



E-ECO DOWNSTREAM

Development of Heating Technologies for the
Efficient Renewable Energy Consumption of
CO₂-Neutral Downstream-Processes



The heat challenge in EAF downstream processes

Steelmaking's reheating furnaces and EAF off-gases leak massive amounts of thermal energy. EAF off-gas reaches **~750°C** post-dedusting, while reheating furnace exhaust exits at **300–400°C** (both measured at Feralpi's plant), even after standard recovery systems.

In the **E-ECO Downstream project**, an investigation led by Scuola Superiore Sant'Anna tackles three core questions:

- Which energy streams should we recover first?
- How much of this energy is realistically usable?
- Does the strategy change when plants switch to **hydrogen fuel**?

The joint team from **Feralpi** and **Scuola Superiore Sant'Anna** deployed thermocouples and Venturi flow meters for thermal mapping at **Feralpi Siderurgica** in Lonato del Garda, Italy.

To sort through the data, the team used an **Exergy Analysis**. Think of exergy as the “high-grade” energy fraction: heat rate measures total energy, while exergy rate reveals **usable work**. In this baseline assessment, high-exergy streams preheat combustion air, while low-exergy streams suit district heating.



Key Findings

Priority ranking

1. EAF primary off-gas — before quenching

Flow: **130,000 Nm³/h**, **575°C avg** — Recoverable heat: **21 MW** — Exergy rate: **11.2 MW**

Best use is **combustion air preheating**: **1st after dedusting** (reaching 750°C) affords deeper investigation in specific heat recovery systems, **2nd via the pre-quench off-gas stream**, building on Lonato's existing recuperator infrastructure (currently reaching ~350°C). Fuel-saving potential is under review with Feralpi. Key challenge: EAF and reheating furnace are physically distant at Lonato; insulated-piping losses and cost need assessment.

2. Reheating furnace off-gas — Roll Mill 2

330°C avg, 11.8 kg/s — **3.5 MW heat, 1.3 MW exergy** — second recuperator stage feasible with low-cost stainless steel

3. EAF primary off-gas — after quenching

250°C, 46.6 kg/s - **9.5 MW heat, 3.0 MW exergy** — fallback if pre-quench is impractical

Key insight: It is the quality of the energy (the exergy ratio), not just the sheer volume of heat, that determines the best technology for the job. For instance, the EAF secondary off-gas carries a massive 27.3 MW of heat, but because its energy quality is only 8%, it is actually reserved for district heating.

What changes with H₂?

When steel plants transition from natural gas to **full hydrogen** (H₂) fuel injection, the impacts differ significantly by process area:

- Electric Arc Furnace (Primary Off-Gas): **Minimal impact**. Recoverable heat and exergy change by **less than 2%** because three factors cancel out: a **5%** drop in mass flow is offset by a **2%** increase in temperature and a **3%** increase in heat capacity.
- Reheating Furnace Exhaust: A net **4–5%** thermal power reduction requires careful heat exchanger sizing. Additionally, higher water vapor increases corrosion risk, meaning high-temperature recuperators will need nickel-base superalloys (e.g., Inconel 625), while standard units can keep using stainless steel.

Conclusion: These thermal recovery investments are actually **future-proof** for the upcoming hydrogen economy.

■ Natural Gas (NG) ■ Hydrogen (H₂)

