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From sewer to furnace: how wastewater sludge is greening steel production

By turning wastewater sludge into biocoal and green hydrogen, EU-funded researchers are helping reduce the steel industry's environmental impact.

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What comes out of our wastewater treatment plants may not be very appealing, but the real problem is what is left behind after water treatment. Wastewater plants produce a liquid sludge that is usually dried and then burnt or dumped. This is costly, polluting, and has long been considered wasteful.

A group of EU-funded researchers see it differently. This sludge, they argue, could become an unlikely ally in the fight against climate change – a feedstock for producing the hydrogen and carbon needed to make greener steel.

"This sludge has value, it is not just waste," said David Chiaramonti, professor of energy systems, energy economics and the bioeconomy at the Polytechnic University of Turin in Italy. "With it we can create things like carbon and hydrogen."

Towards green steel

Chiaramonti is leading an EU-funded research initiative called H2STEEL that brings together academics and steel industry experts from France, Italy, the Netherlands, Spain and the UK. Their goal is to design a process to extract the useful materials from wastewater sludge so that they can be reused and help reduce the steel industry's emissions.

Steel production is essential for everything from aeroplanes and cars to buildings and wind turbines. It is also a major driver of climate change.

According to a 2023 report by the International Energy Agency, the steel sector alone accounts for 8% of global CO_2 emissions. By comparison, the aviation industry emits about 2.5% of global CO_2 emissions.

Cutting these emissions is particularly difficult. Steelmaking is complex and typically requires carbon-rich ingredients, which inevitably release greenhouse gases. That makes it one of the hardest industries to decarbonise – and one of the most expensive to transform.

Traditional steel production methods face increasing carbon pricing pressures across Europe under the EU's Emissions Trading System. According to market forecasts, carbon prices could reach €120-150 per tonne of CO_2 by 2030, potentially adding significant costs per tonne of steel produced.

For a global steel market worth more than €2.5 trillion annually, finding affordable low-carbon alternatives is urgent.

Hot sludge

This is where H2STEEL comes in. "It's a good example of the circular economy," said Chiaramonti. "We take a little-used resource, wastewater sludge, and make it useful again."

The process works in two main steps. First, sludge is heated without oxygen to create biocoal, in a process called "carbonisation". Then methane from biogas plants is processed using this biocoal as a catalyst to produce hydrogen.

During this process, the biocoal becomes even richer in carbon, making it valuable for steelmaking. Another by-product, phosphorus, is separated for use in fertilisers.

Both outputs – hydrogen and carbon-rich biocoal – could help make steel cleaner. Traditional steelmaking burns coal with iron ore, releasing CO_2. With H2STEEL's approach, hydrogen can replace some of that coal. Meanwhile, the biocoal substitutes regular coal, turning waste into a useful industrial input.

The team is now building a 4-metre-tall processing machine in Turin to demonstrate the technology. "We break the biomethane into carbon and hydrogen by using the carbonised sludge at 900°C," explained Chiaramonti. "That's how we turn it into biocoal and circular hydrogen."

Carbon and hydrogen

Official results are not available yet for the project, which will finish in March 2026, but the potential is significant.

Decarbonising steel is attracting intense research efforts, from electrical furnaces to hydrogen-based processes. H2STEEL's sludge-based approach could slot into this wider transformation.

"This technology is very flexible," said Jan Wiencke, team leader for sustainable carbon at steelmaker ArcelorMittal's research centre in Maizières, northern France.

Headquartered in Luxembourg, ArcelorMittal is the second-largest steel producer in the world.

The company is also a partner in the H2STEEL project and hopes to be able to use the technology being developed at their steel plants.

"Whether we use a hydrogen furnace or an electrical one, we will still need ingredients like carbon and hydrogen in our processes," said Wiencke.

"With this technology we can already reduce emissions now, and it will continue to be useful in the future."

Other partners include Leiden University in the Netherlands and Imperial College London.

Next steps

One of H2STEEL's biggest advantages is speed. If trials succeed, the technology could be rolled out within a few years – unusually fast in an industry where infrastructure changes often take decades.

Still, challenges remain. "We need to secure the sludge, transform it, and deliver it to the steel plants," said Chiaramonti. Setting up supply chains and minimising costs will be crucial.

ArcelorMittal, which aims to be carbon neutral by 2050, is watching closely. "This is a great technology for the steel industry, but it must prove itself economically," said Wiencke.

A patent is already pending, and the partners are eager to see results from the demonstrator. "What we're doing looks very promising," said Chiaramonti. "Now it's a question of taking the last steps."

If successful, H2STEEL could deliver more than a technical breakthrough. By turning waste into valuable raw materials, it embodies the principles of the circular economy, helping Europe stay competitive while moving closer to its net-zero goals.

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More info

- H2STEEL (CORDIS)
- H2STEEL project website
- European Green Deal
- Green Deal Industrial Plan