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# Breakthrough in the quest for energy-efficient steel

**ArcelorMittal-led team with Argonne  
National Laboratory and Purdue University  
Northwest (PNW) refines furnace  
efficiency to reduce energy costs**

Our built environment depends on steel. Cars, powerlines, natural gas pipelines, machine tools, surgical scalpels, shipping containers, and more—steel is integral to the modern world. The challenge for its manufacturers is to produce steel at a lower cost, with reduced emissions while raising the quality. The ArcelorMittal-led team is transforming furnace efficiency to cut energy use so that the industry can overcome these challenges to minimize environmental impact.

## Producing cleaner, stronger steel

It is a long-established truth in the steel industry that high-quality steel requires high-temperature furnaces. The trick is understanding how to maintain the optimum temperature to ensure the best quality at the lowest possible energy use.

It is a subject that has occupied the minds of steel producers worldwide for years and one that has become paramount as the industry battles to manage crippling energy costs.

The industry may be closer than ever to a breakthrough. New research being conducted at Argonne National Laboratory, alongside a team led by ArcelorMittal and Purdue University Northwest (PNW), the world's largest steel producer and operator of large North American steel mills, is striving to unlock efficiencies in the steel production process. Using computational fluid dynamics modeling from PNW's Center for Innovation through Visualization and Simulation (CIVS), the project will study different factors influencing operation performance and output quality.

The project uses current and historical data from ArcelorMittal furnaces to feed the PNW models; it focuses on one specific part of the process: oxygen-enriched combustion in steel furnaces at the hot-rolling stage of production. This stage accounts for 70–80% of the energy needed to produce high-quality steel.



**Argonne**  
NATIONAL LABORATORY

**Industry:** Manufacturing, product research and development

**Region:** United States

### Vision

Test new computational models to find efficiencies in steel furnaces, reducing energy use and improving quality

### Strategy

Incorporate the latest ArcelorMittal production data in computational fluid dynamic models running on an HPC environment at Argonne National Laboratory

### Outcomes

- Promises doubling of combustion efficiency, reducing energy consumption costs by ~20%
- Findings could avoid more than 300,000 metric tons of greenhouse gas emissions
- Improves operational performance and output quality

The Argonne research team's challenge is generating insight quickly and efficiently.

"Our aim is to help U.S. manufacturers become more productive and competitive through the advancement of energy-efficient and cleaner production technologies," says May Wu, Principal Environmental System Scientist and Technical Representative at Argonne National Laboratory. "If we can find an answer, we can grow the steel industry."

### Transforming furnace efficiency to cut energy use

Some challenges are so vast that they require industry, science, and governments to work in partnership. The U.S. Department of Energy is involved in a host of initiatives looking to transform manufacturing processes and involving the high-performance computing (HPC) of Argonne National Laboratory.

The project has already produced stunning results. Models put through HPC systems at Argonne demonstrate that oxygen enrichment helps reduce natural gas use in heating steel furnaces, more than doubling combustion efficiency. Less gas used equates to a huge cost saving.

Moreover, natural gas consumption decreased by 19.6% to 26.8% per kg of hot-rolled steel produced in the model. Greenhouse gas (GHG) emissions are projected to be decreased by 11.1%; air pollutant emissions decreased by 14%.

These peer-reviewed results will have a transformational environmental impact in the real world and can deliver a huge competitive advantage for U.S. steel producers.

"There are 10 steel mills with pusher-type reheating furnaces, producing 26.7 million metric tons of hot-rolled steel in the U.S.," says Chenn Zhou, Director, PNW CIVS and the Steel Manufacturing Simulation and Visualization Consortium (SMSVC). "Adopting these findings would eliminate 6.61 billion megajoules of fossil energy use and avoid 319,800 metric tons of GHG emissions. We would like the findings adopted at scale, across the industry."

### Accelerating the time to insight to drive further innovation

HPE Cray is essential to the high-performance computing environment at the Argonne National Laboratory. Supercomputers can handle

today's massive, converged modeling, simulation, AI, and analytics workloads. It is the ideal environment to test the computational fluid dynamic models of the steel consortium.

"There are a huge number of furnace parameters to consider in our work," says Wu. "HPC illuminates the physical complexity of phenomena in the steel production process."

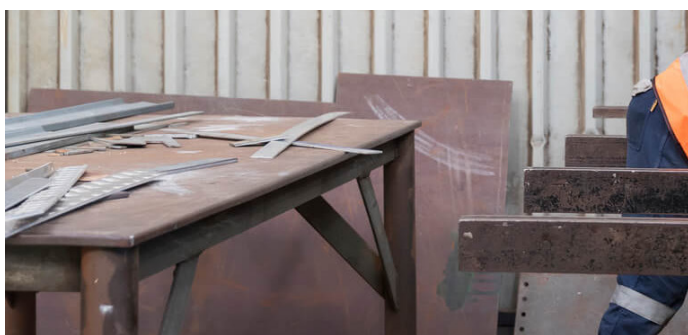
The project team can work at speed and collaboratively. It can refine the models from Purdue's CIVS while working from the latest production data from ArcelorMittal furnaces.

"The difference with our work using high-performance computing at Argonne is the level of detail and speed at which we get to this detail," says John J Low, Computational Scientist, Argonne National Laboratory. "We're able to turn around the calculations incredibly quickly, as much as 100 times faster than previous compute set-ups. Plus, we're able to run different models in parallel. We can run hundreds of models a week here."



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The work of the U.S. Department of Energy continues. It wants to support industrial innovation in the U.S. and help the country meet its net-zero emissions target by 2050. It has invested in three exascale-class supercomputers, including one at Argonne National Laboratory. A by-product will be new jobs and energy independence.

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