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Argus Hydrogen and Future Fuels

Market news, analysis and prices

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Labor win brings relief for Australian H2

The election result means tax credits will survive, but subsidies alone will not be enough to propel the sector forward decisively, writes Stefan Krumpelmann

Australia's fledgling renewable hydrogen sector has breathed a sigh of relief following the Labor Party's victory at the general election on 3 May. Project developers will be able to count on continued government support, including billions of dollars in tax credits that the Coalition had vowed to scrap if elected.

Incumbent prime minister Anthony Albanese and the Labor Party won a comfortable majority in the House of Representatives, even substantially increasing its number of seats. This followed a remarkable turnaround in recent months. Labor had been trailing in most polls at the start of this year in a campaign which focused heavily on cost-of-living issues.

In Albanese's first term that started in 2022, the government had introduced several measures to boost Australia's renewable hydrogen ambitions. This included the Hydrogen Headstart programme, which for now has been bankrolled with A$4bn ($2bn), and hydrogen production tax credits worth more than A$14bn.

Coalition leader Peter Dutton had pledged to axe the tax credit plans if elected. The programme "is not going to work", Dutton said, dismissing Labor's hydrogen plans as a "hoax" and "fantasy projects". Renewable hydrogen is not commercially viable, and the focus should be on immediate relief for households from high energy costs, he argued. The Coalition's plans envisaged removing a ban on nuclear power and more support for domestic natural gas production.

Unsurprisingly, industry body the Australian Hydrogen Council views the election results as "welcome news". Chief executive Fiona Simon says she was relieved given that support for the sector had been at risk. "We are not political, and needed to stay out of politics, which was very hard when hydrogen was used politically," Simon said.

The election result shows clearly that "Australians will back and support policies that recognise the economic opportunities that come from acting on the existential threat of climate change", says Andrew Forrest, chairman of mining and energy firm Fortescue, a fervent advocate of renewable hydrogen. The hydrogen tax credits will "provide a strong foundation for a green energy future", he adds.

But the subsidies alone will not be enough to revitalise Australia's renewable hydrogen hopes, and Albanese's government will have to tackle a myriad of issues in its second term. Constraints on renewable power supply, high electricity costs and long permitting procedures, among other challenges, have held back or derailed projects, resulting in a seemingly never-ending stream of setbacks for the sector.

Funds allocated so far via Hydrogen Headstart have remained far below the first round's A$2bn budget, possibly because several shortlisted projects have been shelved. Meanwhile, Albanese and the Labor Party were forced to shift some funding promised for renewable hydrogen to more urgent economic priorities. Development of a flagship project in Whyalla, South Australia, was halted as the government redirected public funds to rescue the nearby steelworks.

The government tacitly acknowledged that many of Australia's planned hydrogen projects will not be realised as indicated in its hydrogen strategy from September 2024. The strategy's production targets were relatively modest compared with the large pipeline of announced projects and other countries' goals.

Progress is not entirely in Australia's hands. Its hydrogen fortunes will also depend on developments in key offtake countries such as Japan and South Korea.

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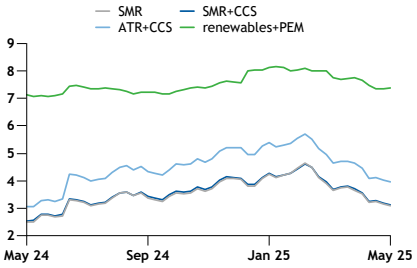
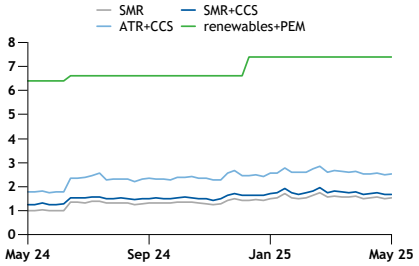
HYDROGEN COSTS

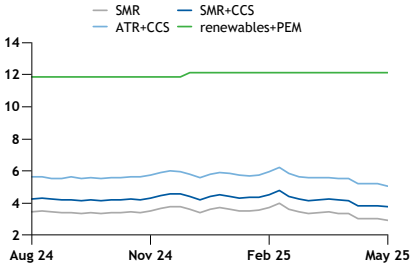
Northwest Europe average cost €/kg



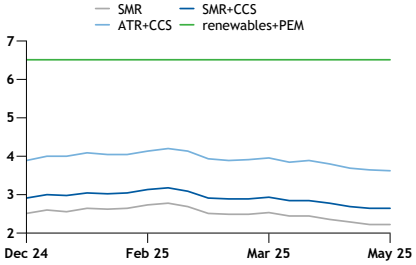
North America average cost $/kg



Northeast Asia average cost $/kg



Exporter average cost $/kg



Regional hydrogen cost markers			Incl. capex		Excl. capex	6 May
	Process	Unit	Cost	± 29 Apr	Cost	± 29 Apr
Baseline						
Northwest Europe	SMR	€/kg	3.09	-0.06	2.58	-0.06
Northwest Europe	SMR	$/kg	3.50	-0.09	2.92	-0.09
North America	SMR	$/kg	1.52	+0.01	0.95	nc
Northeast Asia	SMR	$/kg	2.93	-0.09	2.30	-0.10
Middle East	SMR	$/kg	2.61	-0.09	2.05	-0.09
BAT+						
Northwest Europe	SMR+CCS	€/kg	3.12	-0.07	2.51	-0.07
Northwest Europe	SMR+CCS	$/kg	3.54	-0.09	2.85	-0.09
North America	SMR+CCS	$/kg	1.68	+0.01	1.00	nc
Northeast Asia	SMR+CCS	$/kg	3.74	-0.09	3.00	-0.09
Middle East	SMR+CCS	$/kg	2.99	-0.09	2.32	-0.09
Low-C						
Northwest Europe	ATR+CCS	€/kg	3.95	-0.07	2.85	-0.07
Northwest Europe	ATR+CCS	$/kg	4.48	-0.10	3.23	-0.10
North America	ATR+CCS	$/kg	2.52	+0.02	1.30	+0.02
Northeast Asia	ATR+CCS	$/kg	5.06	-0.12	3.72	-0.12
Middle East	ATR+CCS	$/kg	4.00	-0.09	2.79	-0.09
No-C						
Northwest Europe	Island renewable+PEM	€/kg	7.39	+0.03	4.63	+0.02
Northwest Europe	Island renewable+PEM	$/kg	8.38	nc	5.25	nc
North America	Island renewable+PEM	$/kg	7.38	nc	4.55	nc
Northeast Asia	Island renewable+PEM	$/kg	12.12	nc	9.34	nc
Middle East	Island renewable+PEM	$/kg	6.02	nc	3.36	nc
Exporter						
Exporter baseline	SMR	$/kg	2.23	nc	1.66	nc
Exporter BAT+	SMR+CCS	$/kg	2.64	nc	1.96	-0.01
Exporter low-C	ATR+CCS	$/kg	3.63	-0.02	2.42	-0.01
Exporter no-C	Island renewable+PEM	$/kg	6.52	nc	3.64	nc

Argus hydrogen taxonomy	Purity	Pressure	tCO2e/tH2
Baseline	99.9%	30 bar	<11.3, >8.0
BAT+	99.9%	30 bar	<2.88, >1
Low-C	99.9%	30 bar	<1, >0.5
No-C	99.99%	30 bar	<0.01

CO2e emissions on a gate-to-gate basis

Pump prices, 70MPa				6 May
	Unit	Price		± 1 Apr
Japan				
Iwatani	¥/kg	1,650.00		nc
		Low	High	
Eneos	¥/kg	2,200.0	2,750.0	nc
Germany				
H2Mobility (stations with “green” H2 supply)	€/kg	13.00		nc
		Low	High	
H2Mobility (stations with conventional H2 supply)	€/kg	16.05	19.25	+0.50

MARKET DEVELOPMENTS

Air Products eyes fob Saudi ammonia sales in near term

Air Products will for now focus on selling output from Neom as ammonia and aims to build a terminal with a cracking complex to start EU imports by 2030, writes Aidan Lea

US industrial gas company Air Products will slow the development of renewable ammonia import and cracking terminals in Europe, focusing instead on selling output from Saudi Arabia's Neom project on a fob basis in the near term, according to chief executive Eduardo Menezes.

Air Products, the sole offtaker for the 1.2mn t/yr of renewable ammonia from Neom, has been considering constructing terminals across northwest Europe, including Rotterdam in the Netherlands, Hamburg in Germany, Le Havre in France and Immingham in the UK, to send the ammonia and crack some or all of it to extract hydrogen for sale.

But the company plans to narrow down the list based on securing long-term customer contracts and adequate government support. Previous estimates suggested some terminals could be ready as soon as 2026 and 2027, but the first facilities are likely to materialise later than initially planned. Air Products in the past criticised EU "over-regulation" for ammonia cracking facilities, especially rules for third-party access, which require operators to make some of their capacity available to other potential importers.

