Reuters Events

# US INDUSTRY PEERS **FORGE PATH TO DECARBONIZING OPERATIONS**

# INTRODUCTION

Image: REUTERS/Toby Melville

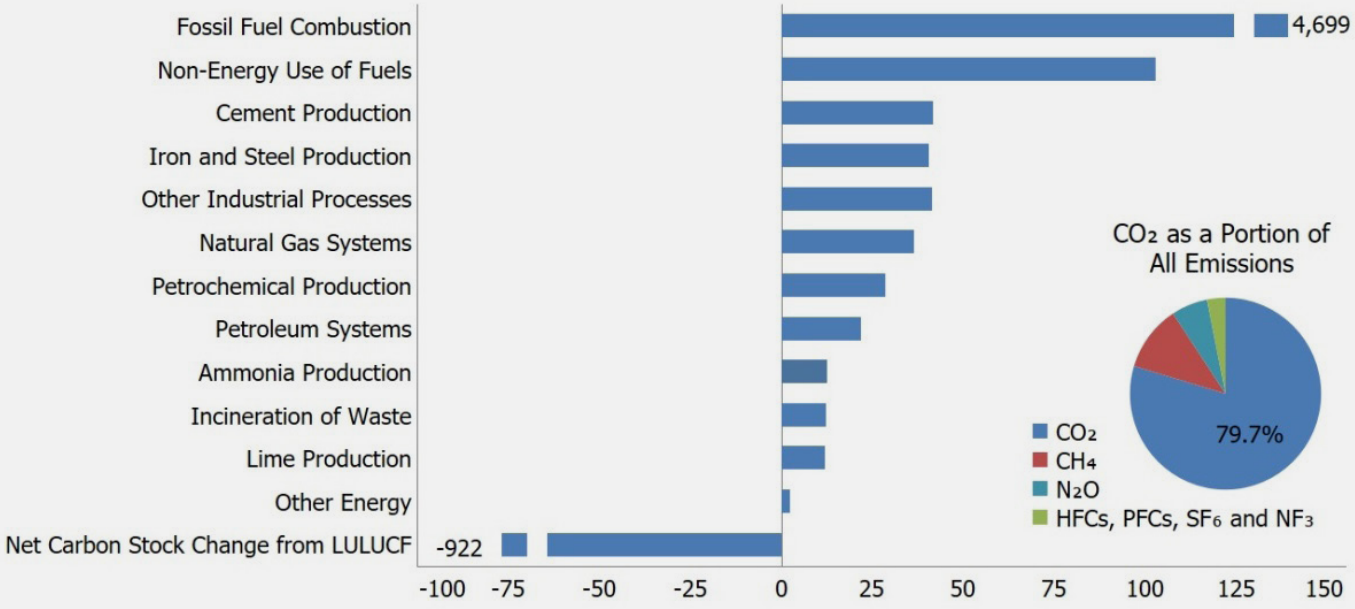
Progress is being made on decarbonizing the U.S. power sector and rolling out electric vehicles (EVs), but the decarbonization of heavy industry and other hard-to-abate sectors is lagging behind.

Electrification, fuel-switching and carbon capture, utilization and storage (CCUS) technologies all offer the prospect of cleaner industrial processes but faster progress is required.

The U.S. industrial sector accounted for 30% of total end user emissions in 2023, according to the U.S. Environmental Protection Agency (EPA). Direct emissions, including upstream oil and gas, stood at 1.5 gigatons, a fall of 8.5% from 2005. Economy-wide emissions fell by 16.5% over the same period, led by a 36% reduction in the power sector.

Industrial processes such as hydrocarbon production and refining, chemical processing, steelmaking and cement production are often energy intensive and produce significant greenhouse gas emissions. The highest emitting sub-sectors involve a small number of companies which produce huge volumes with low margins per unit.

## SOURCES OF U.S. CO2 EMISSIONS IN 2022




*Source: EPA report 'Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990–2022'*

Progress in decarbonization to date has mainly been driven by switching from coal to natural gas on the back of lower gas prices, as well as reduced methane venting by hydrocarbon producers. The Biden administration set out support measures for clean hydrogen, CCUS and other decarbonization technologies, spurring more investments into these projects. Companies like electrofuel (eFuel) developer Infinium, clean hydrogen efuel developer HIF Global and Cement producer Brimstone Commercial, are rolling out larger projects and early commercial contracts are being signed.

