Steel Industry needs in Energy field

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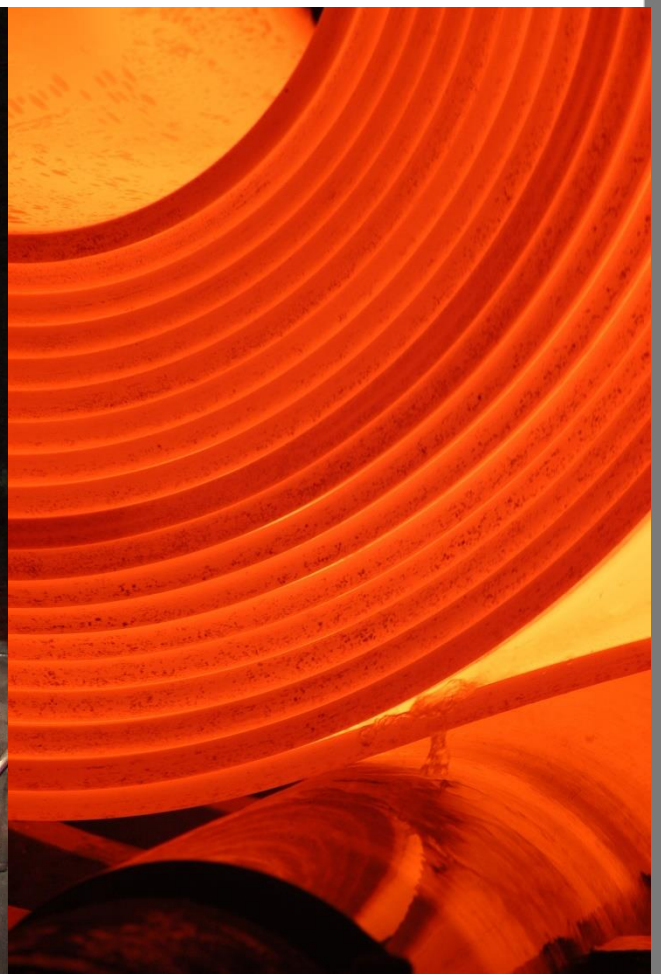
Nancy, 22th March 2018



ArcelorMittal: leader in steel and mining industry

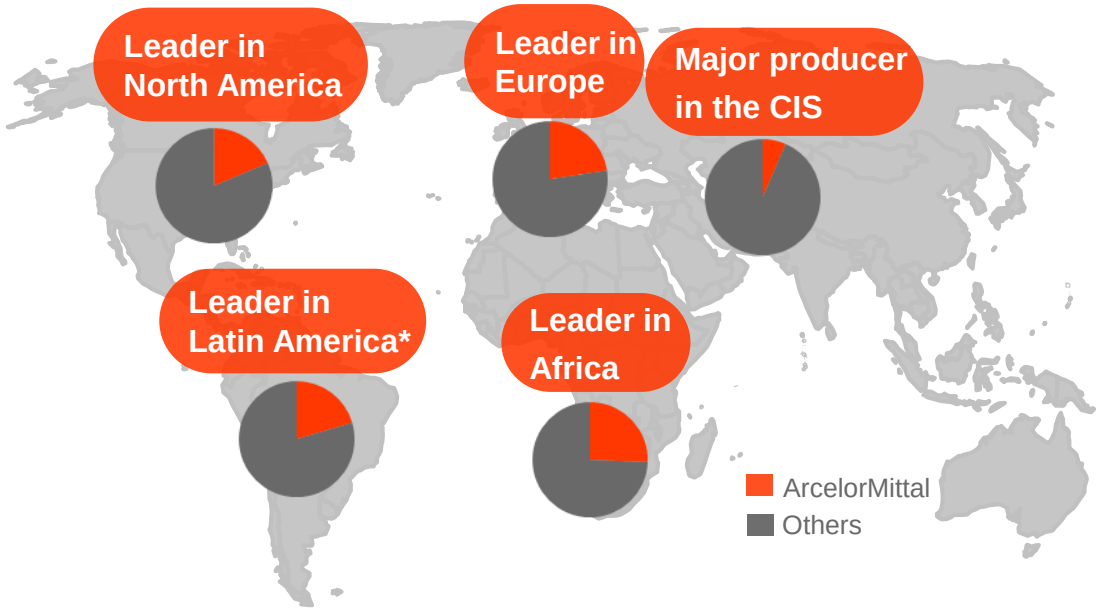
- 200,000 employees in more than 60 countries with an industrial presence in 18 countries.
- Leader in all major global steel markets, including automotive, construction, household appliances and packaging.
- The largest producer of steel in the EU, North and South America and Africa, and a growing presence in Asia, including investments in China and India
- Annual shipments of 68,700 M$ (2017)
- One of the world's largest producers of iron ore (90 000 Mt/year) and metallurgical coal strategically positioned to serve our network of steel plants and the external global market