Air Products is "basically pausing all activity" on its planned terminals for now, Menezes says. The company has spent some money, but not a significant amount compared with earlier estimates of $2bn, and it will not spend "anywhere close to this amount going forward", he says.

Air Products has struck a deal with TotalEnergies for delivery of 70,000 t/yr of renewable hydrogen, which could equate to roughly a third of Neom's output, starting from 2030. The two firms are still deliberating which of TotalEnergies' European refineries will receive the supply.

"What we're basically doing today is engineering work and permitting work and trying to wait to see how each country will transpose the EU regulations, so together we can decide which refinery would make more sense for us to supply the green hydrogen," Menezes says.

EU member states have some flexibility in transposing regulations from the revised Renewable Energy Directive (RED III), including how to stimulate renewable hydrogen use in refineries as part of transport sector mandates starting in 2030.

A cracking end to 2025

'In the short term, we're going to have a little less contribution. In the long term, it's a very favourable outlook for us in the market'

Air Products and TotalEnergies aim to decide which of the French firm's refineries to target by "no later than 2027", Menezes says. This would allow time to build a facility with a cracking complex to start imports by 2030.

Once Neom starts up in 2027, Air Products will focus on selling output on a fob basis from Saudi Arabia until 2030, Menezes says. The company is exploring partnerships to sell the ammonia, as it "does not intend to be long-term marketers of ammonia", he says.

Menezes says he hopes to have firm plans by the end of 2025. Activist investor Mantle Ridge, which successfully campaigned to install Menezes as chief executive earlier this year, previously said that it would undo Air Products' 30-year offtake commitment from Neom.

Menezes is optimistic about Air Products' estimated production costs, which he says are in the lower range of analyst estimates. He suggested that the project could be profitable, even from 2027, with margins increasing post-2030.

"I'm relatively optimistic that the project will contribute to us when we start up the plant," he says. "In the short term, 2027-30, until the regulations in Europe are more developed, we're going to have a little less contribution. In the long term, it's a very favourable outlook for us in the market."

NEWS

Air Products' Canada H2 project cost overruns to $3.3bn

US Air Products' expected costs for a plant making hydrogen from natural gas with carbon capture and storage (CCS) in Edmonton have nearly tripled to $3.3bn.

The plant was expected to cost C$1.6bn ($1.15bn) when it was first announced. The cost inflation was partly "self-inflicted" and then worsened by the "unforgiving environment" in Canada, chief executive Eduardo Menezes says. The project fell behind schedule and missed out on "windows in terms of weather" and suffered "low productivity from contractors that are very expensive to start with". The project's main flaws are its cost overrun and its oversized liquid hydrogen production capacity for the Canadian mobility market, which is developing more slowly than expected, Menezes says.

Menezes is part of new management at the company, which recently changed several board members after a manoeuvre from activist investors Mantle Ridge.

Air Products identified a number of "underperforming projects" amounting to $5bn in capital costs, which the firm will take forward to fulfil its contractual obligations, but which are likely to eventually break even rather than generate significant profits, Menezes says (*see table*). Air Products will finish these projects, where it has already spent 90-95pc of the costs, to recover its outlay. But it scrapped projects that had not reached that tipping point, such as a renewable hydrogen plant in New York which would have needed another $400mn, he says.

Air Products has also set out cost reduction hopes for its CCS-based hydrogen plant in Louisiana. The firm plans to delegate the CCS and ammonia production aspects to partners, which should cut its capital costs to $5bn-6bn rather than the $8bn for the full project, Menezes says. The project was estimated to cost $4.5bn when first announced in 2021. The expected start date has been pushed back to late 2028-early 2029 from 2026.

By Aidan Lea

Air Products projects	$bn
	Est. capital costs
Underperforming	
CCS-based H2 in Edmonton	3.30
CCS-based H2 in Rotterdam	0.80
Renewable H2 in Arizona	0.36
Other energy transition projects	0.54
Cancelled*	
SAF/H2 in California	-
Renewable H2 in New York	-
Carbon monoxide in Texas	-

**cancelled projects have a "pre-tax charge" of roughly $3bn*

— Air Products

LSB pauses CCS-based ammonia project in Texas

US nitrogen fertilizer producer LSB Industries is pausing development of a project in Houston, Texas, that was due to make 1.1mn t/yr of ammonia from natural gas with carbon capture and storage (CCS) through autothermal reforming.

Global economic uncertainties, US tariff-related cost increases and slow demand growth for low-carbon ammonia drove the decision, LSB says (*see p8*).

LSB partnered with industrial gas firm Air Liquide, Japanese oil company Inpex and Dutch storage operator Vopak on the facility that was due to be located on the Houston Ship Channel. Air Liquide was expected to produce the hydrogen and calculated costs based on availing the 45Q tax credits for carbon sequestration.

Final guidelines for the 45V hydrogen production tax credits released in January could allow the developers to access more lucrative incentives under this programme because of a new section pertaining to cryogenic separation, a process that captures CO_2 from industrial gas streams, LSB clean energy vice-president Jakob Krummenacher said at last week's *Argus* Clean Ammonia North America conference. As a result, many of the assumptions from the initial engineering studies would in any case have to be revised.

Chief executive Mark Behrman warned that the project would not necessarily be revived even if the full 45V tax credits can be availed. "We still need a customer to move forward," he said.

LSB is advancing plans to add CCS technology at its plant in El Dorado, Arkansas, with low-carbon ammonium nitrate solution supply to begin in late 2026.

By Chris Mullins and Jasmina Kelemen

45V hydrogen tax credit		$/kg
Emissions ***kg of CO_2e/kg of H_2****	**Base**	**Multiplier†**
2.5-4	0.12	0.60
1.5 to <2.5	0.15	0.75
0.45 to <1.5	0.20	1.00
<0.45	0.60	3.00

**based on lifecycle emissions; †applies if prevailing wage and apprenticeship requirements are met*

— US government

NEWS

Oman opens third land auction for 150,000 t/yr of H2

Oman state-owned Hydrom has opened a third auction to allocate land for renewable hydrogen production, with 300km² to be made available for approximately 150,000 t/yr of output.

The land will be offered in the Duqm region in south-central Oman under 47-year contracts. Unlike in two previous auction rounds which had offered plots of a similar size, participants would not have to submit project proposals for the full land. They can submit bids for plots of 100km² or more, which means that Hydrom expects to allocate the land to 1-3 developers.

Developers would have to produce a minimum 50,000 t/yr of renewable hydrogen per 100km². They would be free to produce hydrogen for local industry or derivatives of their choice for exports.

The plots will also have to host renewable power generation assets for the hydrogen output. This is in line with Oman's aim to transport hydrogen, rather than electricity, via common-user infrastructure. Unlike in previous auctions, developers can sell excess power they produce on the spot market "subject to regulatory approvals and alignment with national energy policy objectives", Hydrom says.

The plot on offer is outside of the Duqm special economic zone, which means corporate taxes will apply. Developers would also have to pay base royalties, an "upside fee" and land fees.

The area offers high wind speeds of about 7.1-8.3 m/second, high solar irradiation and "level terrain with minimal development constraints", Hydrom says.

The company has extended the application period to nine months, based on feedback from previous rounds. The bid submission deadline is set for the end of January 2026, with winners to be announced in the second quarter of next year.

Hydrom will look at various factors when selecting projects, including "financial, development and operational criteria". The auction "is a beauty contest and not a numbers game" and the more value a project brings to Oman, the better its chances, Hydrom's business development manager, Rumaitha Al Busaidi, says.

Hydrom has so far awarded plots to eight developers — five in the Duqm region and three in the Dhofar area. Not all of these were allocated through the auctions, with some based on "legacy contracts" that were agreed before the more streamlined tender process was introduced.

By Stefan Krumpelmann

Companies with land awards	*'000 t/yr*
Company/consortium	**Est. green H2 output**
Duqm region	
Copenhagen Infrastructure Partners, Blue Power Partners, Al Khadra	200
Posco, Engie, Mescat Middle East, Samsung Engineering, Futuretech Energy Ventures, Korea East-West Power, Kospo	200
OQ, Shell Oman, EnerTech, Intercontinental Energy, Golden Wellspring Wealth for Trading	150
BP	150
OQ Alternative Energy, Deme, BP Oman	50
Salalah region	
Actis, Fortescue	200
EDF, J-Power, Yamna	178
OQ Alternative Energy, Dutco, Samsung C&T	175

— *Hydrom*

South Australia closes Hydrogen Power SA office

Whyalla, South Australia

The state government of South Australia (SA) has rolled its Office of Hydrogen Power SA (OHPSA) into the Department for Energy and Mining (DEM), after scrapping plans for a 250MW electrolyser and 200MW hydrogen-fired power station.

The OHPSA has been absorbed into the other state department, a spokesperson for SA energy minister Tom Koutsantonis said on 2 May. This comes after the state cut the A$593mn ($381mn) it had promised for its Hydrogen Jobs Plan in early 2025. The funds were reallocated to subsidise the 1.2mn t/yr Whyalla steelworks, which entered administration on 19 February.