However, much faster progress is required and President Donald Trump has pledged to unwind climate policies and is reviewing key federal funding packages, creating major uncertainty.

"More projects, demonstrating a wider range of technologies and for more end uses, will be required for these technologies to play a major role in industrial decarbonization," Ben King, associate director at research company Rhodium Group, told Reuters Events.

Rhodium predicts the deployment of CCUS and electrolysers to create green hydrogen could reduce industrial emissions by 5 to 10%, by 2040. However, the industrial sector will become the biggest source of emissions by the early 2030s, Rhodium says, and more measures are required to tackle the challenges in hard to abate sectors.

"U.S. is definitely lagging behind other industrial regions like Europe, Randall Field, Director of Research for the MIT Energy Initiative, told Reuters Events.

"U.S. lack policy durability and this undermines industrial decarbonization. Europe has more policy sticks to drive decarbonization and they have greater consistency in their policies with better inclusivity for tough-to-decarbonize industries," he said.

# TECHNOLOGY SOLUTIONS, CROSS SECTOR LEARNINGS

Image: REUTERS/Amit Dave

There are three primary strategies for industrial decarbonization: electrification, fuel-switching and CCUS, all of which require massive investments to scale up and be deployed widely.

Industrial groups use fossil fuels to transform input materials into industrial products, such as producing steel from iron ore using coking coal. High-temperature processes face the greatest challenge in switching to cleaner fuels while remaining commercially viable.

Low-cost fossil fuels have offered a competitive advantage for heavy industries, Field said.

For moderate temperatures, such as in the paper, food and beverage industries, "heat pump technology can be used to deliver more heat," he noted.

Electrification of high-temperature industrial processes such as steel and aluminium smelting is challenging. In February 2025, ArcelorMittal said it would move forward with the construction of an advanced electrical steel manufacturing facility in Alabama with production capacity of up to 150,000 metric tons.

Early switching to low carbon fuels such as clean hydrogen and eFuels offer an alternative and early commercial projects are being deployed. Switching from fossil fuels to hydrogen and eFuels requires some retrofitting of the industrial processes but this is cheaper than electrification, Field said.

CCUS requires additional equipment, more energy and new systems to deal with the resulting CO2. The hardest to abate industrial sectors like cement, chemicals and steel are "likely first-movers for CCUS deployment" as they face increasing pressure to reduce emissions, Field said.

European cement group Heidelberg Materials is installing the world's first industrial-scale CCUS facility at its operational Brevik cement plant in Norway. The plant has an annual cement production capacity of 1.2 million tons and the CCS system will capture approximately 400,000 tons of CO2. The company will deploy amine-based carbon capture technology, which separates the carbon dioxide from the flue gas through amine absorption.

More CCUS needs to be developed at scale to strengthen confidence in the technology, Field said.

"The key is to keep the [US federal 45Q tax credit for carbon sequestration] intact and support for an initial set of projects, otherwise the momentum will be lost", he said.

The need for electrification means industrial emissions reductions depend on access to clean power.

Renewables and nuclear energy accounted for 40% of power production in 2023, figures from U.S. Energy Information Administration (EIA) figures show. The Biden administration set hugely ambitious targets of 80% clean energy by 2030 and 100% by 2035 which are unlikely to be hit, particularly following Trump's return to office.

Solar power is currently leading new power plant installations, after years of cost reductions, but the rate of growth could be dented by Trump's reorientation of priorities towards fossil fuels, illustrated through executive orders and the review of federal funding support programs.

CASE STUDY

# LOW CARBON FUELS

EFuels producer Infinium is helping to spearhead commercial deployment of low carbon transport fuels. In September 2024, Brookfield Asset Management agreed to invest more than $1.05 billion in Infinium's operations.

EFuels are 'drop-in' replacements for hydrocarbons that can be used without changes to aircraft, ship and truck engines. The transport sector accounted for 39% of all U.S. CO2 emissions in 2023, EIA data shows, including 31% from gasoline and diesel. EVs will help cut the use of these fuels but alternatives to jet and marine fuels are needed to erode the remaining 8% emitted by the transport sector.

