Continuous Casting Refractory impact on Sustainability and on CO_2 footprint reduction

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Steel Meets Refractory

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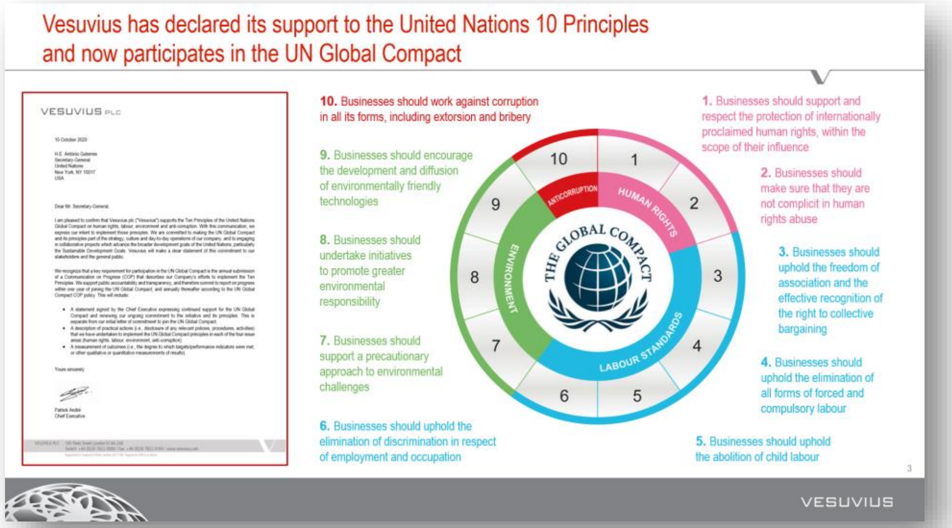
Sustainable Development - Common challenge, complimentary approaches



Creating a **better tomorrow** for **Our Customers**

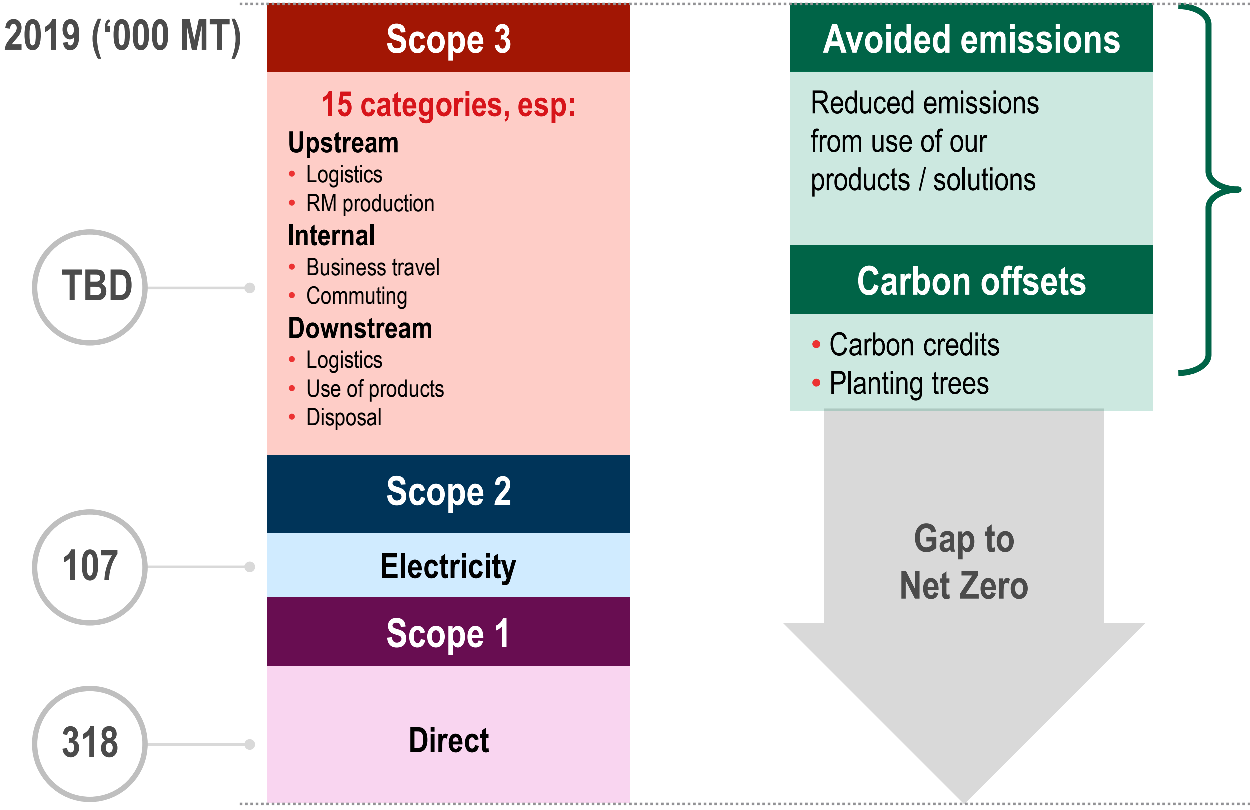
....Reduce our customers' environmental footprint and CO_2 emissions

- Develop **longer lasting and better performing refractories**
- **Develop technologies** to improve our customers' operational performance
- Identify the most forward-looking customers and **build partnerships** in all Regional Business Units

Sustainable Development – Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC), to limit global warming to 1.5°C above pre-industrial levels:

- the world **must reduce by 55% CO_2 emissions by around 2030** and reach net-zero CO_2 emissions by mid-century.