The associated Office of Northern Water Delivery, which was intended to support the renewable hydrogen sector in the state's upper Spencer Gulf region with new water pipeline supply, has also been incorporated within the DEM.

SA's other major hydrogen hub planned at nearby Port Bonython was also overseen by the OHPSA. Development deals with five firms have been signed for Port Bonython, including with London-based Zero Petroleum for an e-SAF plant.

By Tom Major

NEWS

Brazil's Aneel rejects grid access for green H2 projects

Brazil's electricity regulation agency Aneel has rejected requests for power grid connections filed by two renewable hydrogen project developers in the northeast of the country — but the decision can be reversed, according to one of the firms.

Spain's Solatio, which is planning a renewable ammonia project in Piaui state, had its request for an electricity grid connection rejected by Aneel in late April.

The regulator's decision was based on recommendations made by Brazil's grid operator ONS, which found the grid connection request to be unfeasible as it "could result in overload and risks of voltage collapse".

Aneel says the decision "does not constitute a sanction or opposition to the investment itself". Instead, it is a reflection of the "current technical limitations" of the power system. Aneel expects "in the near future, structural works capable of safely serving large loads in the northeast will be proposed and granted".

The energy ministry has asked energy research body EPE to add 4GW capacity in the northeast grid to help with demand from renewable hydrogen projects.

Meanwhile, Solatio has already submitted a "new technical solution" that was designed with support of the Piaui government and state investment promotion agency Invest Piaui, and that could be approved soon, the developer tells *Argus*.

Solatio in March received approval from Brazil's industry and trade ministry to implement the project in the Parnaiba export processing zone and last week it received environmental approval from the Piaui state authorities for 3GW of electrolysis. It is eyeing renewable ammonia exports and says it could eventually expand capacity to 11GW.

Earlier in April, renewables firm Casa dos Ventos had a grid connection request rejected for its 900,000 t/yr renewable ammonia project planned at the Pecem port complex in Brazil's Ceara state. Output from the Iracema project could supply TotalEnergies, which is a shareholder in Casa dos Ventos.

Aneel has asked ONS to provide "the set of technical information" for its recommendation and increase transparency on its assessments. Casa dos Ventos did not respond to *Argus* requests for comments.

Hydrogen industry participants in Brazil are increasingly concerned about power grid bottlenecks. They worry that planned expansions could come too late for projects that hope to be early beneficiaries of Brazil's tax credit scheme.

By Pamela Machado

Norway's Statkraft cancels 40MW Nel electrolyser order

Norwegian utility Statkraft has cancelled its order for a 40MW alkaline electrolyser from compatriot Nel that was envisaged to be used at a planned renewable hydrogen facility in Mo i Rana in central Norway.

"We have not been able to create a viable commercial model for the project in the current market conditions," Statkraft hydrogen senior vice-president Bjorn Holsen says. This was despite the firm putting "considerable engagement and commitment into developing and attracting funding to a hydrogen project in Mo".

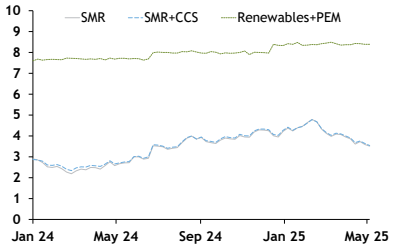
The plant at Mo industrial park was intended to produce renewable hydrogen for steel manufacturer Celsa from 2027.

The cancellation will trim Nel's order backlog by 120mn kroner ($11.5mn), Nel says. It might not be the last cancellation, as Nel's backlog contains NKr293mn alkaline electrolyser supply contracts at "significant risk of delay or cancellation", the company said on 30 April. Nel has put alkaline electrolyser manufacturing at its 1 GW/yr Heroya facility on hold because of muted demand.

By Alexandra Luca

NEWS

Northwest Europe H2 costs €/kg



New EU low-carbon H2 draft lifts gas emissions default

A new leaked draft methodology underpinning the EU's delegated act on low-carbon hydrogen lifts the default value for natural gas emissions, but otherwise introduces few changes, which is bound to frustrate industry participants.

The European Commission sets the default value for upstream lifecycle greenhouse gas (GHG) emissions for natural gas at 15.1g of CO_2 equivalent (CO_2e) per MJ, according to the document seen by *Argus*. This is up from 10.5g CO_2e/MJ in a version that the commission put forward for consultation in September.

The default value is crucial for companies looking to produce or consume hydrogen made from natural gas with carbon capture and storage or other methods to abate emissions. A higher default value for upstream emissions makes it harder to keep overall lifecycle GHG emissions for the full production process below the EU's 28.3g CO_2e/MJ — or 3.38kg CO_2e/kg — threshold for low-carbon hydrogen.

It would be "basically impossible" for gas-based hydrogen to qualify as low-carbon using the new default value, one industry participant says. The increase would effectively push companies even more towards using "supplier-specific emissions values", but rules for calculating these specific values have yet to be established, the source says, adding that this "creates quite a bit of uncertainty".

Provisions on electrolysis using non-renewable power are unchanged in the new draft. It still does not include a specific pathway for nuclear-based power purchase agreements to make low-carbon hydrogen. The document foresees a review for this by 1 July 2028, even though it adds a new date for the launch of a consultation on the matter by the end of June 2026. Emissions would for now be calculated using a default number from the CO_2 intensity of each country's electricity grid. Participants have criticised this, saying it would prevent nuclear-based production in countries where grid emissions are above the EU's threshold.

The commission formally has until 5 August to finalise the delegated act and the methodology. It had said in February that it would do this in the first quarter but missed this deadline.

By Stefan Krumpelmann

China's 2025 renewable hydrogen goal within reach

China had 125,000 t/yr of renewable hydrogen production capacity in operation by the end of 2024, according to the country's National Energy Administration (NEA), putting it in a strong position to reach its output target for this year.

China in 2022 set a target to produce 100,000-200,000 t/yr of renewable hydrogen by 2025. This goal appears within reach even with plants running below capacity, as capacity could still grow throughout this year.

China's total electrolytic hydrogen production capacity reached approximately 500,000 t/yr by the end of last year, with actual output at 320,000t in 2024, equivalent to 64pc of capacity, NEA data show. This indicates that only about a quarter of total installed capacity is powered by renewable sources, while 375,000 t/yr would be designed to draw on non-renewable electricity.

By expanding its electrolysis production capacity, even without the climate benefits of renewable power, China could boost demand for electrolysers and gain substantial experience in their manufacturing and operation.

But China might struggle to meet targets for hydrogen vehicles. The country had built 540 hydrogen refuelling stations and placed about 24,000 fuel cell vehicles (FCVs) on the road by 2024, according to the NEA. This was just about half of its target for 1,000 stations and 50,000 FCVs, respectively, by 2025.

By Alexandra Luca

ANALYSIS

US tariffs add to challenges for CCS-based H2 projects

Trump's tariffs have exacerbated concerns over an uncertain outlook and might have knock-on effects for projects outside the US, but some are still moving ahead, writes Jasmina Kelemen

US president Donald Trump's tariff policy is further complicating plans for North American projects looking to produce hydrogen and derivatives from natural gas with carbon capture and storage (CCS) — at a time when potential buyers still balk at making long-term commitments at prevailing costs.

Lower-carbon hydrogen produced through autothermal reforming with CCS is still expected to lead the nascent sector's development. Most large CCS-based hydrogen projects in the US have focused on exports in the form of ammonia to Asia and Europe, where governments have promised more support to implement decarbonisation mandates. But Trump's tariffs could drive up construction costs, and the uncertainty surrounding them is complicating planning.

This contributed to fertiliser producer LSB's decision to place a proposed 1.1mn t/yr CCS-based ammonia project in the Houston Ship Channel on hold. "I think for us it's really about uncertainty and capital costs now, as things are moving around," chief executive Mark Behrman said on the firm's first-quarter 2025 earnings call on 30 April. "One day we have tariffs and the next day we don't."

'There has been a lack of willingness to commit at the prices that we were able to talk about, based on our capital costs'

These challenges exacerbated concerns over an uncertain demand outlook, as offtakers are still shying away from the comparatively high costs of low-carbon supply. "Demand has certainly ramped up slower than expected," Behrman told *Argus* in an interview. "In the conversations we have had with many offtakers in Asia and Europe, and even here domestically, there has been a lack of willingness to commit at the prices that we were able to talk about, based on our capital costs." For long-term supply contracts, buyers were seeking prices below $600/t fob, he said.

The tariffs might also have knock-on effects for CCS-based projects outside of the US. Citing uncertainty around the tariffs and the potential for retaliatory tariffs by US trading partners, chemicals company Dow has paused work on its Path2Zero ethylene plant in Canada's Alberta province, which was due to be a key offtaker for a nearby $2bn CCS-based hydrogen plant developed by industrial gas firm Linde and originally planned for a first-phase start-up in 2027.