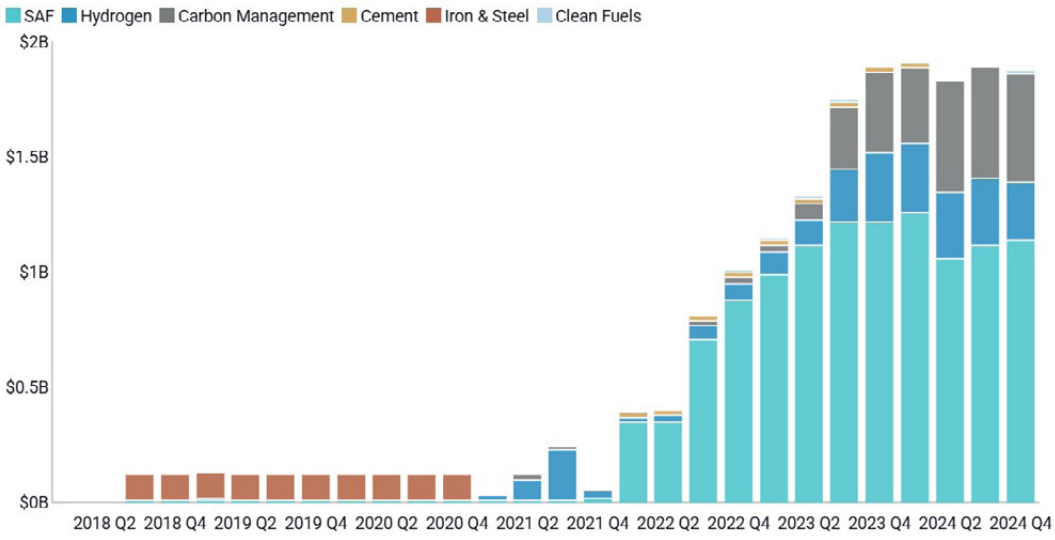
Infinium's eSAF eFuel process combines water, waste CO2 and renewable energy to produce synthetic ultra-low carbon fuels including aviation fuel, eDiesel for long-haul trucking and maritime applications, as well as eNaphtha for plastics manufacturing. Infinium says that its eFuels' lifecycle emissions are 90% lower than for conventional fuels.

"We continue to expand our developments in the U.S. and internationally. Today, Sustainable Aviation Fuel (SAF) is our largest product and focus of our large scale facilities," an Infinium spokesperson told Reuters Events.

British Airways owner IAG and American Airlines have agreed to buy unspecified commercial volumes of eSAF aviation fuel from 2026 from Infinium's Project Roadrunner in West Texas. This represents only a fraction of U.S. jet fuel consumption, estimated at around 25.3 billion gallons a year, according to the EIA.

"As our airline partners continue to push for more SAF and decarbonization options, Infinium remains committed to accelerating production to help meet those demands," Infinium CEO Robert Schuetzle said in September 2024.

## US INDUSTRY DECARBONIZATION INVESTMENT BY TECHNOLOGY




*Note: SAF = sustainable aviation fuel*
*Source: Rhodium Group-MIT/CEEPR Clean Investment Monitor*

EFuels are currently at least twice as expensive as jet fuel but scaling should cut costs. They are blended with fossil fuels but only up to a maximum of 50%.

Wood Mackenzie has predicted that subsidies and other incentives could help make hydrogen eFuels commercially viable and "locations with low-cost sources of hydrogen and CO2 will have the edge in eFuel production."

## GOVERNMENT SUPPORT

Image: REUTERS/Nathan Howard

The main challenge in scaling these technologies is moving from pilot projects to commercial roll-out.

Global rules under the Greenhouse Gas Protocol incentivize corporations to pursue decarbonization but faster implementation requires support from national governments.

Federal funding from the Biden demonstration, including tax credits for clean hydrogen and CCUS, has helped companies develop larger projects on the route to commercialisation.

The support offered by the Biden administration meant "the economic pull has never been stronger for new industrial technologies," Milo Werner, General Partner at tech venture capital firm DCVC, told Reuters Events.

However, many sources of federal funding are under threat from the Trump administration.

President Trump has ordered a review of federal funding programs, pledged to revoke emissions reduction regulations, ordered agencies to consider disregarding the social cost of carbon and asked agencies to reconsider the EPA's endangerment finding on emissions.

The Trump administration could also remove methane regulations imposed by the Biden administration on the oil and gas sector, a key decarbonization driver for industrial sectors, said King. In addition, the DOE under Trump could cease industrial decarbonization financing, such as the $6.3 billion Industrial Demonstrations Program and $7 billion regional hydrogen hubs program following the federal funding review, he said.

The Biden administration announced three funding packages in January 2025 to support the development of commercial-scale CCUS and transport technologies, totalling over $3.5 billion, and the Trump administration may choose to cut these.