- No clear and agreed standard
- Main issue: what reference to use in calculation?
- Strong Final User impact

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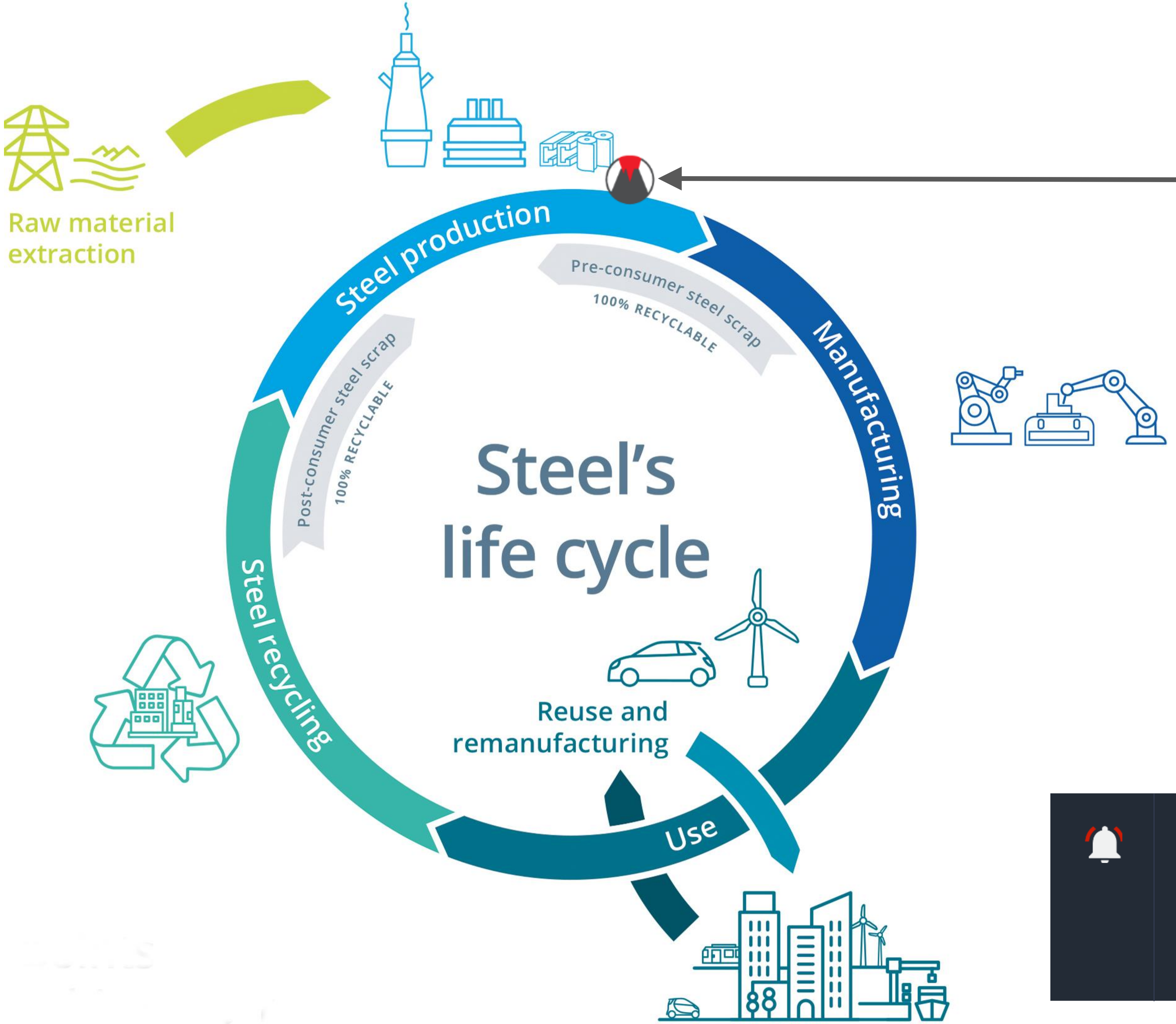
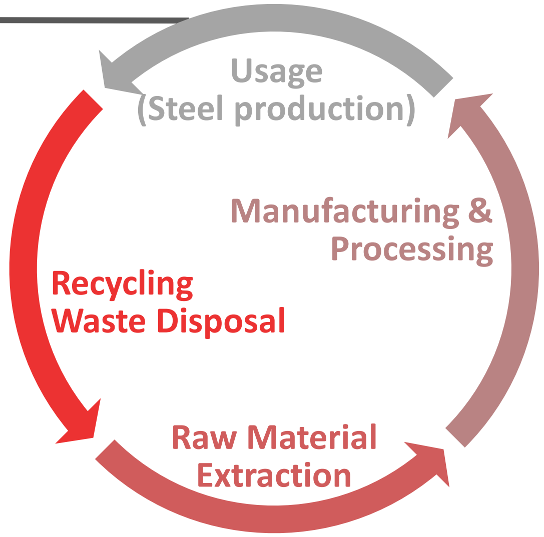
55% CO_2 reduction