Linde has not responded to questions about what Dow's pause means for its plans in Alberta. But the firm had mentioned Dow's offtake deal central to its announcement of a final investment decision (FID) for the hydrogen plant in August, although it noted at the time it would also be looking to supply other existing and new customers from the facility. During an earnings call last week, Linde said it will work with Dow "to look at alternatives and opportunities to see how we can help them meet their goals while maintaining Linde's interest in the project".

Venture into the unknown

While the tariffs have created uncertainty, some projects are still moving ahead.

A little over a week after Trump announced his plans, fertilizer producer CF Industries took an FID on a $4bn CCS-based ammonia venture with Japan's Jera and investment firm Mitsui at its Blue Point complex in Louisiana.

CF Industries expects trade policies to "evolve" until the firm would feel the effect of the tariffs for its project, its clean energy solutions director Jonathan Flynn said at the *Argus* Clean Ammonia North America Conference on 29 April.

"Our hope and expectation is that by the time we actually have to do things we'll be in a different policy environment," Flynn said. "We're going to have to order it, construct it and shift it over — that's a very long process".

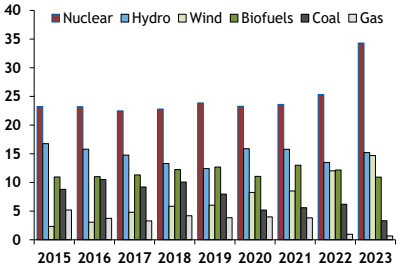
But the firm is hedging its bets, Flynn said. "We're early enough in our process that we are able to look to manufacture a lot of our equipment and modules in the countries we believe are going to have low tariffs."

ANALYSIS

Finland's wind power buildout to drive H2 sector

Finland's pipeline of wind projects is attracting significant interest from the H2 sector, and wind farms could provide about half of the country's electricity by 2030, writes Pamela Machado

Finland power mix (IEA) *TWh/yr*



The single bidding zone gives project developers flexibility to choose where to install renewable power generation assets in optimal areas

Finland is set to scale up its wind power generation capacity considerably in the next few years as it pursues ambitious climate goals. A sturdy wind power sector, combined with rich biogenic CO_2 availability, investment incentives and supportive policies, has been attracting hydrogen projects to the country.

Finland has one of the most ambitious climate targets globally as it aims to reach carbon neutrality by 2035. Bulking up its wind power generation capacity will be key to meeting these goals.

"The pace of change is remarkably high," the country's transmission system operator (TSO) Fingrid said in its 10-year plan from last year.

Coal and natural gas-powered generation has been decreasing over the past decade and now together make up less than 4pc of the electricity mix. Approximately 40pc of Finland's power comes from nuclear reactors — a share that grew considerably in recent years as Finland sought to strengthen its energy independence by reducing imports, especially from Russia.

But the future grid is expected to rely mainly on wind power output, which already doubled between 2019 and 2023 and reached a 20pc share in the electricity mix then, according to data from Paris-based energy watchdog the IEA. By 2030, it could provide half of Finland's electricity, Fingrid estimates. The scale-up could accelerate further in the 2030s, as more GW-scale offshore wind projects — which require more engineering studies than onshore wind and therefore take longer to be realised — come on line, Fingrid says.

Finland's prolific pipeline of wind power projects, onshore and offshore, have contributed to the strong interest from would-be producers of renewable hydrogen and derivatives, says Juha Peltomaki, the head of industry, bio and circular economy at Business Finland, the investment promotion arm of the trade and industry ministry.

Increased renewables and nuclear output in recent years have driven down the emissions intensity of Finland's grid. Data for 2024 are not yet available, but the emissions intensity was almost certainly less than 18g of CO_2 equivalent/MJ, meaning hydrogen producers would be exempt from additionality requirements under the EU's definition of renewable fuels of non-biological origin (RFNBOs).

Producers could then use grid power to make renewable hydrogen or derivatives, but they would still need a power purchase agreement for renewable electricity and must adhere to temporal and geographical correlation requirements.

For geographical correlation, Finland could benefit from its single bidding zone, which differentiates it, for example, from its neighbour Sweden. The single bidding zone gives project developers flexibility to choose where to install renewable power generation assets in optimal areas — and potentially far from the hydrogen and associated infrastructure — and still be compliant with the geographical correlation requirements.

Un-Finnished business

Finland's electricity system is resilient and well-prepared for growing electrification, Peltomaki says. Fingrid can offer 1GW connection points in several locations, allowing for the implementation of energy-intensive offtake projects without much of a challenge, he says. The TSO had a pipeline of 3GW worth of energy storage projects to be connected with wind and solar facilities, according to the 2024 grid plan.

A lack of grid connection capacity, and long procedures around getting access to the electricity network, have been a concern for would-be hydrogen producers in other countries, both in Europe and further afield.

ANALYSIS

RED III H2 target implementation tracker

An overview of EU member states' plans to implement renewable hydrogen targets from the revised renewable energy directive (RED III) is available here

In pursuit of its climate goals, the Finnish government recently launched a €2.3bn ($2.6bn) tax credit scheme to support large-scale energy transition and industrial decarbonisation projects, including renewable hydrogen initiatives.

The programme is open to projects with anticipated investments of at least €50mn, and offers firms a 20pc tax credit of up to €150mn over 20 years. The scheme will be open to receive applications until the end of August.

Finland has also set ambitious targets for use of renewable hydrogen and derivatives in the transport sector. It will phase in RFNBO mandates for fuel suppliers already from 2028 and is aiming for a 4pc share by 2030, above the EU's 1pc minimum requirement. This has been viewed with envy by the hydrogen sector in other EU countries, with industry participants in Denmark recently calling on their government to follow Finland's lead.

Cluster development

Finland's rich forestry sector could help reach Helsinki's goals for RFNBO use in transport. The sector is currently generating about 28mn t/yr of biogenic CO_2, according to industry body H2 Cluster Finland.

Finland's rich forestry sector could help reach Helsinki's goals for RFNBO use in transport. The sector is currently generating about 28mn t/yr of biogenic CO_2

This has drawn developers' attention to e-fuels. Finland now boasts the second-largest pipeline of projects for production of hydrogen-based sustainable aviation fuels (e-SAF), trailing only France, *Argus* data show. If realised, e-SAF projects in Finland could yield just under 500,000 t/yr of output.

First deals for CO_2 supply to e-fuels projects have been signed, such as between Finnish energy company TSE and Sweden-headquartered Liquid Wind.

H2 Cluster Finland is mapping roughly 11GW of electrolysis capacity planned across more than 50 renewable hydrogen and derivatives projects in different development stages. Developers include French Verso Energy, Germany's Abo Energy and US hydrogen firm Plug Power.

While many developers are targeting exports to Europe and abroad — primarily locations close to ports — industrial consumers in Finland have shown a willingness to pay a higher price for the benefit of reducing emissions, Peltomaki says.

But just like elsewhere, costs for renewable hydrogen and derivatives will arguably still have to come down considerably for the sector to take off in earnest and for a substantial share of the project pipeline to be realised.

The vast majority of renewable hydrogen projects are still in early development stages despite promising foundations. The largest Finnish project in operation is a 20MW electrolysis plant developed by domestic firm P2X, which makes e-methane in Harjavalta in western Finland.

Selected announced H2 projects in Finland*

Developer	Location	Product	Electrolysis cap. *MW*	Phase
OX2	Lumparland	Marine fuels	3,000	Planning
Plug Power	Kristinestad	H2 for DRI	1,000	Planning
Plug Power	Kokkola	Ammonia	1,000	Planning
Vetyalfa	Kemijarvi	E-fuels	1,000	Early development
Vetyalfa	Vaala	E-fuels	1,000	Zoning approved
Vetyalfa	Utajarvi	E-fuels	1,000	Early development
Fortum/SSAB	Raahe	H2 for green steel	700	FEED
Abo Energy	Oulu	E-fuels	600	Planning
Flexens	Kokkola	Ammonia	300	Pre-FEED
Verso Energy	Oulu	E-fuels	300	Zoning
Verso Energy	Tornio	E-fuels	300	Planning
eTehdas	Simo	H2	300	Feasibility
Green North Energy	Naantali	Ammonia	280	Feasibility
Green North Energy	Pori	Ammonia	280	Feasibility
Green North Energy	Kemi	Ammonia	280	Feasibility
ET Fuels	Ranua	E-methanol	220	Feasibility
Plug Power	Porvoo	H2 for export	200	Planning
Prime Capital AG	Kristinestad	E-methane	200	Feasibility
Abo Energy	Nivala	H2	200	Planning
Nordic Ren-Gas	Pori	E-methane	150	Permitting
Nordic Ren-Gas	Lahti	E-fuels	120	Feasibility
Oulun Energia	Oulu	E-fuels	100	Planning

**Projects over 100MW electrolysis capacity*

— H2 Cluster Finland; Argus

INTERVIEW

IPCEI award comes with challenges: H2Apex

German firm H2Apex is developing several renewable hydrogen projects in the country. Following a recent acquisition from fellow developer HH2E, which ceased operations earlier this year, the company has two projects planned in Lubmin in northeast Germany. Both are due to start with 100MW capacity, but could subsequently expand. Besides its own projects, H2Apex also has an engineering, procurement and construction (EPC) arm that is involved in multiple projects developed by other firms. Argus spoke with H2Apex chief executive Peter Rossner about the company's project plans, opportunities and challenges arising from an Important Project of Common European Interest (IPCEI) designation, offtake sectors and the EPC business. Edited highlights follow:

You now have two projects in Lubmin. Are these completely separate or are you planning to link them?
These are currently still two completely separate projects. HH2E as a first mover had secured their plot very early, and it is arguably the best piece of land in Lubmin for a hydrogen project in terms of connections. But we, of course, have synergies we can leverage and that both projects can benefit from, for example on the electricity grid connections.