The Biden packages include $1.3 billion of support for point source CCUS projects and regional carbon management

networks, pledging to provide 50 to 80% of costs on 11 projects in three areas: coal-fired or industrial plants, each minimum capture capacity of 300,000 tonnes/year; large-scale point source pilot projects designed to capture either 75,000 tonnes/year of CO2 from an exhaust stream or CO2 from at least 20 MW at a coal or gas-fired facility; and locally networked CCUS demonstrations.

The packages also offer $1.8 billion to up to 17 direct air capture (DAC) projects to help develop four regional DAC hubs, each with 1 million tonnes/year CO2 capture capacity. DAC technology removes CO2 directly from the air.

In addition, $500 million is offered for expanded CO2 transport systems. The DOE said that it hoped the financing would help "de-risk CCUS technology and increase investor confidence."

Full applications for the first two options are due by July 2025, with the chosen projects to be announced by the end of this year, unless Trump makes changes.

The federal government has invested billions of dollars into decarbonization pilot and demonstration phases and innovations in these new technologies must be leveraged and aligned with shifting supply chain dynamics, Werner said. One example would be Pivot Bio's microbial nitrogen, which replaces ammonia made from the fossil fuel intensive Habor-Bosch process, making agriculture more sustainable, she said.

The Biden administration's 2022 Inflation Reduction Act aids clean hydrogen and CCUS but "a broader, technology-neutral tax credit for clean industrial heat could do more," King said.

"Additional decarbonization will not occur without meaningful new policy action at all levels of government" with economy-wide and sectoral emissions targets, additional investment through the tax code and/or direct investment, including through government procurement, Rhodium said in a May 2024 report.

Image: REUTERS/Todd Korol

CASE STUDY

# CEMENT

Cement producer Brimstone Commercial is developing a first-of-a-kind commercial scale demonstration plant for low carbon cement production.

About 60% of emissions from established cement production come from limestone, which breaks down into lime and CO2 when heated. Brimstone Commercial has developed three industrial products: ASTM C150 Portland Cement, Supplementary Cementitious Materials and smelter grade alumina, from calcium silicate, which the company describes as "highly abundant and carbon-free".

Brimstone's products will not require subsidies or financial incentives to be commercially viable, the company says, although the DOE has provided $189 million to enable Brimstone to build a first-of-a-kind commercial-scale demonstration plant that would produce 103,000 metric tons/year of the three products.

The demonstration plant will "reduce technical risks and demonstrate sufficient demand to support the development of future industrial-scale decarbonized industrial manufacturing facilities," the DOE said.

The most successful decarbonization solutions "blend superior economics with sustainability," as no decarbonized solution can scale globally unless it's cost-competitive, Cody Finke, CEO at Brimstone Commercial, told Reuters Events.

Other low carbon cement projects backed by the Biden administration's DOE include Roanoke Cement Company's Limestone Calcined Clay Cement project, which will receive $61.7 million to demonstrate how carbon-intensive production of clinker, an intermediary material in cement making, can be replaced with widely available clay types to cut carbon intensity by 83%.

The National Cement Company of California's Lebec Net Zero project was awarded $500 million to produce carbon-neutral cement. The company will use locally-sourced agricultural biomass, such as pistachio shells, make use of calcined clay, and capture the plant's remaining 950,000 tonnes a year CO2 emissions.

It remains to be seen if the Trump administration will cut any of this funding.

# HYDROGEN

Clean hydrogen can promote decarbonization in the transport, ammonia and energy storage sectors, among other uses, and a number of projects are being developed across the United States.

The Biden administration supported the buildout of clean hydrogen projects with tax credits and funding support and launched a scheme to fund hydrogen hubs that would encourage buildout across different regions. Under Trump, there is major uncertainty over whether these programs will continue.

