



Steel coils in a hot rolling process at the SSAB hot strip mill in Raahé, Finland

INDUSTRY

The next frontier for clean energy

Many industrial processes are closely intertwined with fossil-fuels, making them difficult to decarbonize. Clean hydrogen, produced by a nuclear reactor, may be the key.

Imagine a young couple living in Tokyo, Haruto and Yui, whose lifestyle gives them one of the lowest carbon footprints that can be imagined in Japan at the moment.

They take the Metro to work at the University of Tokyo, and when the weather's good they cycle to complete their errands. Haruto and Yui take the Tokaido *Shinkansen* ("bullet train") when they visit family in Kyoto, which runs on electricity generated by increasing shares of renewables and nuclear plants returning to operation. They have an electric heat pump at home instead of kerosene or natural gas for heating.

From electricity and transport to buildings and agriculture, Yui and Haruto are doing what they can for the climate. They regularly buy eco-friendly products and sometimes even write letters to public officials, pushing companies and government to do more in all these areas.

But they would be surprised to learn that there is an often overlooked contributor to their carbon footprint. An unseen source of emissions from something so commonplace that they take it for granted.

Steel

The bikes they ride are made of it. The wind turbines that have started to dot the hillsides make heavy use of it. As do many parts of the buses and trains they travel on and dozens of components of their heat pumps. In fact, almost every sector involved in the clean transition makes use of steel in some way.

But steel production accounts for 7 to 9 percent of global greenhouse gas emissions. Steel is an intricate combination of iron and carbon that requires baking molten metal at extremely high temperatures—over 900°C. These temperatures are very hard to achieve electrically, and for most of the world's steel, there are few practical options for reducing emissions from the process.

And steel isn't alone. Many other crucial industrial processes, like the production of cement, fertilizer and plastics, likewise need high-temperatures achieved via fossil fuel.

Industry is in many ways the next frontier for clean energy solutions. Carbon capture, storage, and utilization techniques are being perfected as an option for reducing emissions. And nuclear energy systems are also

emerging as a way to provide the high temperature heat needed to drive industrial processes without causing emissions in the first place.

In Yui and Haruto's own backyard, in Ibaraki prefecture, next to Tokyo, the Japan Atomic Energy Agency has been developing very high temperature test reactors since the mid-2000s for this purpose. The Agency is currently at work on creating nuclear cogeneration systems capable of operating at 850-950°C. In the near future, this system could deliver enough heat to produce up to 650,000 metric tons of steel a year or 120 metric tons of hydrogen production a day. It is also able to provide heat for homes and fresh water production.

Other countries are also developing high-temperature test reactors. In fact, China is likely to be first out of the gate, with the world's first high-temperature reactor based on next-generation nuclear technology expected to come online later this year. An industrial group in Sweden is also looking to demonstrate an entirely new way to make steel using hydrogen with virtually no emissions. The process doesn't have to run on nuclear energy, but nuclear reactors could be an ideal way to deliver a clean source of hydrogen, via nuclear waste heat, that it needs to work.

These industrial innovations are integral to further decrease emissions. Solutions like these are going to be an essential part of a clean energy lifestyle for us all.