'HH2E as a first mover had secured their plot very early, and it is arguably the best piece of land in Lubmin for a hydrogen project in terms of connections'

Are you in any way collaborating with other firms that are planning hydrogen projects in Lubmin?
We have indeed created a consortium with other developers through which we will jointly purchase land to build a substation for the conversion from 380kV down to 110kV. Construction of the substation is a major cost factor for the first 100MW but it will allow for projects to scale up and costs for the connection per MW of capacity will fall then. Through the consortium, we will also develop joint infrastructure for future desalination of seawater, which will be needed for expansion stages from about 300MW onwards.

Green H2 plans at Lubmin	*MW*
Developer	**Capacity**
Apex (former HH2E project)	100-1,000
Apex	100-600
Deutsche ReGas	200-500
Lhyfe	800
PtX Development	210-1,050

What are the next steps for your projects in Lubmin?
Compared with the other developers in Lubmin, we have the advantage that our original project there is receiving funding as an IPCEI. We got the funding originally for our project in Rostock-Laage, but transferred it to Lubmin. We are now preparing the site for future construction, are deciding on the electrolysis technology and a partner for this and are finalising financing models. Then we can go into final negotiations with offtakers. Securing an offtaker is of course the Holy Grail, because it allows us to take a final investment decision (FID).

We are still a rather small company, with 160 employees, and do not have the same balance sheets as bigger players, so we are also looking for a partner to realise the project. The project will cost about €300mn-400mn ($341mn-454mn), including all auxiliary infrastructure. The project we took over from HH2E is further along when it comes to permitting, but commercially the plans for the other project are more advanced, as we have offtake deals close to being finalised.

So does the original Lubmin project replace your plans in Rostock-Laage?
No. We are also still building a project in Rostock-Laage. But it is not clear at the moment when we would get a pipeline connection there, hence the link to the hydrogen backbone. [Gas transport system operator] Ontras has not been able to give us planning security with regard to when we will be connected. But we need to avail the IPCEI funding within a certain timeframe, and this is why we said we transfer it to Lubmin where the infrastructure, including the pipeline connection,

INTERVIEW

is there. The shift was possible because the two plants are in the same federal state and have the same scope of 100MW. The funding amount of €167.2mn will be unchanged.

It seems surprising that even with large funding, many of the IPCEIs have still not reached an FID. Why is that? Is it because of difficulties securing offtake?
Yes. Also, the conditions attached to the funding are quite demanding, especially for a rather small company like ours. We have to work with guarantees and have to stick to specific rules in tender processes, for example for electrolyser suppliers. It requires an enormous amount of documentation, because we need to constantly justify how the taxpayers' money has been used. So there is very strict controlling and a large 'downside protection'.

'The IPCEI funding is a big boon for us, and it has drawn massive interest from the market that we have a project at this location with such funding'

At the same time, the amount of money we can earn with the project is capped. There is a clawback mechanism, which means that if my returns for the project exceed 8.03pc, I have to pay back some of the public funds. That is a challenge for potential investors that have different expectations for the returns on a project. Nonetheless, the IPCEI funding is a big boon for us, and it has drawn massive interest from the market that we have a project at this location with such funding. That is why we are convinced there is a high likelihood that we will be able to implement the project.

Has there been a shift in terms of potential offtakers?
Yes. For a long time steel was a very interesting market that was to provide somewhat of a 'floor'. So when all the steel firms would shift to greener production, they would provide the base offtake and create a market pull. This has changed a little, as the steel market has not developed as everyone expected and steelmakers' competitiveness would be jeopardised further through green hydrogen use. That said, we also see there is an interest to finish those projects that have been started already.

'We are now seeing the refineries as the target corridor to which we want to deliver most of the hydrogen, supported by Germany's greenhouse gas quotas'

But still, we are now seeing the refineries as the target corridor to which we want to deliver most of the hydrogen, supported by mechanisms such as Germany's greenhouse gas quotas. We are also negotiating with traditional traders, so gas traders which have traded methane for many years and are looking to move step by step towards hydrogen to deliver this to their customers.

How is the EPC side of your business progressing?
We currently still have four projects that we are working on, and are participating in tenders for more. But we also realise that not many projects are advancing as we had expected. Last year, when the IPCEI awards were made, we thought, 'OK, now there are 52 projects in the market', and expected at least 20-30 of these should in some shape or form register their interest in our EPC services. But in fact, so far it has only been three, one of which is now on hold. Still, we see synergies as our EPC teams are working together with our own project development teams and are supporting one another. This helps with the planning of our own projects.

Are you leaning towards any specific electrolysis technology or provider?
We are generally totally agnostic, but in the IPCEI context we lean towards working with German suppliers. That makes sense from a political perspective and with a view to using local content, even though it is not officially prescribed. Also, we will have long-term supply agreements that we need to deliver on so we need technology providers that can provide 'back-to-back' security for this. That makes it harder to look overseas.

IN BRIEF

Finnish hydrogen site pivots to e-methanol

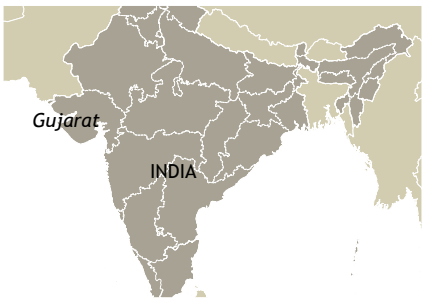
Developer Koppo Energia has appointed Germany's Thyssenkrupp Uhde to design a methanol synthesis plant for a renewable hydrogen project in Kristinestad, Finland, as it has shifted its focus from e-methane to e-methanol and e-gasoline for "market offtake reasons". Koppo says it plans to produce up to 450 t/d, or about 164,000 t/yr, of e-methanol using CO_2 captured from a waste incineration facility. Koppo is a joint venture between renewables firm Clean Power Company (CPC) Finland and German asset manager Prime Capital. It has secured "a number of term sheets" with customers for e-methanol, CPC chief executive Erik Trast says.

Engie to upgrade Dutch power plant for H2, seeks supply

French energy firm Engie has announced it will invest more than €40mn ($45.5mn) to modernise the second turbine of the Maxima gas power plant in the Netherlands and make it capable of co-firing up to 50pc hydrogen, but its hydrogen supply is "pending". The work will be completed in early 2027, and would make the facility the first power plant in the country to be capable of co-firing up to 50pc hydrogen, Engie says. Maxima's first turbine was upgraded to allow co-firing hydrogen in 2023. Hydrogen supply and the infrastructure to connect the site near Lelystad is still uncertain, Engie says, adding that it is keen to start "discussions" with the "government and partners" about hydrogen infrastructure and supply.

RIL to build 3GW grid network for green H2 in Gujarat

India's Gujarat



Indian conglomerate Reliance Industries (RIL) has been selected by PFC Consulting — a subsidiary of state-run Power Finance (PFC) — to develop power transmission infrastructure to facilitate renewable hydrogen and ammonia production in Kandla, Gujarat. The award followed a tariff-based bidding process launched in October for setting up 3GW of transmission capacity between Halvad and Kandla. The project includes turnkey construction of a substation at Kandla with transformers, reactors and a 765kV transmission line. Reliance's own hydrogen plans could benefit from the new transmission capacity. The company says it holds 2,000 acres in Kandla, where a "green hydrogen ecosystem could come in".

India delays green NH3 tender again, amendments expected

India has once again extended the bid submission deadline for its renewable ammonia supply tender, pushing it back by more than two weeks to 20 May, according to the organiser, the state-owned Solar Energy Corporation of India (SECI). Launched in June last year, the tender has faced repeated delays and strong pushback from fertiliser companies. SECI issued amendments last month, but several key concerns remain unresolved. SECI is awaiting further amendments to the tender from the Ministry of New and Renewable Energy, particularly regarding a payment security mechanism, a government official tells *Argus*.

Tokyo to run second trial H2 exchange market

Japan's capital city Tokyo plans a second trial run for a renewable hydrogen exchange market for delivery of supply in July-September. Japan Exchange Group's Tokyo Commodity Exchange (Tocom), on behalf of the Tokyo Metropolitan Government, will hold a tender for suppliers on 14 May and one for buyers within the city on 30 May. Tocom expects to decide the winners by 2 June and will then ask them to sign a supply agreement in the same month. As in a first trial in January-March this year, gaseous renewable hydrogen will be delivered in cargo trailers with 2,484Nm³ capacity or 263Nm³ cylinders on a weekly basis, with Tokyo to cover the gap between sales and purchase prices.