Underpinning all our operations is a philosophy to produce safe, sustainable steel

Presence on the 5 continents:

Geographical reach

Market position by region



Production of **85,200 Mt/year** in 2017
(5.3% of world's production)

* Latin America includes Mexico.

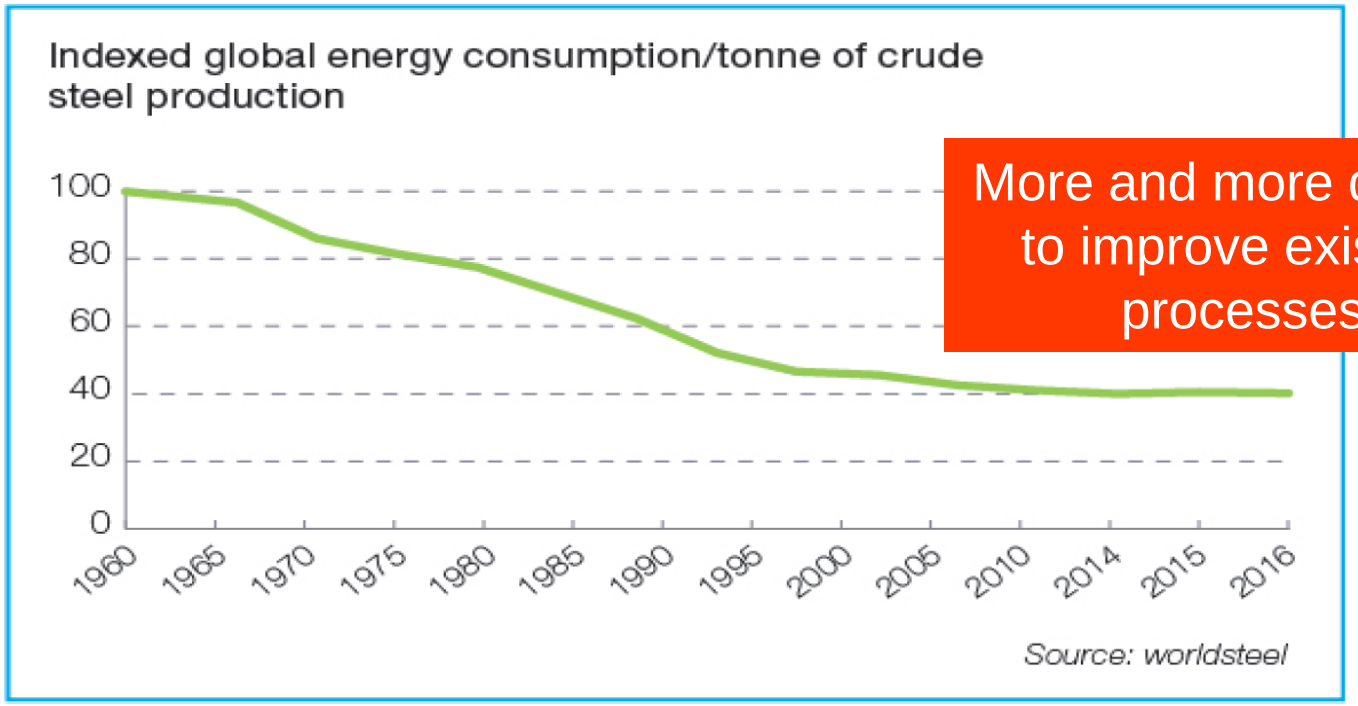
Main markets

- **Automotive**
  - worldwide presence, delivering a large scale of innovative products, solutions and services to automotive customers
- **Construction**
  - Globally, the largest single market for steel: a 715 million tonne steel consumption market comprised of diversified products
- **Packaging**
  - New packaging concepts constantly designed to achieve differentiation by steel solution
- **Household appliances**

Steel industry is energy intensive

Energy use in steelmaking

- World crude steel production reached 1,691 Mt in 2017 (50% in china, 10% in Europe, 1% in France). → 33,820 PJ/year
- Steel production is energy intensive (20 GJ/t). However, improvements in energy efficiency have led to reductions of about 60% in energy required to produce a tonne of crude steel since 1960.