But from what baseline value? For refractory suppliers, the scope III is unknown and requires partnership for joint calculations

LIFE CYCLE PERSPECTIVE IS THE MUST

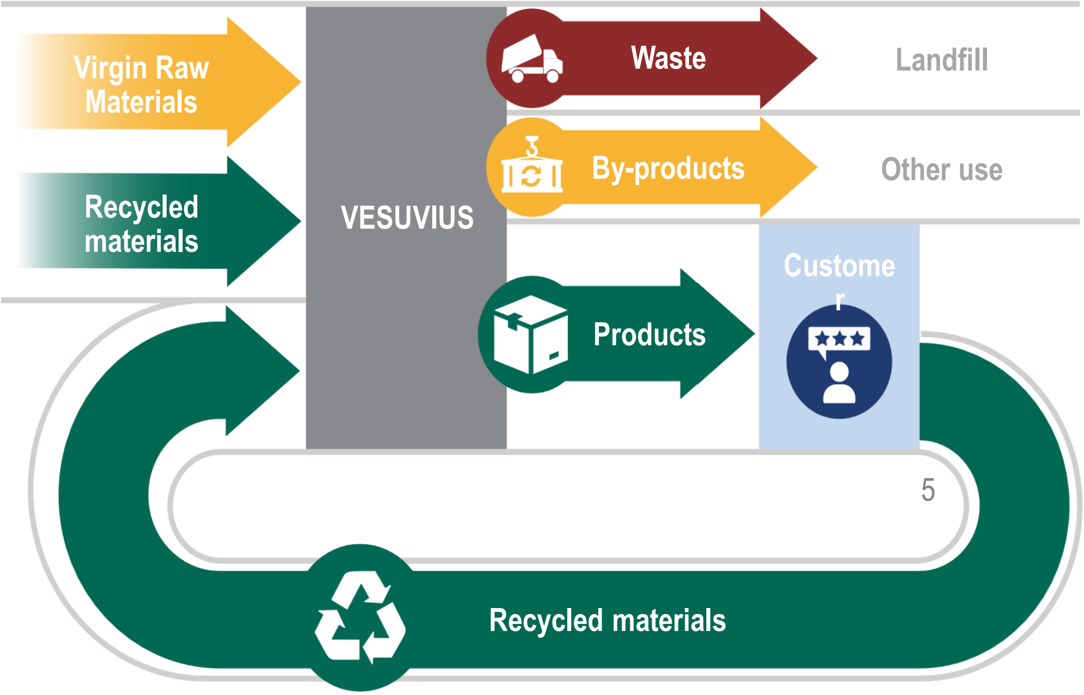




TRADEOFF LEVERAGE

Global Vesuvius CO_2 emissions (Scope 1&2) equals 2h of steel production.....

Sustainable Development – Circular Economy



- **Replace high-CO_2 electricity** (coal) with greener electricity or other sources of energy
- **Reduce our energy wastage**, recover heat to power equipment
- Grow the use of **Externally Recycled Materials**
  - Recover more of our products after they have been used,
  - Increase the usage of recycled materials

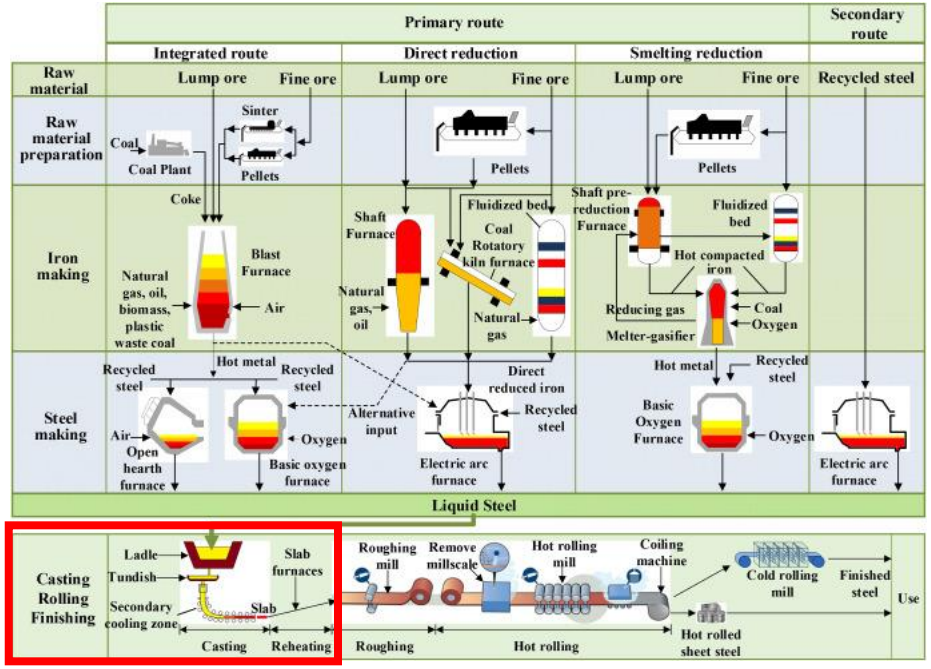
User-Supplier Relationship

Scope I Direct CO_2 emissions from facilities of the steel producers			
Sinter Plant	Ironmaking (e.g.: Blast Furnace, Direct Reduction Plant, Smelting Reduction Plant)	Steelmaking	Casting Plant
Pellet Plant			Hot Rolling Mill
Coke Oven			Cold Rolling Mill and Downstream Plants

