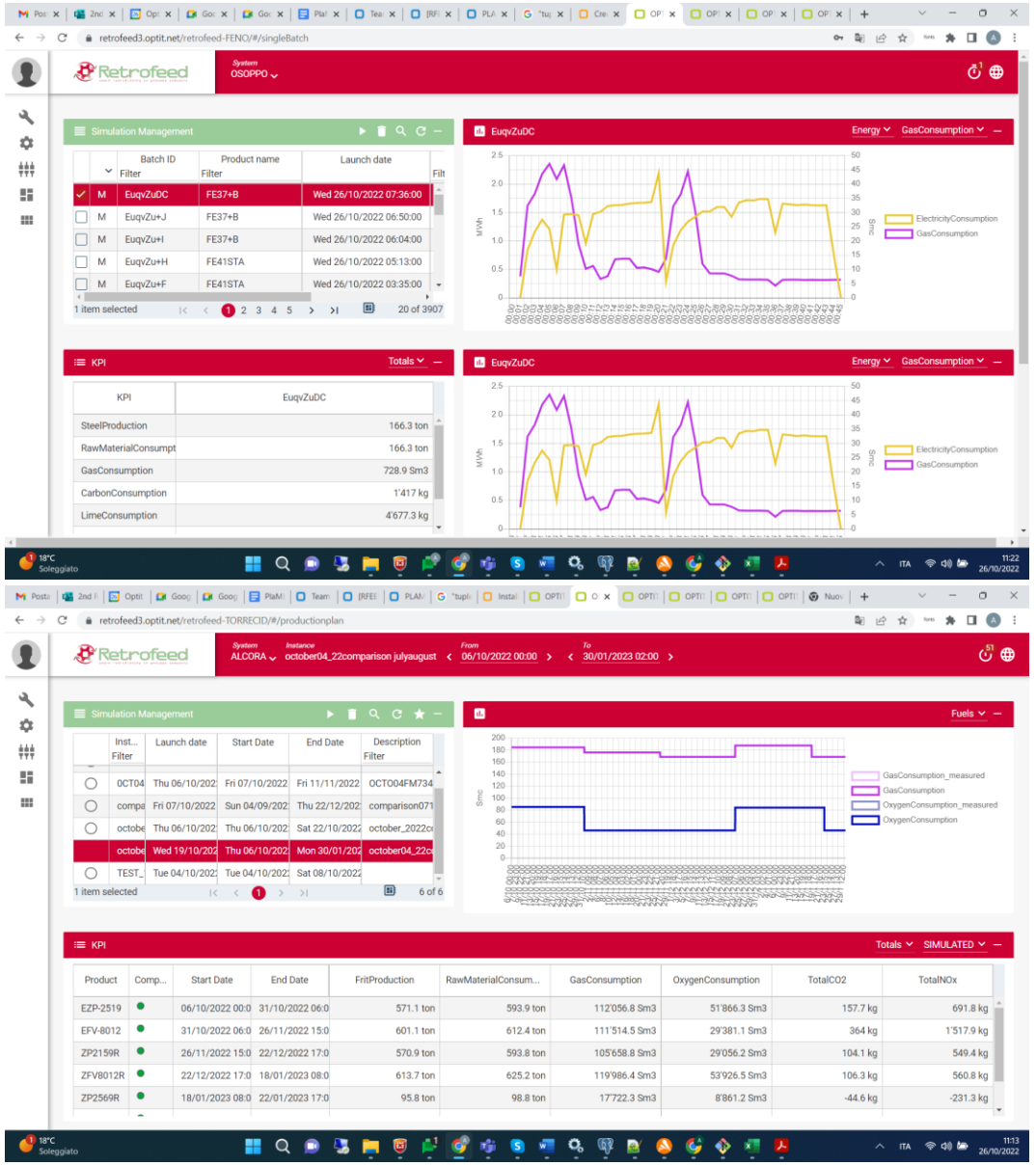
Started the burning of the first AM in addition to CH_4 and O_2

The DSS currently on OPTIT optimal solutions Cloud

DSS (Decision Suport System)

- to provide a **diagnosis of the processes under different scenarios** differing in the retrofitting solution and feedstock selected

- to optimize the **management of the plant** by obtaining real-time data from the processes and providing information on the **operation conditions to be implemented** depending on the quality, quantity and price of feedstock, among other parameters