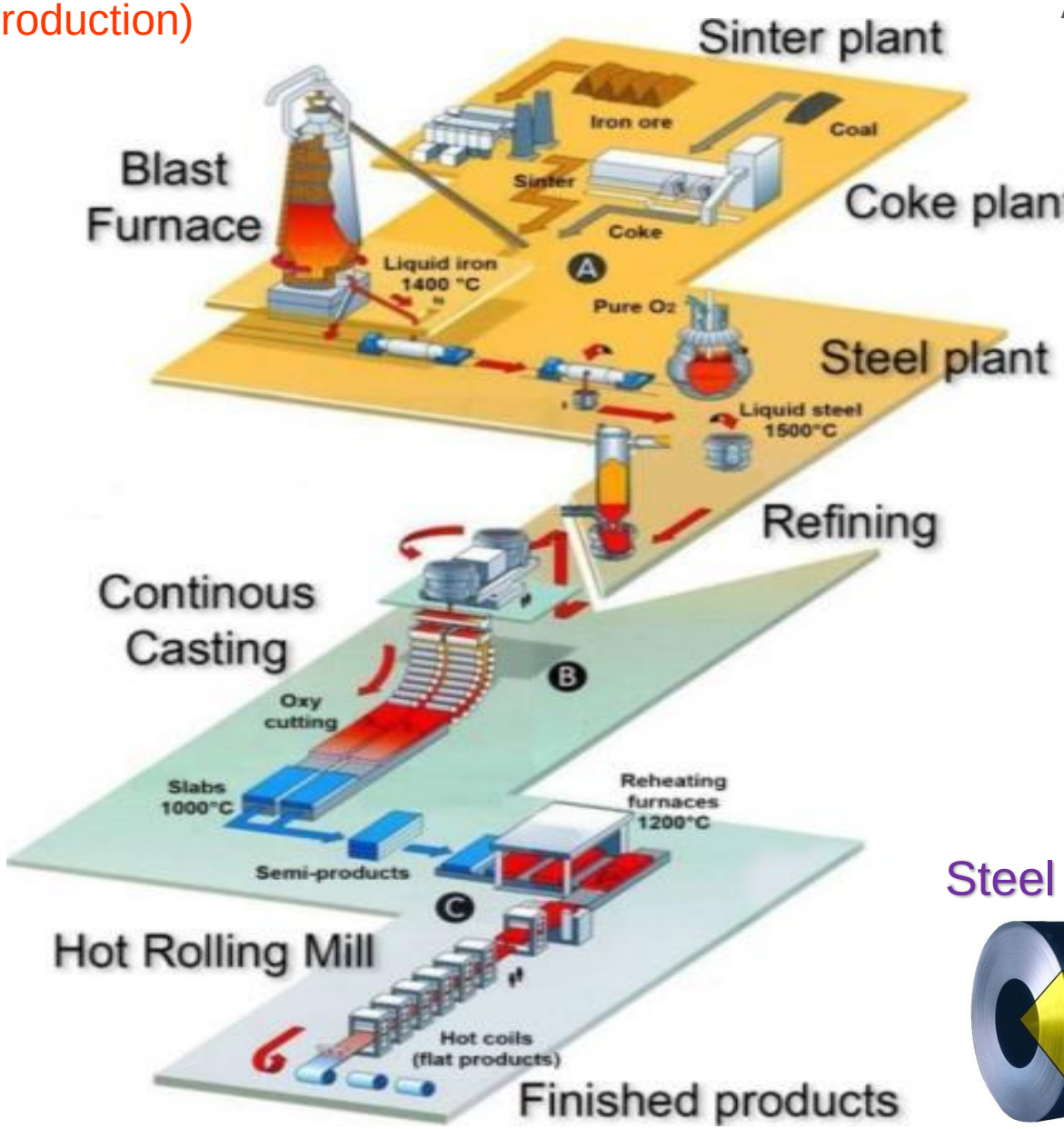
Indexed global energy consumption/tonne of crude steel production (WorldSteel, 2014)

Integrated steelmaking route

(75% of world's production)