Scope II Indirect CO_2 emissions from purchased energy
Electricity

Scope III: Indirect CO_2 emissions from the value chain (upstream and downstream), which are not included in Scope I and II				
purchased materials				sold materials
Pellets	DRI / HBI	Pig Iron	Graphite Electrodes	Process Gases[1]
Oxygen	Natural Gas	Coke	Lime	Slag[2]
Hydrogen	Steam	Scrap	Biomass	

1. The utilisation of byproducts, such as process gases or waste heat, is not counted as credit because such use helps reduce the energy consumption of facilities. Only byproduct gases, that are sold to a second party can be counted as a credit, because they help to reduce emissions of a different sector.
2. Currently no credits are given for the CO2 savings through slag usage in cement production.

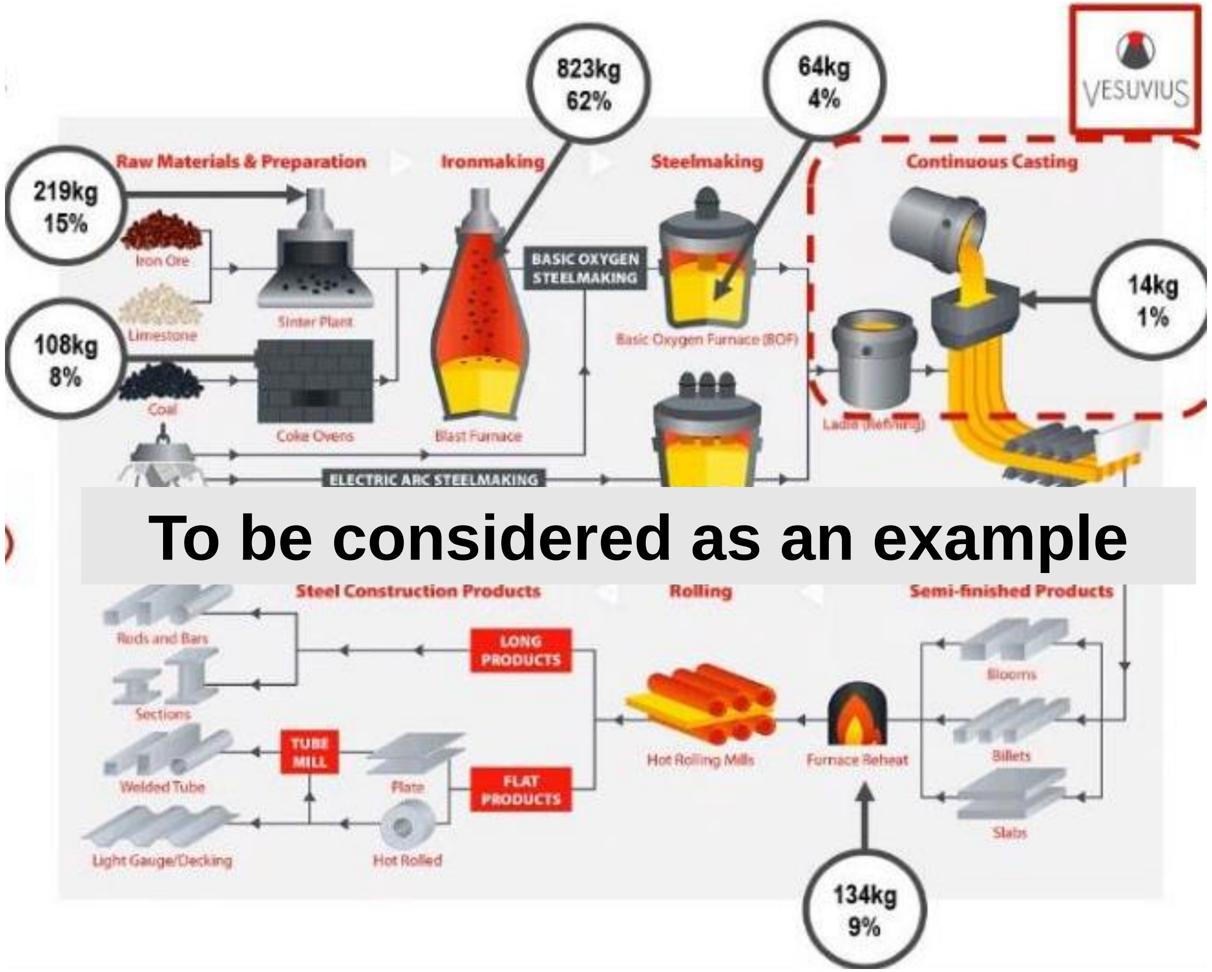


Steel Plant Scope I and II ⬄ Vesuvius Scope III (products in use)

Collaborative Work between suppliers and users to define their scope I to reduce their scope II (energy losses)

From today to tomorrow's goals to reduce CO2

ArcelorMittal Dunkerque
6,500 KT steel output
9,176 KT CO_2e emissions
1,423 kg CO_2e / T steel



Today's CO_2 reduction is mainly focused on the elaboration of iron then steel
Tomorrow reduction of energy losses around the continuous casters will be the main challenge for all suppliers involved.