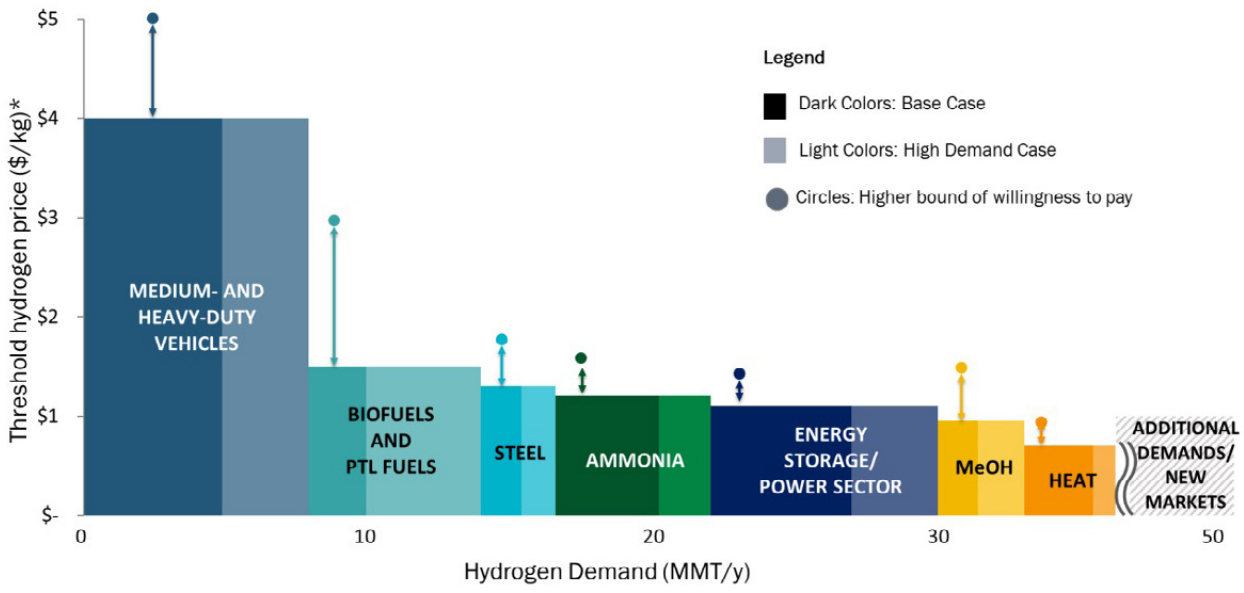
Grey hydrogen, produced from gas-based steam methane reforming (SMR), dominates existing production, while blue hydrogen utilises gas with carbon capture. Green hydrogen is produced using electrolysers powered by renewable energy rather than SMR.

Before the Biden administration left office, the Treasury agreed to provide 45V tax credits to blue as well as green hydrogen in a final guidance ruling.

"The Treasury's final guidance on 45V is a step forward in providing clarity for the hydrogen industry to move ahead with planned projects," Sachin Nijhawan, CEO of thyssenkrupp nucera, an electrolyzer manufacturer, told Reuters Events in February.

The 45V tax credit is worth $0.60-$3.00 per kilogram of hydrogen depending on energy intensity.

## US ESTIMATED CLEAN HYDROGEN DEMAND AT THRESHOLD PRICES




*Source: U.S. Department of Energy's National Clean Hydrogen Strategy and Roadmap, May 2023*

If no action is taken by Trump, national installed electrolyser capacity will increase from 70 MW in 2023 to 15 to 18 GW by 2040, while many SMRs will reach the end of their operational life, Rhodium forecasts.

In 2023, the Biden government announced seven hubs as part of a $7 billion Regional Clean Hydrogen Hubs Program. In July 2024, about $3 billion of this was awarded to Appalachia (ARCH2), California (ARCHES), and the Pacific Northwest (PNWH2) to help fund planning analysis, design activities and stakeholder and community engagement.

A further $2.2 billion was shared between the Midwest and the Gulf Coast in November 2024, while planned hubs in the Heartland (HH2H) and the Mid-Atlantic region (MACH2) remained under award negotiations, the Biden administration DOE said.

However, Field said that while many green and blue hydrogen projects have been proposed over the past five years, few have received final investment decision approval.

"A key challenge is the lack of offtakers of the low-carbon hydrogen product," he said.

