Addressing the energy transition challenge: Low carbon materials

CSIRO actively researches the challenges associated with the transition of energy, industrial, manufacturing, agricultural and transport sectors to meet Australia's net zero emissions ambitions.

As Australia's national science agency, CSIRO is well positioned to support governments, industries and communities through the energy transition.

Science and innovation will be critical in supporting Australia's transition, which is being driven by new technologies, changing consumer preferences, and efforts to reduce greenhouse gas emissions.

As we move towards a net-zero emissions future the four key components of the energy sector – electricity, industry, transport and exports – are evolving rapidly. In this dynamic landscape, CSIRO provides reliable, actionable, evidence-based research.

Here we look at the role of low carbon materials.

The challenge: Low carbon materials like steel and aluminium

Thousands of people are employed in Australia's steel and aluminium industries, each playing a vital role in the production and distribution of these important global commodities.

Metal production is highly carbon-intensive. Globally, the steel industry is one of the three biggest producers of CO_2. Our export market is important to Australia's economy and many of our global partners are increasingly looking for low-carbon products. But as we move towards a net zero emissions future, every sector has a contribution to make. There are social, economic and environmental pressures on heavy industries such as steel and aluminium production to reduce their impact.

Australian industry is ready and willing to accelerate the development and adoption of low emissions technology that will help achieve emissions reduction targets while also maintaining and expanding economic prosperity and employment opportunities.

However, the cost and risk of major process changes, along with uncertainty in carbon pricing and regulatory requirements, has so far dissuaded many operations from pursuing these opportunities.

We need to find the right combination of innovation and investment that will enable Australia to make low emissions steel and aluminium a reality.

What is the goal?

In the Low Emissions Technology Statement (LETS), the Australian Government identifies low carbon materials as one of five priority technologies.

Their stated goal is to develop low emissions steel for under $900 per tonne, and low emissions aluminium for under $2,700 per tonne. This would retain cost-competitiveness with existing steel and aluminium production.

Attaining this goal will require close collaboration between government, industry and researchers to develop, demonstrate and integrate new technologies.

Production of low emissions aluminium is relatively straightforward, and could be achieved by increasing the supply of low-cost firmed renewable electricity, and more efficient smelter technology.

Transitioning to low-emissions steel production is more complex, but also has the potential to bring more rewards. Australia's unmatched iron ore and renewable energy provide an opportunity to reinvigorate our manufacturing industry and position Australia as global leader in green steel.

Most of the world's steel is produced from iron ore using a blast furnace and a basic oxygen furnace. The main source of carbon emissions comes from the use of metallurgical coal as fuel or coke to melt the waste material – also known as gangue – from the ore to extract the iron.

In order to reduce emissions, this processing route needs to evolve.

As a first step, renewable electricity can be used to reduce the carbon intensity of electricity use, or CCUS technologies can be added to production processes. In the future, electric arc furnaces, which can be powered by renewable electricity, will increase in usage as blast furnaces are decommissioned.

To achieve significant emissions reductions, we need to replace coal with more sustainable sources of carbon as reductant: natural gas in the short term, and clean hydrogen in the longer-term.

One of the key challenges Australia faces is that although we are a major producer of iron ore and metallurgical coal, the heavy industries that turn ore into iron and steel are located overseas.

One immediate action that can be taken to reduce emissions in the steel industry – and a key focus for CSIRO researchers – is to improve the ore quality before it is shipped. If there is less waste material to transport and to melt in the blast furnace, then less fuel is required to extract it.

Looking ahead, if we can build a domestic hydrogen industry, domestic steel production or production of pre-reduced products may begin to look competitive compared to shipping hydrogen and iron ore to to countries such as Japan or Indonesia that have fewer renewable resources.

The Australian Government has indicated that hydrogen-steel making should be a commercially viable option by 2040, but there is significant investment and innovation required to reach that point.

What is CSIRO doing to help?

CSIRO has a breadth and depth of expertise that enables us to undertake cutting-edge research in the areas of metal production, CO2 capture, hydrogen, renewable energy, and sustainable sources of carbon.

We are also to work with industry partners to test options at pilot plant and demonstration scale.

Our current focus includes improving the quality of ore before it is shipped to the smelters, thereby reducing the energy consumption for the iron making process. This step is also the gateway to the investigation of further processing options such as direct reduced iron (DRI), pig iron and, potentially, green steel production.

We take a collaborative approach to research, and work closely with stakeholders in industry, government and other research institutions. Most recently, this work has taken place as a partner in the Heavy Industry Low-carbon Transition Co-operative Research Centre (HILT CRC), which was established to help achieve technology-driven solutions for low-carbon industry transformation with an inter-disciplinary approach.

Further reading

Grattan Institute 'Start with Steel' report
https://grattan.edu.au/wp-content/uploads/2020/05/2020-06-Start-with-steel.pdf

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