Refractory performance impact on CO_2

CO_2eq
from Refractory improvement

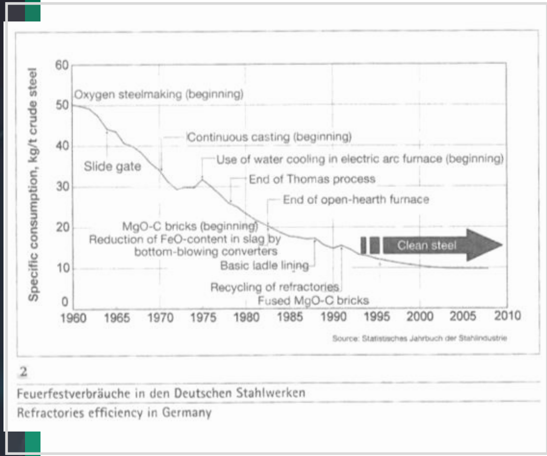
CO_2eq
from Refractory failure prevention

CO_2 emission can be reduced by preventing the RE-PRODUCTION of steel after a <u>refractory failure</u> such as: non opening of purging plug, ladle none free opening, casting sequence interruption.......

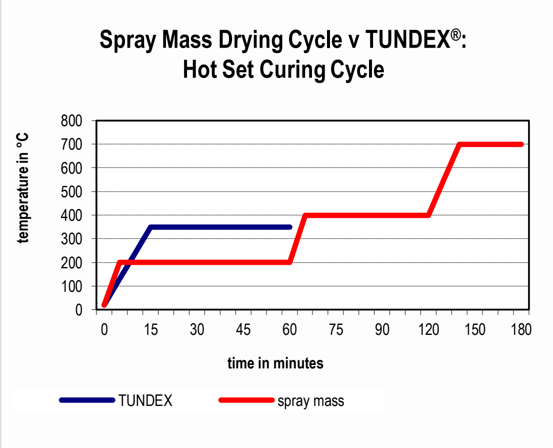
Quality, Reliability and Repeatability of refractory performance

Sustainable Development – Continuous Casting Refractory impact on CO2 footprint reduction

Reduce consumption of refractory material per ton of steel



Tundish lining that reduces CO_2 emissions by few kg per Ton of steel cast vs. spray mass drying



Improve yield (ton of molten metal per ton of finished product) with smaller residuals in ladles

Improve yield by reducing rejection and downgrade during steel grade exchange

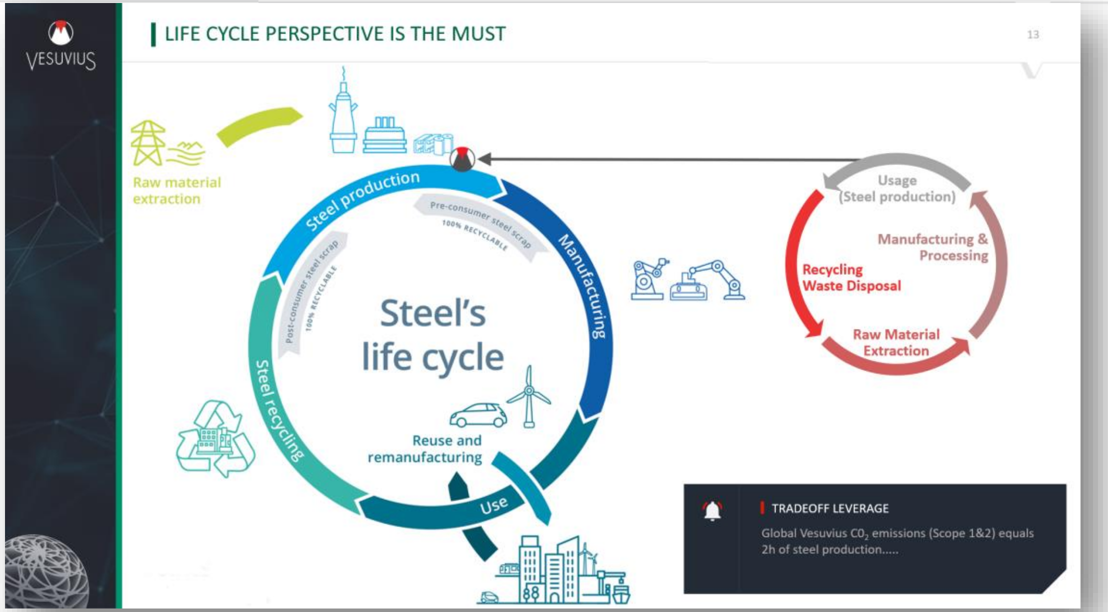
Slide gates recovered and recycled after usage