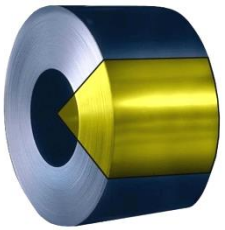
Iron ore

ArcelorMittal



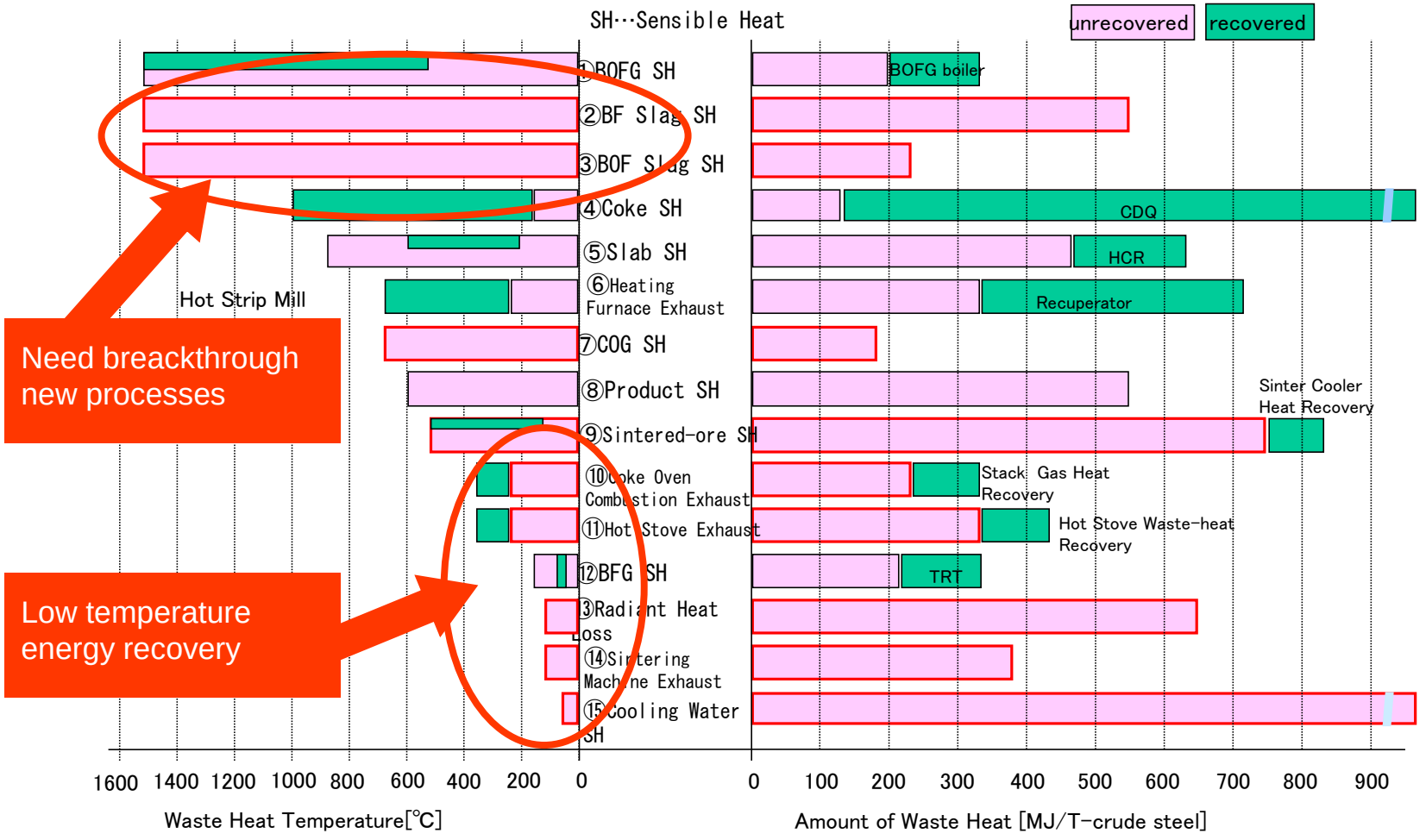
← Coal

Steel coils

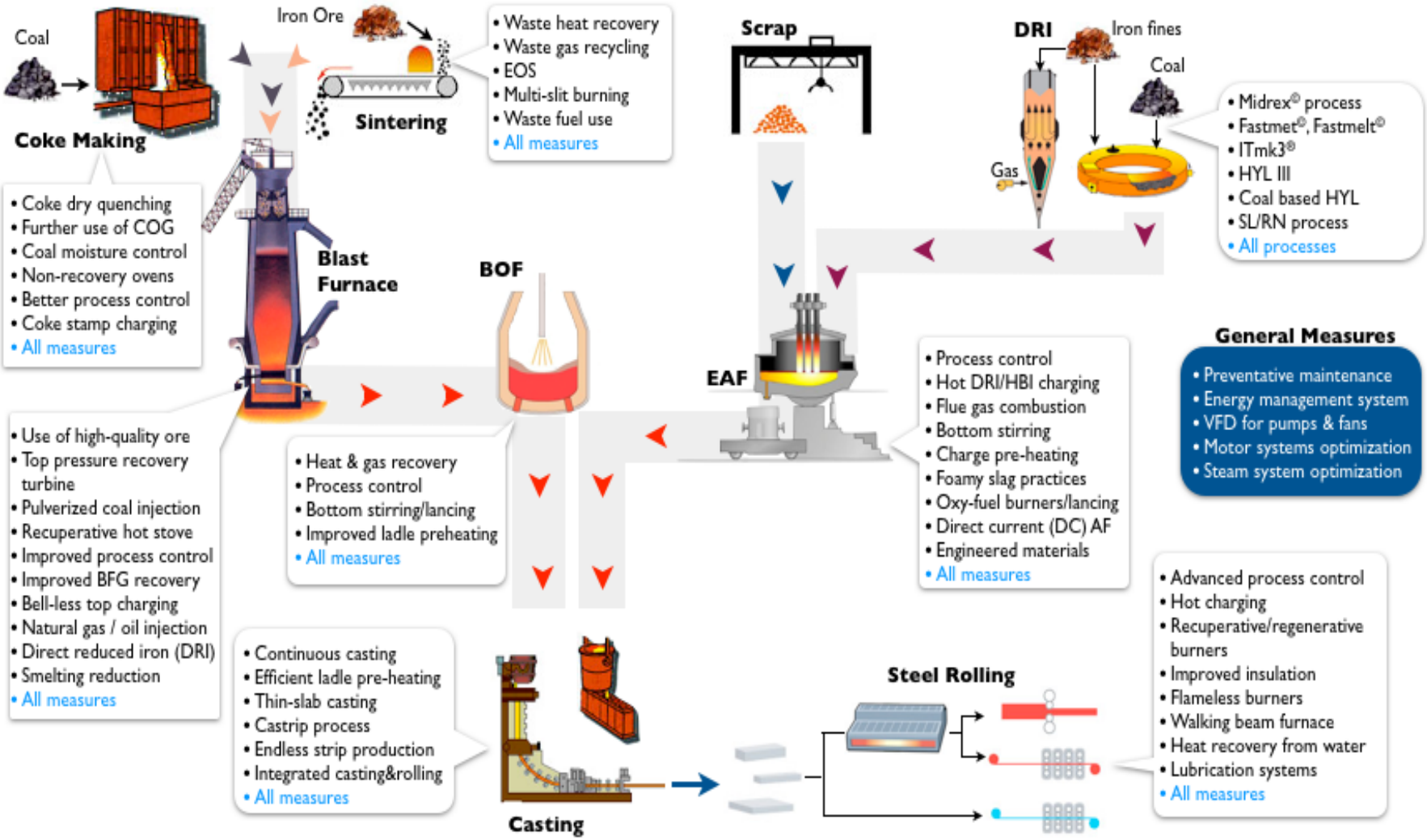


List of waste heat sources (Energy and Temperature) in the integrated plant

ISIJ Heat Economy Technology Committee



Main existing technologies for waste heat recovery in each process



Remaining challenges in our processes to recover energy from gases and solids at very high temperature

- Recovery of high temperature waste heat with gas/gas or liquid/gas exchangers

  i.e. converter gas (1600 ° C), EAF fumes (1500° C), variable streams

  Big losses not yet recovered (nothing done, or water quenching)

  → How to cool these processes with higher temperature fluids than cold water to allow efficient heat recovery and use?

