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# Turning up the heat on steel's carbon pollution problem

EU-funded researchers are testing new hydrogen-powered burners that could slash emissions from one of the world's most carbon-intensive industries – without shutting down production.

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When trucks filled with hydrogen arrive outside a Barcelona steel plant next year, most bystanders will barely register their arrival. But for Raquel Torruella Martínez, project manager at the Spanish steel company CELSA, their arrival will be a blessing.

She is leading an EU-funded R&D initiative called TWINGHY that is developing hydrogen-powered burners for steel reheating furnaces to help decarbonise the steel sector.

CELSA Group, headquartered in Barcelona, is one of Europe's largest producers of circular steel, recycling nearly all its raw material from scrap metal in electric arc furnaces. This makes its operations significantly cleaner than traditional coal-based steelmaking.

Through the TWINGHY project, CELSA is tackling one of the last major sources of emissions in its process: the natural gas used to reheat steel before rolling.

These furnaces heat semi-finished steel before further shaping it in rolling mills. The TWINGHY researchers want to make the process less polluting by using hydrogen instead of gas.

"We need to reduce the impact of the steel industry, and this is one of the ways we can do that," said Torruella Martínez.

## Cleaning up a heavy industry

Steelmaking is one of the world's most emissions-heavy industries. According to the International Energy Agency, it accounts for about 8 % of global $CO_2$ emissions – more than triple those from aviation. Most of

these emissions come from burning coal or natural gas to reach the high temperatures needed to melt and reshape steel.

Hydrogen offers a cleaner alternative. When burned, it releases only water vapour, not $CO_2$. Yet the supply of green hydrogen – produced using renewable energy – remains limited, especially in regions such as Catalonia.

“In Catalonia, hydrogen infrastructure is not yet ready to provide enough supply, particularly of green hydrogen,” said Torruella Martínez. “But we’ve secured sufficient quantities for our trials.”

Planned for early 2026, the trials will test hybrid burners capable of running on either hydrogen or natural gas, or a combination of both, depending on fuel availability.

## Flames of the future

TWINGHY’s burners will be used in steel recycling, where scrap metal is melted and reshaped. Current reheating burners use natural gas, blasting flames up to 7 metres long and heating the steel up to 1 250 °C.

Replacing them with hydrogen is a complex challenge.

“Hydrogen burns faster,” explained Sébastien Caillat, combustion chief expert at French engineering firm FIVES, which designed and built the new burners. “That makes the flame shorter, which gives a different result, like a pizza cooked too hot, burnt at the edges and raw in the middle.”

To solve this, the team engineered hybrid hydrogen–gas burners that can maintain an even flame while allowing operators to adjust the hydrogen ratio according to supply.

“Even in the future, it’s unlikely steel companies will always have enough hydrogen,” Caillat said. “Flexibility is key.”

## A digital double

The project also includes a digital twin – a virtual replica of the furnace – to help engineers monitor performance and simulate how different fuel mixes affect efficiency and emissions.

“The digital twin is updated in real time with operational data,” said Torruella Martínez. “That allows us to simulate scenarios, optimise combustion and support decision-making.”

The Barcelona Supercomputing Center (BSC), one of Europe’s leading high-performance computing institutions and a partner in the project, is playing a key role in developing an advanced version of this digital twin.

Using its computational infrastructure, BSC is building detailed models of how heat and gases flow inside the furnaces, helping predict how hydrogen combustion will behave at industrial scale.

“The supercomputing power of BSC allows us to model highly complex physical processes that would otherwise be impossible to test in real time,” Torruella Martínez explained. “This helps us refine burner design, reduce emissions and optimise the transition from gas to hydrogen.”

The BSC team is now refining the digital twin, which is expected to be fully operational in 2026. It will enable the CELSA 3 plant to simulate furnace operations, predict its behaviour and improve energy efficiency.

## Supported by Europe’s clean steel drive

Funding for this development comes from the EU's Research Fund for Coal and Steel (RFCS), which reinvests the assets of the former European Coal and Steel Community to support cleaner, more efficient steelmaking.

In line with the European Green Deal, the RFCS is backing large-scale research to achieve near-zero carbon steel production by 2030.

Hydrogen is at the heart of this vision, offering a realistic path to decarbonise furnaces that are too energy-intensive to electrify.

"The TWINGHY project combines Europe's green and digital transitions," said Torruella Martínez. "Hybrid burners gradually increase hydrogen use, while the digital twin helps us control and optimise the process."

Crucially, the system can be retrofitted into existing furnaces, extending their lifespan and avoiding costly replacements – a pragmatic route to cleaner steel.

# Race against supply

Over the summer, CELSA's Barcelona plant installed the hybrid burners during a regular maintenance period. They are already operating on natural gas while awaiting hydrogen trials next year.

If all goes well, the burners could reach the market before the end of the project in 2027 – rapid progress by steel industry standards. But success hinges on the availability of sufficient quantities of green hydrogen.

"The technology is ready," said Torruella Martínez. "The question is whether hydrogen supply will keep pace. Investment in clean steel depends on that."

New burners are relatively expensive, and steel companies may be reluctant to buy them before they are sure there is enough hydrogen.

"That could slow down investment decisions," Torruella Martínez warned.

Still, she remains upbeat. "We have to start now. Every step we take brings us closer to a greener, cleaner steel industry."

*Research in this article was funded by the EU's Research Fund for Coal & Steel (RFCS). The views of the interviewees don't necessarily reflect those of the European Commission. If you liked this article, please consider sharing it on social media.*

# More info

- TWINGHY
- TWINGHY project website
- Research Fund for Coal and Steel
- European Green Deal
- European Clean Industrial Deal