ANNOUNCEMENT

Proposed changes to and discontinuation of modelled hydrogen and ammonia production costs

Argus proposes changes to its calculated hydrogen and ammonia production costs to better align with developing industry conditions. Under this proposal:

- Costs for "island renewables", electrolysis projects connected to dedicated renewable power assets, would be calculated for specific, optimal locations within each country and not as national averages. The new locational costs would replace national values and would be backfilled to 5 January 2021 using historical assumptions. Historical country-average series would be available for bulk download but would no longer be available on Argus Direct. Regional averages would change accordingly.
- *Argus* would update project financing assumptions for "island renewables" and power purchase agreement (PPA)-based grid-connected electrolysis projects. Revised costs for PPA-based projects would be backfilled to the series' start date of 25 June 2024 for consistency. Historical costs would be available for bulk download.
- Costs for all grid-connected electrolysis projects that are not based on electricity supply via PPAs would be discontinued.
- SMR, SMR+CCS and ATR+CCS hydrogen and ammonia production costs in the Middle East based on LNG prices would also be discontinued.

For a complete list of affected cost series, contact Stefan Krumpelmann at stefan.krumpelmann@argusmedia.com.

Argus will accept comments on these proposed changes until 20 May. To comment on these proposals, please contact Stefan Krumpelmann at stefan.krumpelmann@argusmedia.com or +49 40 82210498. Formal comments should be marked as such and may be submitted by email to hff@argusmedia.com and received by 20 May. Please note, formal comments will be published after the consultation period unless confidentiality is specifically requested.

Argus Hydrogen and Future Fuels Data & Downloads

Argus Hydrogen and Future Fuels subscribers can access the full range of data available to the service through the Data & Downloads section of Argus Direct or by clicking on the links below.

- Global cross-border offtake agreements for low-carbon hydrogen and derivatives
- Global e-Methanol production facilities
- Global electrolyser orders
- Global electrolyser manufacturing capacity
- Global planned ammonia cracking facilities
- Global hydrogen production and electrolyser capacity targets
- Global renewable hydrogen-based SAF production sites
- Global hydrogen production and consumption targets by company
- Global hydrogen subsidy auctions tracker
- Global planned hydrogen DRI steelmaking plants
- Global planned and operational synthetic natural gas plants
- Global LOHC and liquid hydrogen seaborne transport plans
- EU member state implementation of RED III renewable hydrogen targets
- Indian state targets and policy incentives for hydrogen
- Bid prices in China Energy Engineering hydrogen electrolyser supply tenders

COMPLETE HYDROGEN PRODUCTION COSTS

No-C Hydrogen									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands	Wind + PEM	Green	€/kg	7.26	8.23	nc	4.57	5.18	nc
Netherlands	Grid + PPA + ALK	Green	€/kg	7.78	8.82	-0.02	5.29	6.00	-0.02
UK	Wind + PEM	Green	£/kg	6.08	8.09	nc	3.69	4.91	nc
UK	Grid + PPA + ALK	Green	£/kg	7.44	9.91	+0.13	5.24	6.98	+0.13
Germany	Wind + PEM	Green	€/kg	7.29	8.27	nc	4.55	5.16	nc
Germany	Grid + PPA + ALK	Green	€/kg	7.44	8.44	-0.02	4.92	5.58	-0.02
France	Wind + PEM	Green	€/kg	7.61	8.63	nc	4.76	5.40	nc
France	Grid + PPA + ALK	Green	€/kg	7.81	8.85	+0.05	5.18	5.87	+0.06
Spain	Diurnal + PEM	Green	€/kg	5.71	6.47	nc	3.15	3.57	nc
Spain	Grid + PPA + ALK	Green	€/kg	6.27	7.11	+0.03	3.60	4.08	+0.03
Italy	Grid + PPA + ALK	Green	€/kg	8.55	9.69	+0.04	5.46	6.19	+0.04
Portugal	Grid + PPA + ALK	Green	€/kg	6.01	6.81	+0.03	3.47	3.93	+0.02
US west coast	Diurnal + PEM	Green	$/kg	6.62	6.62	nc	4.03	4.03	nc
Canada	Wind + PEM	Green	C$/kg	11.23	8.13	nc	6.99	5.06	nc
Oman	Diurnal + PEM	Green	$/kg	6.30	6.30	nc	3.33	3.33	nc
Saudi Arabia	Diurnal + PEM	Green	$/kg	6.05	6.05	nc	3.38	3.38	nc
UAE	Diurnal + PEM	Green	$/kg	5.65	5.65	nc	3.22	3.22	nc
Qatar	Diurnal + PEM	Green	$/kg	6.07	6.07	nc	3.52	3.52	nc
Namibia	Diurnal + PEM	Green	$/kg	7.35	7.35	nc	3.70	3.70	nc
South Africa	Diurnal + PEM	Green	$/kg	7.04	7.04	nc	3.79	3.79	nc
Japan	Wind + PEM	Green	¥/kg	2,360	16.39	nc	1,876	13.03	nc
China	Diurnal + PEM	Green	Yn/kg	32.72	4.50	nc	19.78	2.72	nc
India	Diurnal + PEM	Green	Rs/kg	559.35	6.61	nc	297.87	3.52	nc
South Korea	Wind + PEM	Green	W/kg	21,812	15.48	nc	17,275	12.26	nc
Vietnam	Wind + PEM	Green	$/kg	9.72	9.72	nc	5.68	5.68	nc
Australia	Diurnal + PEM	Green	A$/kg	9.80	6.30	nc	5.73	3.68	nc
Brazil	Diurnal + PEM	Green	$/kg	6.85	6.85	nc	3.53	3.53	nc
Chile	Diurnal + PEM	Green	$/kg	6.48	6.48	nc	3.71	3.71	nc

Low-C hydrogen									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands	ATR + CCS	Blue	€/kg	4.02	4.56	-0.07	2.95	3.35	-0.07
UK	ATR + CCS	Blue	£/kg	3.45	4.60	-0.11	2.49	3.31	-0.11
Germany	ATR + CCS	Blue	€/kg	4.04	4.58	-0.09	2.95	3.35	-0.09
Spain	ATR + CCS	Blue	€/kg	4.04	4.58	-0.03	2.70	3.06	-0.03
France	ATR + CCS	Blue	€/kg	3.80	4.31	-0.13	2.65	3.00	-0.13
US Gulf coast	ATR + CCS	Blue	$/kg	2.71	2.71	+0.07	1.49	1.49	+0.07
Canada	ATR + CCS	Blue	C$/kg	3.20	2.32	-0.04	1.53	1.11	-0.03
Japan	ATR + CCS	Blue	¥/kg	734	5.10	-0.15	537	3.73	-0.15
South Korea	ATR + CCS	Blue	W/kg	7,059	5.01	-0.09	5,227	3.71	-0.08
Australia	ATR + CCS	Blue	A$/kg	5.94	3.82	+0.06	4.03	2.59	+0.06
Trinidad	ATR + CCS	Blue	$/kg	4.56	4.56	-0.07	2.70	2.70	-0.07
Qatar	ATR + CCS	Blue	$/kg	3.91	3.91	-0.09	2.67	2.67	-0.09
UAE	ATR + CCS	Blue	$/kg	4.08	4.08	-0.10	2.91	2.91	-0.09
Russia west	ATR + CCS	Blue	$/kg	3.19	3.19	nc	1.11	1.11	-0.01
Russia east	ATR + CCS	Blue	$/kg	3.12	3.12	nc	1.04	1.04	nc

COMPLETE HYDROGEN PRODUCTION COSTS

BAT+ hydrogen									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands	SMR + CCS	Blue	€/kg	3.15	3.57	-0.08	2.56	2.90	-0.08
UK	SMR + CCS	Blue	£/kg	2.60	3.46	-0.10	2.07	2.75	-0.10
Germany	SMR + CCS	Blue	€/kg	3.17	3.59	-0.09	2.57	2.91	-0.09
Spain	SMR + CCS	Blue	€/kg	3.18	3.60	-0.05	2.43	2.76	-0.05
France	SMR + CCS	Blue	€/kg	3.04	3.45	-0.12	2.41	2.73	-0.12
US Gulf coast	SMR + CCS	Blue	$/kg	1.76	1.76	+0.05	1.08	1.08	+0.04
Canada	SMR + CCS	Blue	C$/kg	2.20	1.59	-0.04	1.27	0.92	-0.04
Japan	SMR + CCS	Blue	¥/kg	541	3.76	-0.10	432	3.00	-0.10
South Korea	SMR + CCS	Blue	W/kg	5,227	3.71	-0.08	4,213	2.99	-0.08
Australia	SMR + CCS	Blue	A$/kg	4.37	2.81	+0.12	3.31	2.13	+0.12
Trinidad	SMR + CCS	Blue	$/kg	3.33	3.33	-0.07	2.31	2.31	-0.07
Qatar	SMR + CCS	Blue	$/kg	2.98	2.98	-0.09	2.29	2.29	-0.09
UAE	SMR + CCS	Blue	$/kg	2.99	2.99	-0.09	2.34	2.34	-0.09
Russia west	SMR + CCS	Blue	$/kg	1.93	1.93	nc	0.78	0.78	nc
Russia east	SMR + CCS	Blue	$/kg	1.88	1.88	+0.01	0.73	0.73	nc