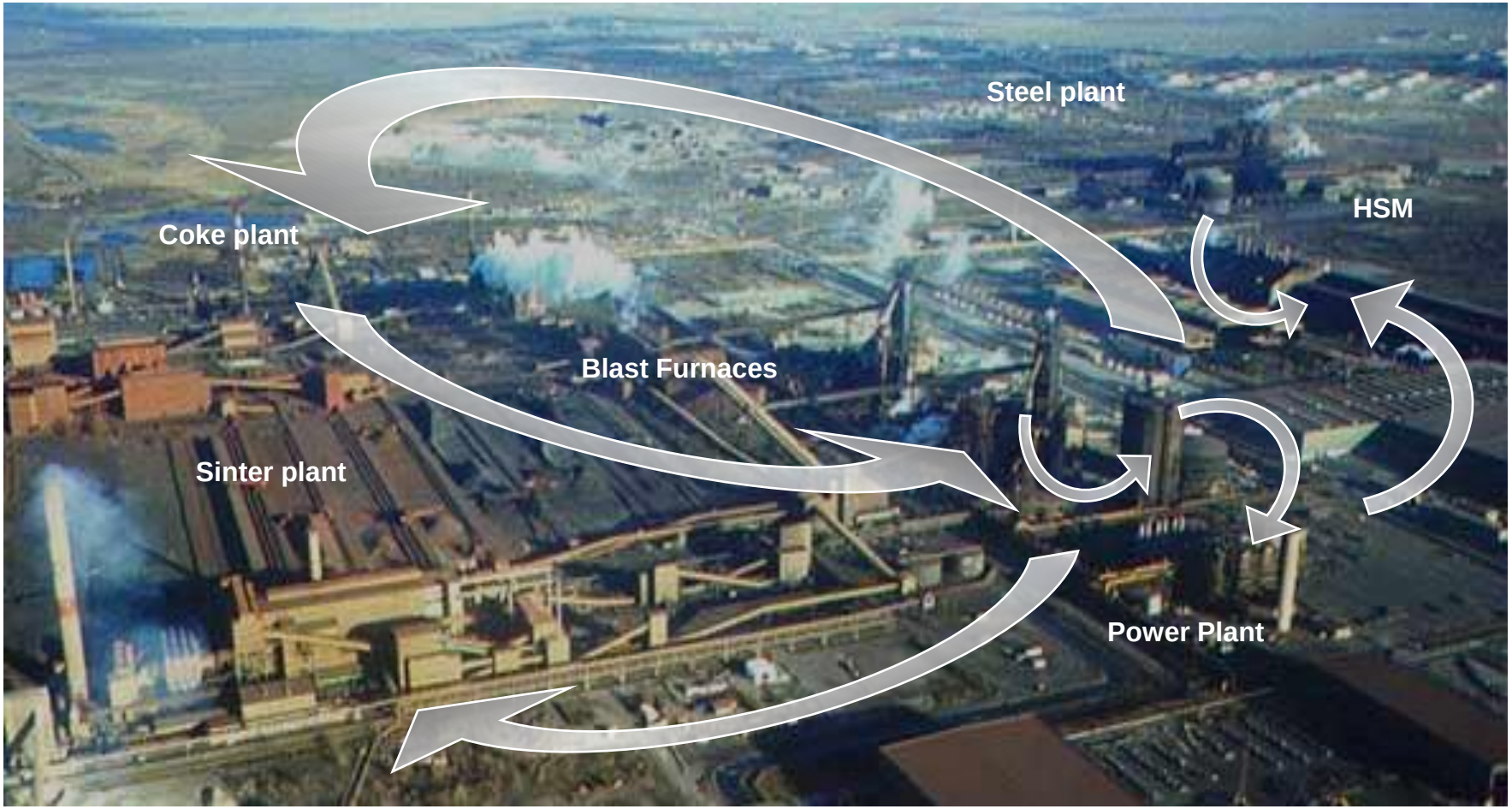


- Recovery of high temperature waste heat with solid/gas or solid/solid heat exchangers

  → How to transfer energy with high global efficiency and low Capex from high temperature solids (like coke, sinter, slags, slabs, coils) to produce high temperature gases or steam or endothermic chemical reactions?