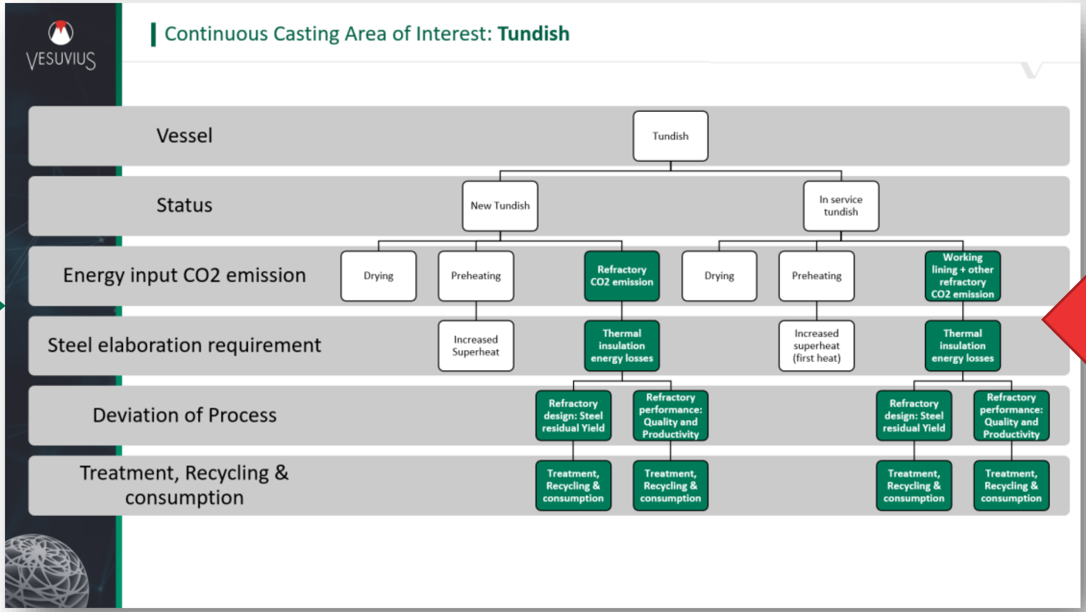
Long life ladle shrouds reduce preheat requirement and waste refractory after use

DEVELOP & IMPLEMENT **EXTERNAL** PART OF SUSTAINABILITY BENCHMARKING

From delivery/distribution to the end of life

- **Reduction of consumption of energy and/or CO_2 emissions at the steel production and during final product lifetime stage?**



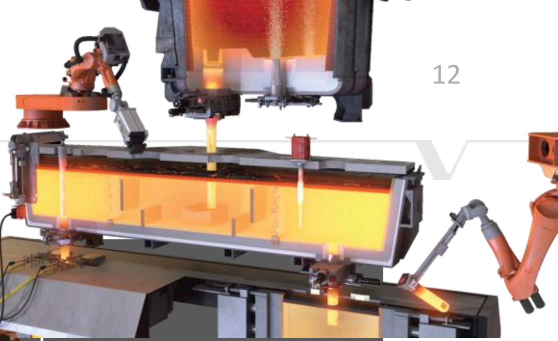


Need of External Collaboration (**Steel maker**(s), Universities,...) Availability of data, benchmarking possibility, verification, credibility ...

Complexity in Life Cycle: example Tundish

EXAMPLE					
Operations	Tundish cooling	Tundish deskulling	Tundish skull handling	Tundish Cooling	Tundish cleaning, repair
Material/ Consumables					Castable, water
Time & Manpower	up to 4h, crane operator	Tundish crew	Scrap handling	Tundish crew	Tundish crew
Impact to CO2	Cooling: heat release	Electrical / hydraulic energy maintenance	Heat, slag, refractories, steel residual losses	Cooling: heat release, Electrical fan	Electricty, water

Complexity in Life Cycle: example Tundish

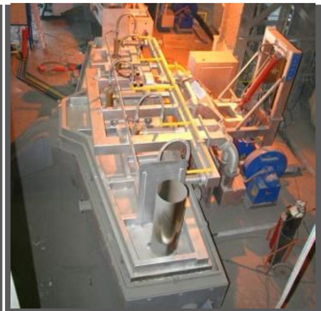


EXAMPLE					
Operations	Tundish preparation: Insulating boards	Anchors fixing	Back up Lining casting	Drying, Curing	Cooling
Material/ Consumables	Ceramic fibre boards		70% low cement castable, Water	Electrcity, Energy	80-90°C before spraying
Time & Manpower	Tundish crew	Tundish crew	Tundish crew	1 to 6hr (25°C/h), 7 to 30hr at 150°C 30 to 40h (25°C/h) to 50h at 400°C then + 11h at 25°C/h and 10h at 800°C	3 to 4hrs cooling before spraying
Impact to CO2		Welding or gluting with tar?	Water	Energy, electricty of gas	Electricty for cooling fans

Complexity in Life Cycle: example Tundish

EXAMPLE					
Operations	Working Lining Spraying	Tundish furniture installation	Drying	SEN/Tunsish nozzle/Stopper installation	Tundish transport to casting floor
Material/ Consumables	85% MgO spray mass, water tundish at 80 to 90°C	Turbostop, dams, weirs, baffles TGD,	Air drying 30 to 45min then 3h at 350°C	SEN, split rings tundish nozzle, stopper	
Time & Manpower	Tundish crew	Tundish crew	Tundish crew	Tundish crew	Crane Operator
Impact to CO2	Heat and water, sprayng energy	End of use recycling	Heat and drying energy		