BAT+ hydrogen							6 May
				Excl. capex			
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	
Netherlands	SMR + CCS retrofit	Blue	€/kg	2.87	3.25	-0.08	
UK	SMR + CCS retrofit	Blue	£/kg	2.28	3.04	-0.09	
Germany	SMR + CCS retrofit	Blue	€/kg	2.86	3.24	-0.08	
Spain	SMR + CCS retrofit	Blue	€/kg	2.72	3.08	-0.05	
France	SMR + CCS retrofit	Blue	€/kg	2.71	3.07	-0.12	
US Gulf coast	SMR + CCS retrofit	Blue	$/kg	1.34	1.34	+0.04	
Canada	SMR + CCS retrofit	Blue	C$/kg	1.77	1.28	-0.04	
Japan	SMR + CCS retrofit	Blue	¥/kg	448	3.11	-0.10	
South Korea	SMR + CCS retrofit	Blue	W/kg	4,396	3.12	-0.09	
Australia	SMR + CCS retrofit	Blue	A$/kg	3.69	2.37	+0.12	
Trinidad	SMR + CCS retrofit	Blue	$/kg	2.48	2.48	-0.07	
Qatar	SMR + CCS retrofit	Blue	$/kg	2.49	2.49	-0.10	
UAE	SMR + CCS retrofit	Blue	$/kg	2.54	2.54	-0.09	
Russia west	SMR + CCS retrofit	Blue	$/kg	0.97	0.97	nc	
Russia east	SMR + CCS retrofit	Blue	$/kg	0.92	0.92	nc	

BAT+ hydrogen											6 May
					Incl. capex			Excl. capex			
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr	
Australia	Coal gasification + CCS	5,500	Blue	A$/kg	5.77	3.71	-0.04	3.84	2.47	-0.04	
Australia	Coal gasification + CCS	6,000	Blue	A$/kg	6.04	3.88	-0.03	4.11	2.64	-0.04	
China	Coal gasification + CCS	3,800	Blue	Yn/kg	30.25	4.16	-0.01	20.65	2.84	-0.01	
China	Coal gasification + CCS	5,500	Blue	Yn/kg	29.23	4.02	-0.01	19.63	2.70	nc	
Indonesia	Coal gasification + CCS	5,500	Blue	$/kg	4.06	4.06	nc	2.57	2.57	nc	
Indonesia	Coal gasification + CCS	3,800	Blue	$/kg	3.93	3.93	nc	2.44	2.44	-0.01	
South Africa	Coal gasification + CCS	4,800	Blue	$/kg	4.22	4.22	nc	2.51	2.51	nc	
South Africa	Coal gasification + CCS	6,000	Blue	$/kg	4.34	4.34	+0.01	2.63	2.63	+0.02	
Russia west	Coal gasification + CCS	6,000	Blue	$/kg	3.89	3.89	nc	2.01	2.01	+0.01	
US east coast	Coal gasification + CCS	6,000	Blue	$/kg	3.66	3.66	-0.02	2.43	2.43	-0.02	

COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands	SMR	Grey	€/kg	3.12	3.54	-0.07	2.62	2.97	-0.08
UK	SMR	Grey	£/kg	2.47	3.29	-0.09	2.02	2.69	-0.09
Germany	SMR	Grey	€/kg	3.14	3.56	-0.08	2.64	2.99	-0.08
Spain	SMR	Grey	€/kg	3.12	3.54	-0.04	2.50	2.84	-0.04
France	SMR	Grey	€/kg	3.01	3.41	-0.12	2.47	2.80	-0.12
US Gulf coast	SMR	Grey	$/kg	1.38	1.38	+0.05	0.81	0.81	+0.04
Canada	SMR	Grey	C$/kg	2.28	1.65	-0.04	1.49	1.08	-0.04
Japan	SMR	Grey	¥/kg	422	2.93	-0.10	330	2.29	-0.10
South Korea	SMR	Grey	W/kg	4,114	2.92	-0.09	3,255	2.31	-0.09
Australia	SMR	Grey	A$/kg	3.59	2.31	+0.12	2.71	1.74	+0.13
Trinidad	SMR	Grey	$/kg	2.78	2.78	-0.07	1.91	1.91	-0.07
Qatar	SMR	Grey	$/kg	2.60	2.60	-0.09	2.02	2.02	-0.09
UAE	SMR	Grey	$/kg	2.61	2.61	-0.10	2.07	2.07	-0.09
Russia west	SMR	Grey	$/kg	1.48	1.48	nc	0.51	0.51	nc
Russia east	SMR	Grey	$/kg	1.43	1.43	+0.01	0.46	0.46	nc

Baseline hydrogen									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands	Grid + ALK	Yellow	€/kg	8.84	10.02	+0.15	6.64	7.53	+0.15
Netherlands	Grid + PEM	Yellow	€/kg	8.70	9.86	+0.14	6.33	7.18	+0.14
UK	Grid + ALK	Yellow	£/kg	8.42	11.21	-0.14	6.50	8.65	-0.14
UK	Grid + PEM	Yellow	£/kg	8.24	10.97	-0.13	6.16	8.20	-0.14
Germany	Grid + ALK	Yellow	€/kg	8.55	9.69	+0.04	6.32	7.16	+0.04
Germany	Grid + PEM	Yellow	€/kg	8.41	9.54	+0.03	6.01	6.81	+0.03
France	Grid + ALK	Yellow	€/kg	5.73	6.50	-0.09	3.44	3.90	-0.08
France	Grid + PEM	Yellow	€/kg	5.82	6.60	-0.08	3.34	3.79	-0.08
Spain	Grid + ALK	Yellow	€/kg	6.47	7.33	+0.53	3.97	4.50	+0.53
Spain	Grid + PEM	Yellow	€/kg	6.53	7.40	+0.50	3.82	4.33	+0.49
US west coast	Grid + ALK	Yellow	$/kg	6.84	6.84	+0.81	4.33	4.33	+0.81
US west coast	Grid + PEM	Yellow	$/kg	6.89	6.89	+0.75	4.19	4.19	+0.75
US Midwest	Grid + ALK	Yellow	$/kg	7.53	7.53	+0.71	5.02	5.02	+0.71
US Midwest	Grid + PEM	Yellow	$/kg	7.54	7.54	+0.66	4.84	4.84	+0.66
US east coast	Grid + ALK	Yellow	$/kg	7.85	7.85	+0.31	5.34	5.34	+0.31
US east coast	Grid + PEM	Yellow	$/kg	7.84	7.84	+0.29	5.13	5.13	+0.29
Japan	Grid + ALK	Yellow	¥/kg	1,276	8.86	-0.97	888	6.17	-0.97
Japan	Grid + PEM	Yellow	¥/kg	1,264	8.78	-0.91	847	5.88	-0.90

COMPLETE HYDROGEN PRODUCTION COSTS

Hydrogen decarbonisation spreads				6 May
	Incl. capex		Excl. capex	
	$/kg	± 29 Apr	$/kg	± 29 Apr
Northwest Europe				
No-C to BAT+	4.84	+0.09	2.40	+0.09
Low-C to BAT+	0.94	-0.01	0.38	-0.01
BAT+ to baseline	0.04	nc	-0.07	nc
North America				
No-C to BAT+	5.70	-0.01	3.55	nc
Low-C to BAT+	0.84	+0.01	0.30	+0.02
BAT+ to baseline	0.16	nc	0.05	nc
Northeast Asia				
No-C to BAT+	8.38	+0.09	6.34	+0.09
Low-C to BAT+	1.32	-0.03	0.72	-0.03
BAT+ to baseline	0.81	nc	0.70	+0.01
Middle East				
No-C to BAT+	3.03	+0.09	1.04	+0.09
Low-C to BAT+	1.01	nc	0.47	nc
BAT+ to baseline	0.38	nc	0.27	nc
Net exporter				
No-C to BAT+	3.88	nc	1.68	+0.01
Low-C to BAT+	0.99	-0.02	0.46	nc
BAT+ to baseline	0.41	nc	0.30	-0.01

Decarbonisation spreads relevant for subsidy mechanisms							6 May
		Incl. capex			Excl. capex		
	Unit	Spread	Spread in $/kg	± 29 Apr	Spread	Spread in $/kg	± 29 Apr
France							
No-C to Baseline[1]	€/kg	4.60	5.22	+0.12	2.29	2.60	+0.12
Germany							
No-C to BAT+[2]	€/kg	4.13	4.68	+0.09	1.98	2.25	+0.09
Netherlands							
No-C to baseline[3]	€/kg	4.14	4.69	+0.07	1.95	2.21	+0.08