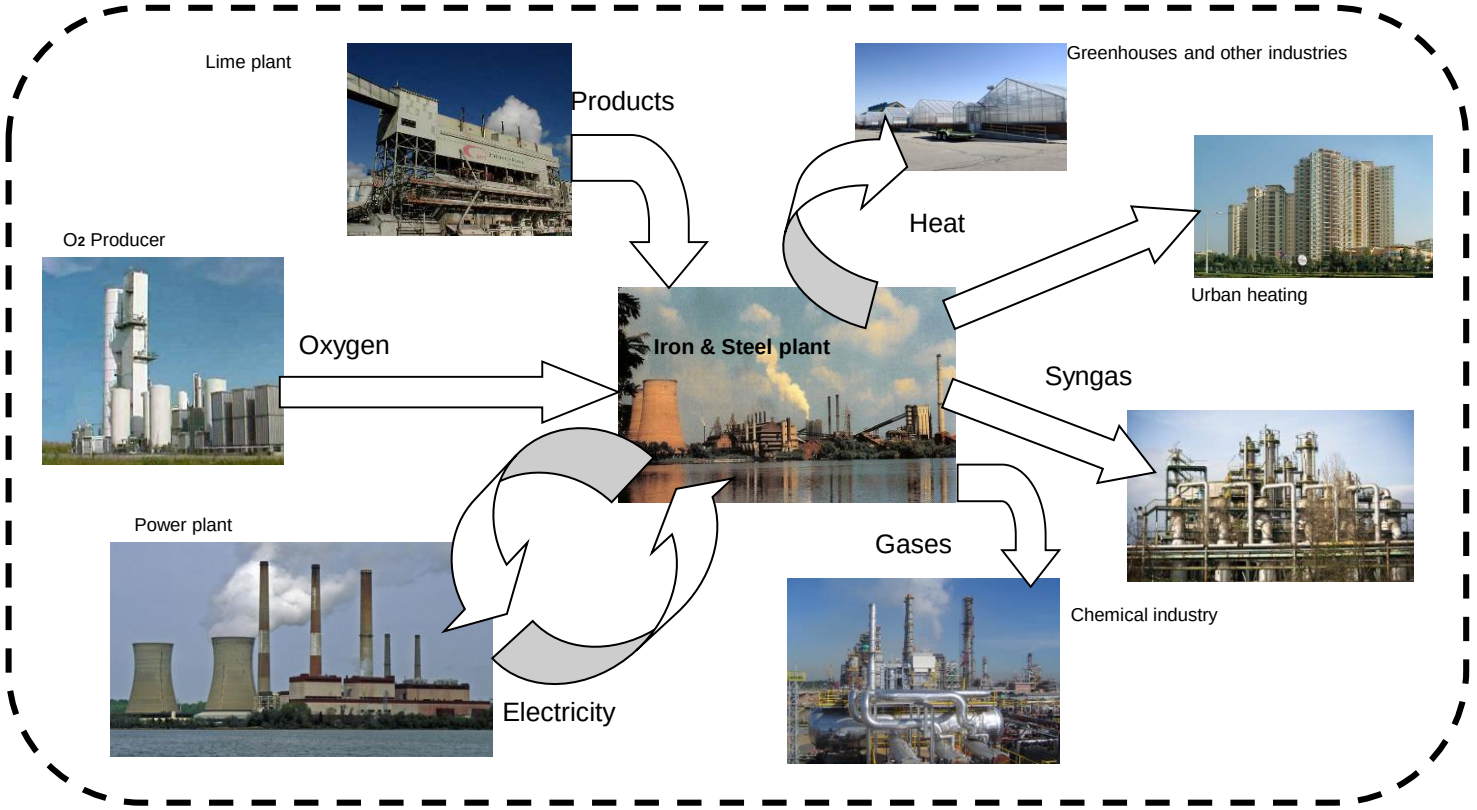

And to go further we need a global view of Energy flows and a dynamic optimisation inside our plants …



Systemic optimization of gas and heat flows in the whole plant

… and also to see outside our plants

Whole plants, in their environments (including possible synergies with different processes and Power Plants, but also with Gas manufacturers, external energy sources, external valorisation of waste heats, gases and water).



Training and research needs in the field of energy for steel industry

- New compact and low cost technologies to recover energy from solids or gases at very high temperature (>1500° C).
- Systemic approach and system dynamics tools (with variable streams).
- Industrial symbiosis knowledge and tools to help decision making and develop circular industry.
- Data sciences to predict in real time the future energy consumption of plants from analysis of big data bases (flow rates, temperature, composition, physical properties tables, variable streams …).
- Optimisation techniques for big energy and materials networks.
- Chemical conversion of gases (including CO_2) to replace external fossil fuels in steel industry or petrochemical industry (CCU techniques).

So, optimizing the energy needs of the steel sector is not only based on heat transfer efficiency, but also a matter of chemical and process engineering, without forget systemic approach and optimisation techniques.