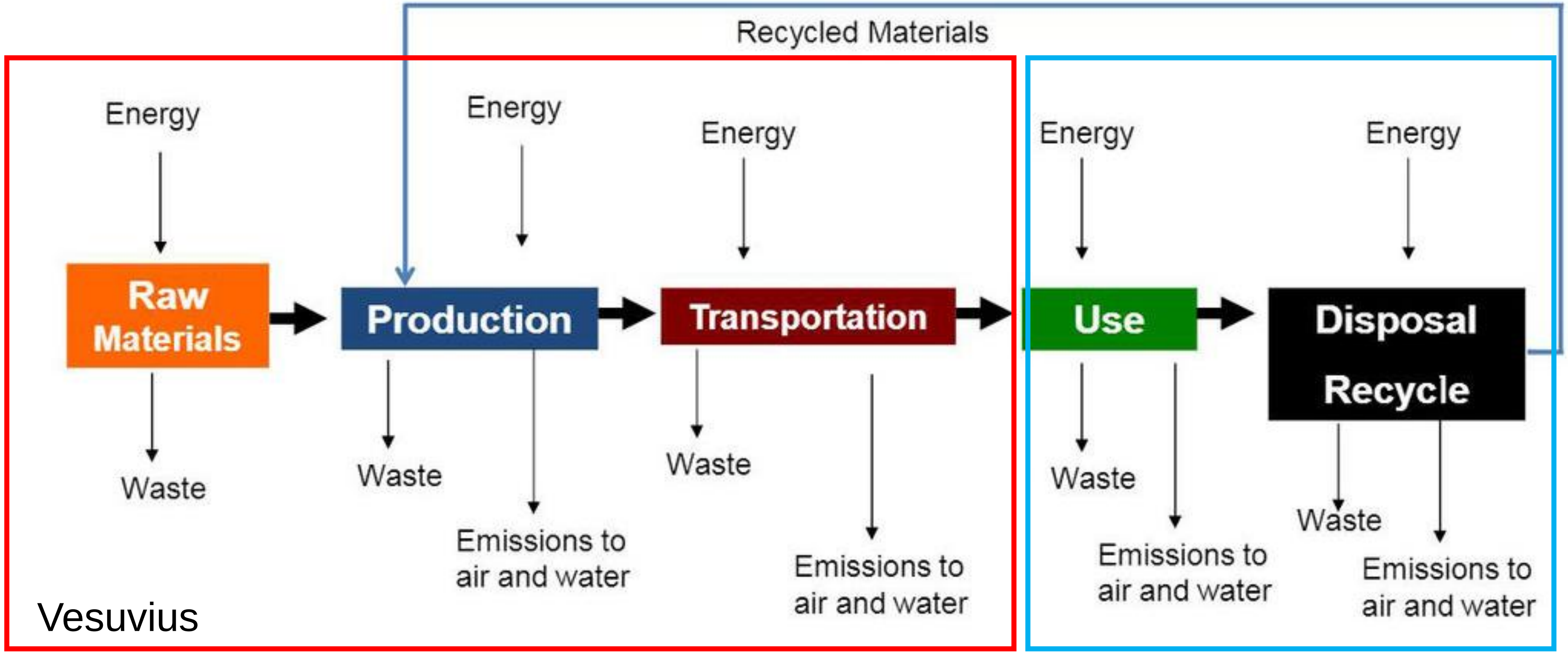
Complexity in Life Cycle: example Tundish

EXAMPLE			
Operations	Tundish Preheating	Casting	Tundish transport
Material/ Consumables	Preheating sleeves, tundish cover	Tundish flux, sensors and probes, Ladle shroud	
Time & Manpower	1125°C in 90 min	Several hours	Crane Operator
Impact to CO_2	Energy, preheating gases	Tundish flux CO_2 release	

Multiples steps, multiples suppliers, multiples stages, multiples parameters

This requires holistic approach with multi criteria expertise

Challenges in Sustainability: Beyond only CO2 emission reduction

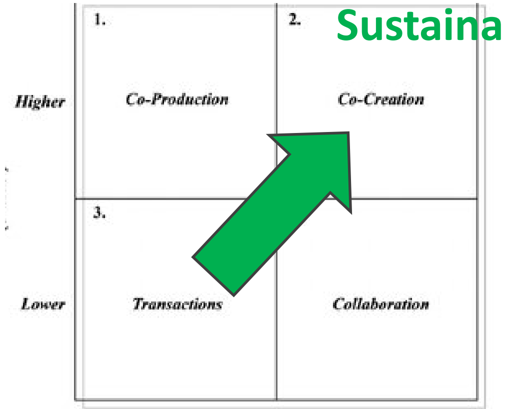


Final user steel plant

LCA: Relationship between key players is extremely important,

Evolution from Suppliers to Partners

Sustainable Value



How to Improve and contribute to CO_2 emission reduction?