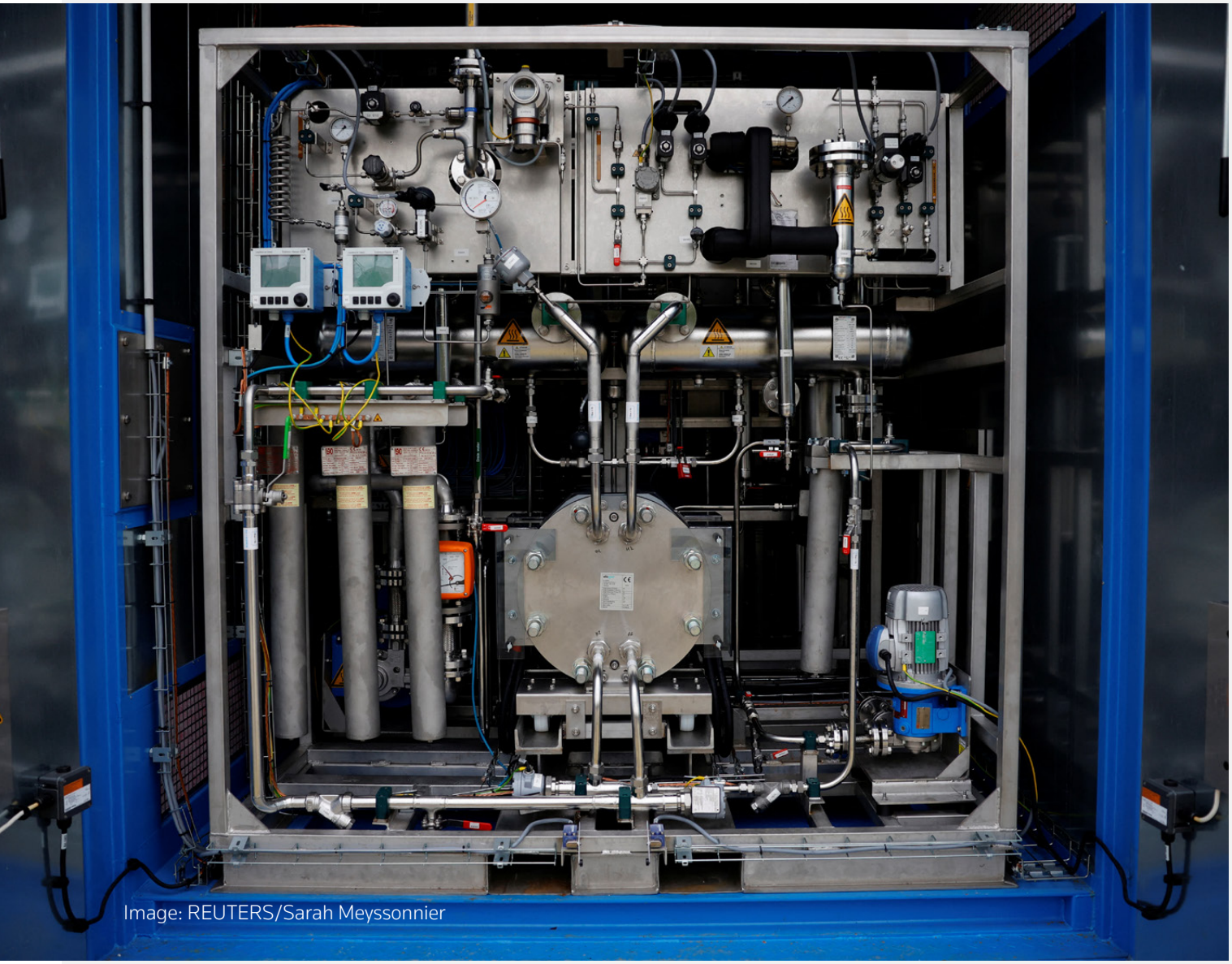


Image: REUTERS/Sarah Meyssonnier

# SUPPLY CHAIN DECARBONIZATION


Image: REUTERS/Rene Van Quekelberghe

Large corporations are also looking to decarbonize supply chains and there has been renewed urgency to build domestic manufacturing since the Covid-19 pandemic disrupted supply.

For 40 years, "the U.S. prioritized cost over resilience" in supply chains but this strategy was badly exposed during the Covid-19 pandemic," Werner said.

New factory constructions have increased by 2.5 times, including a tenfold increase for electronics, but many sectors such as the chemical industry have not seen the same benefit, according to DCVC.

These new domestic facilities are adopting "more efficient, productive, greener technologies" to compete with global mega-factories, Werner said.

In one example, Brimstone is onshoring the supply chain for its cement and alumina, using a "carbon-free, domestically abundant rock to produce these critical materials here in the U.S," Finke said.

This reduces the carbon footprint, but also aligns "with key U.S. policy priorities, strengthening national security and supporting the domestic economy," he said.

Decarbonising long-distance shipping remains challenging because it is highly consolidated and requires immense capital investments.

This makes it "poorly suited for traditional venture-backed innovation," Werner noted.

"However, meaningful disruption will emerge as global supply chains continue to shift toward regionalisation, reducing reliance on carbon-intensive modes of [long distance] transport", he said.

**– Neil Ford**