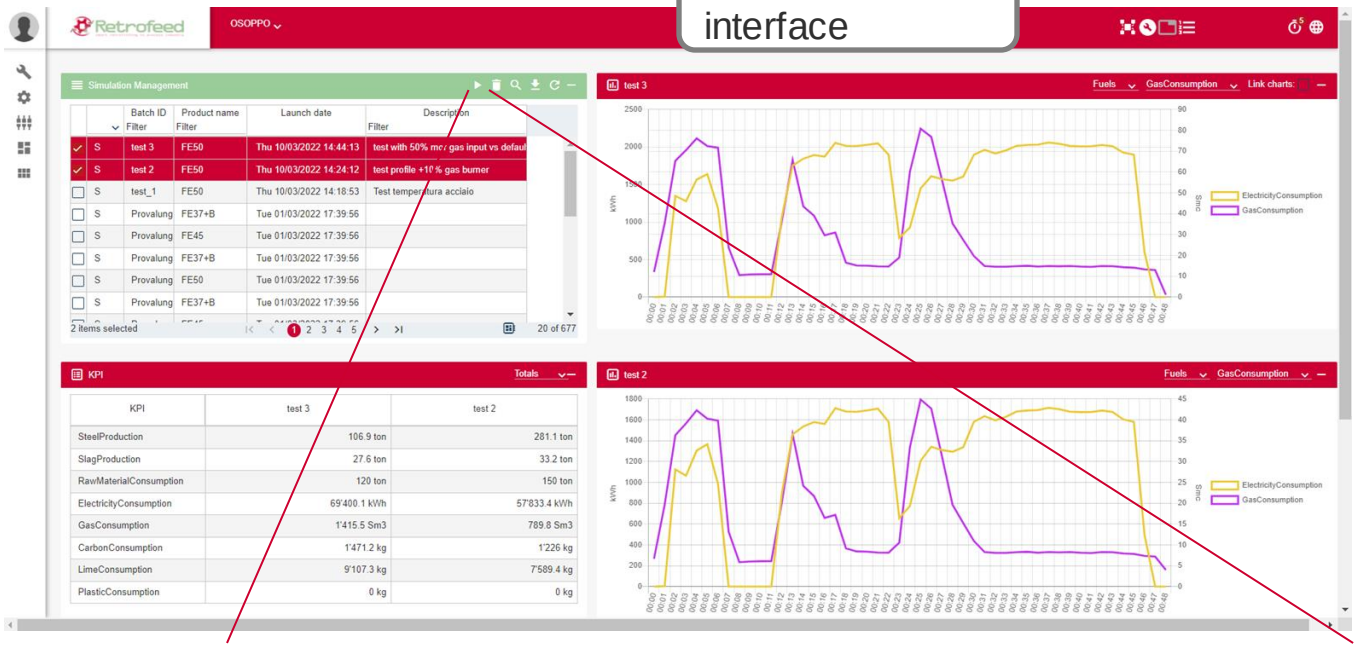


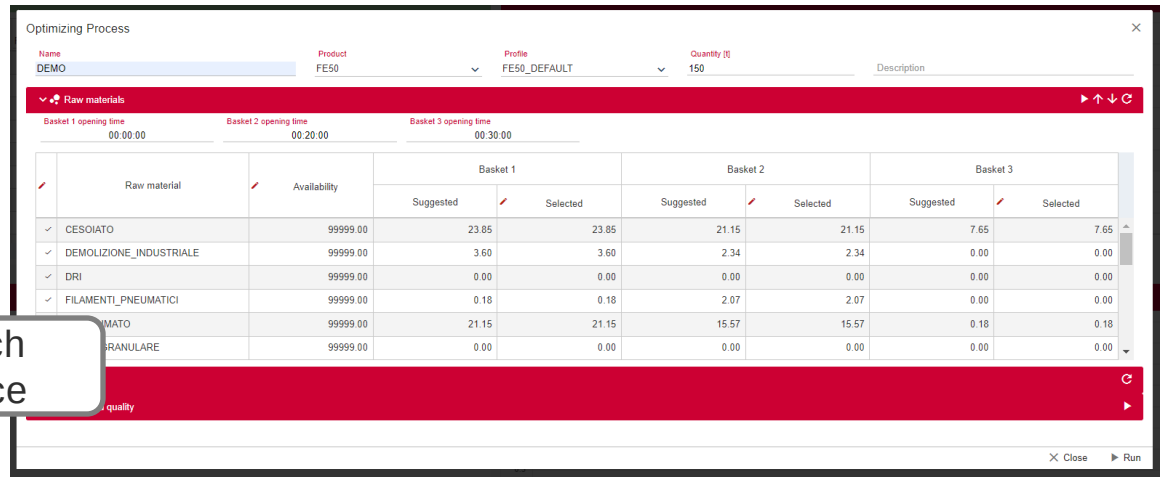
Retrofeed
smart retrofitting in process industry

Simulation and Monitoring

Main Features:

- Digital Twins and Optimization models interfaces for process simulation
- Measured vs Simulation comparison
- Process Monitoring
- KPI calculation
- Easy export of excel files





Model Launch User Interface

Retrofeed
smart retrofitting in process industry

Thank you for your attention!

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