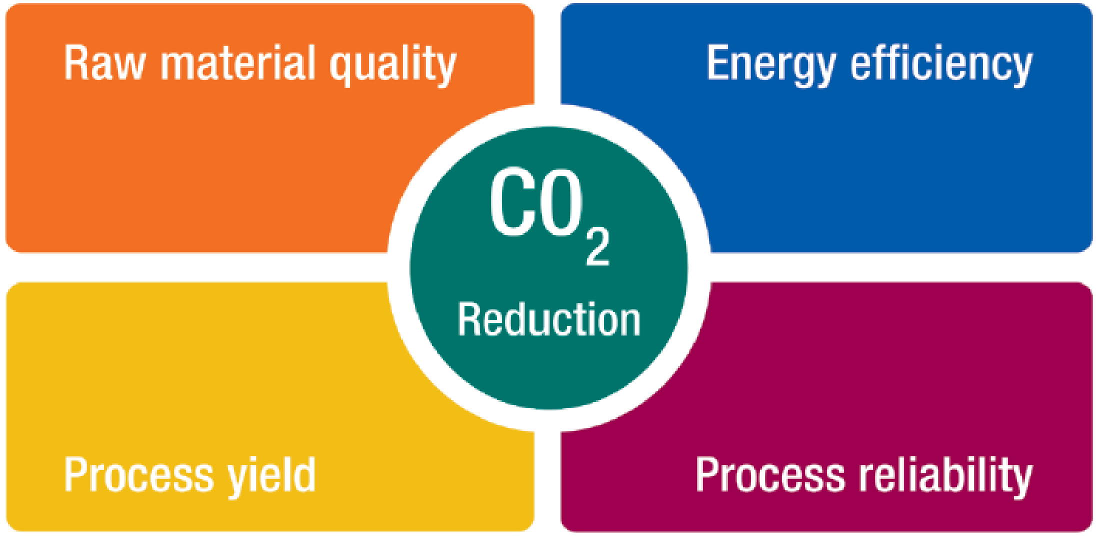
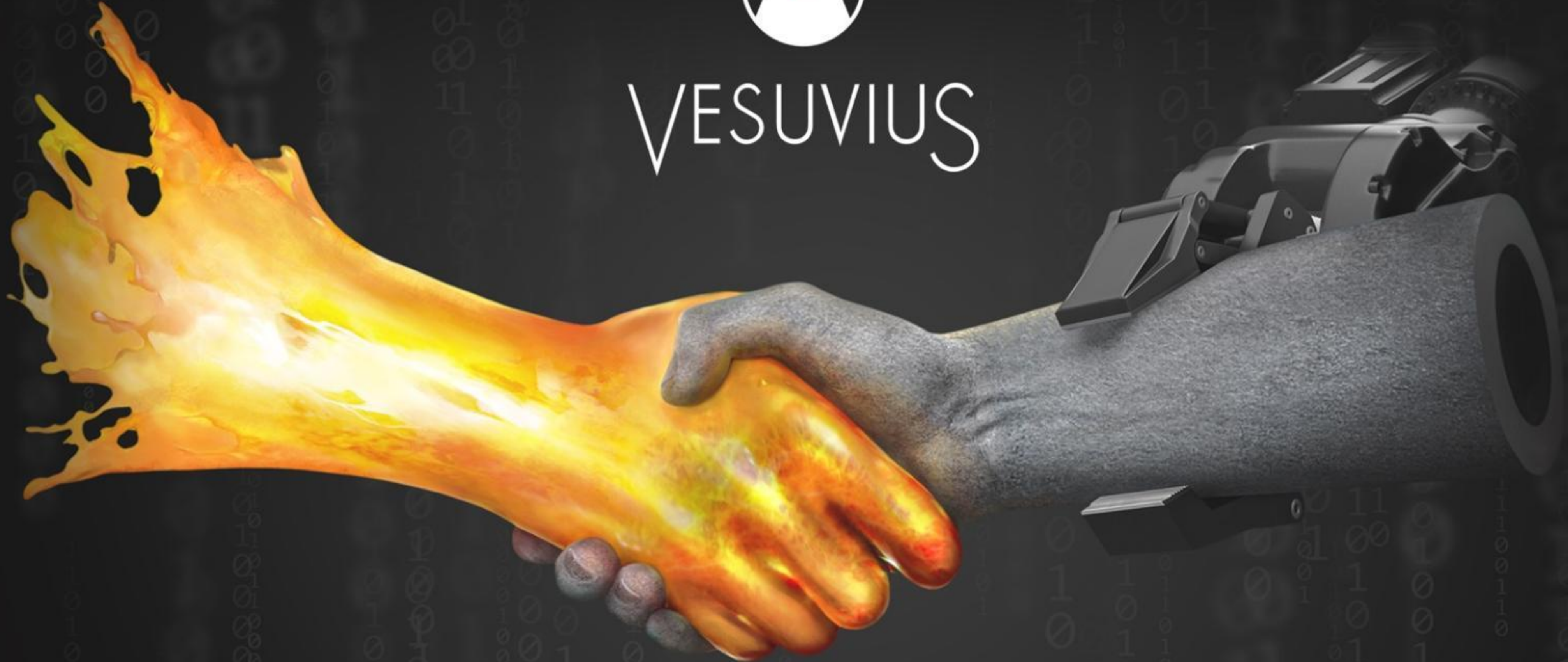


Diagramme 2: Four-stage efficency review process

+ EACH TIME

- **Optimal raw materials selection and use**:
- **Energy efficiency and minimizing waste**: Energy efficiency is a crucial component of resource efficiency and there are several tested and proven improvement measures available: heat or energy recovery from solid and gas streams, electricity savings (aiming toward self-sufficiency), and many more.
- **Improving yield**: Improving yield leads to increased output from the steelmaking processes. It is directly linked to a reduction in energy intensity and raw material use.
- **Process reliability**: Improving a steelmaking plant’s maintenance ensures process reliability, which reduces losses in quality and process time, thereby reducing energy use per tonne of steel.

VESUVIUS



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