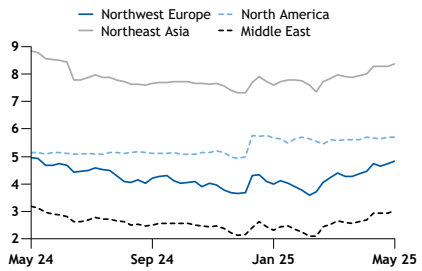
Differentials between the costs of renewable and natural gas-based hydrogen are used in subsidy mechanisms to establish the cost of switching to supply with a lower emissions intensity. The spreads above are relevant for the following:

1 France's planned operational support scheme for renewable hydrogen plants

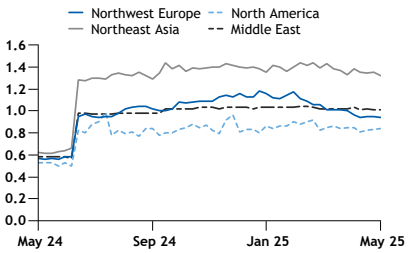
2 Future supply to Thyssenkrupp's direct reduced iron plant in Duisburg

3 Operational support granted to selected projects in Dutch subsidy scheme

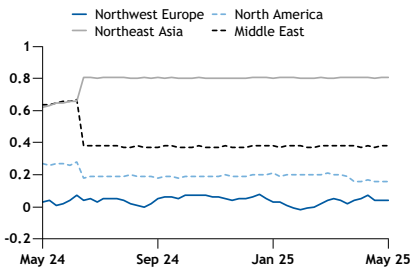
Decarb spread No-C to BAT+ $/kg



Decarb spread Low-C to BAT+ $/kg



Decarb spread BAT+ to baseline $/kg

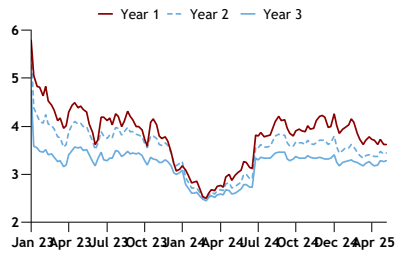


COMPLETE HYDROGEN PRODUCTION COSTS

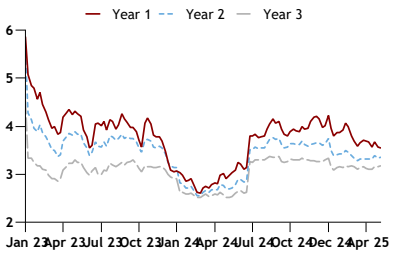
Low-C hydrogen forward									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands									
2026	ATR + CCS	Blue	€/kg	4.05	4.59	-0.01	2.98	3.38	-0.01
2027	ATR + CCS	Blue	€/kg	3.85	4.36	+0.02	2.78	3.15	+0.02
2028	ATR + CCS	Blue	€/kg	3.66	4.15	+0.02	2.59	2.94	+0.02
UK									
2026	ATR + CCS	Blue	£/kg	3.54	4.72	-0.03	2.58	3.43	-0.03
2027	ATR + CCS	Blue	£/kg	3.42	4.56	+0.02	2.46	3.27	+0.03
Germany									
2026	ATR + CCS	Blue	€/kg	4.12	4.67	-0.02	2.61	3.44	-0.02
2027	ATR + CCS	Blue	€/kg	3.93	4.46	+0.02	3.03	3.23	+0.02
2028	ATR + CCS	Blue	€/kg	3.75	4.25	+0.01	2.85	3.02	+0.01
France									
2026	ATR + CCS	Blue	€/kg	3.99	4.52	-0.01	2.83	3.21	-0.01
Spain									
2026	ATR + CCS	Blue	€/kg	4.16	4.72	-0.01	2.82	3.20	-0.01

BAT+ hydrogen forward									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands									
2026	SMR + CCS	Blue	€/kg	3.13	3.55	-0.01	2.54	2.88	-0.01
2027	SMR + CCS	Blue	€/kg	2.95	3.35	+0.02	2.36	2.68	+0.02
2028	SMR + CCS	Blue	€/kg	2.80	3.17	+0.02	2.21	2.50	+0.02
UK									
2026	SMR + CCS	Blue	£/kg	2.70	3.59	-0.03	2.16	2.88	-0.03
2027	SMR + CCS	Blue	£/kg	2.61	3.47	+0.03	2.07	2.75	+0.02
Germany									
2026	SMR + CCS	Blue	€/kg	3.21	3.64	-0.01	2.61	2.96	-0.01
2027	SMR + CCS	Blue	€/kg	3.04	3.45	+0.01	2.44	2.77	+0.01
2028	SMR + CCS	Blue	€/kg	2.89	3.28	+0.01	2.29	2.60	+0.01
France									
2026	SMR + CCS	Blue	€/kg	3.11	3.53	-0.01	2.48	2.81	-0.01
Spain									
2026	SMR + CCS	Blue	€/kg	3.20	3.63	-0.02	2.46	2.79	-0.02

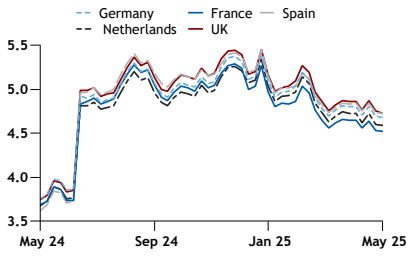
German SMR costs $/kg



Dutch SMR+CCS costs $/kg



European year 1 ATR+CCS costs $/kg



COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen forward									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 29 Apr	Cost	Cost in $/kg	± 29 Apr
Netherlands									
2026	SMR	Grey	€/kg	3.10	3.52	-0.01	2.61	2.96	-0.01
2027	SMR	Grey	€/kg	2.95	3.34	+0.03	2.45	2.78	+0.03
2028	SMR	Grey	€/kg	2.80	3.17	+0.02	2.30	2.61	+0.02
UK									
2026	SMR	Grey	£/kg	2.62	3.49	-0.02	2.17	2.89	-0.02
2027	SMR	Grey	£/kg	2.54	3.38	+0.03	2.09	2.78	+0.03
Germany									
2026	SMR	Grey	€/kg	3.18	3.61	-0.01	2.68	3.04	-0.01
2027	SMR	Grey	€/kg	3.03	3.44	+0.02	2.53	2.87	+0.02
2028	SMR	Grey	€/kg	2.89	3.28	+0.01	2.39	2.71	+0.02
France									
2026	SMR	Grey	€/kg	3.09	3.50	-0.01	2.55	2.89	-0.01
Spain									
2026	SMR	Grey	€/kg	3.16	3.58	-0.01	2.54	2.88	nc

Direct reduction iron costs (2 May)		*$/t*
Specification	**Cost**	**±**
Natural gas DRI, ex-works NW Europe	377.60	+0.56
DRI spread No-C hydrogen (renewables+PEM) vs natural gas NW Europe	400.16	-1.40
DRI spread BAT+ hydrogen (SMR+CCS) vs natural gas NW Europe	124.66	-8.36

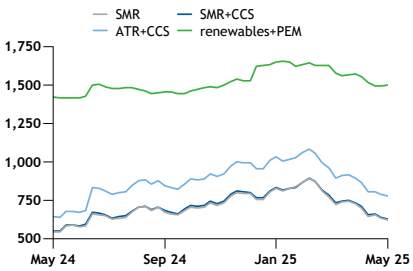
COMPLETE AMMONIA PRODUCTION COSTS

Argus liquid ammonia taxonomy (for calculated costs)	
	tCO2e/tNH3
Baseline	<1.93, >1.37
BAT+	<0.49, >0.17
Low-C	<0.17, >0.09
No-C	<0.01

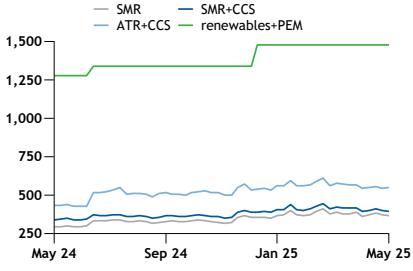
CO2e emissions on a gate-to-gate basis; purity >99.5pc; temperature -33°C

Regional ammonia cost markers						6 May
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 29 Apr	Cost	± 29 Apr
Baseline						
Northwest Europe	SMR	€/t	624	-11	467	-12
Northwest Europe	SMR	$/t	708	-15	529	-16
North America	SMR	$/t	369	-1	195	-1
Northeast Asia	SMR	$/t	609	-15	416	-16
Middle East	SMR	$/t	530	-16	370	-15
BAT+						
Northwest Europe	SMR+CCS	€/t	630	-11	456	-12
Northwest Europe	SMR+CCS	$/t	714	-16	517	-16
North America	SMR+CCS	$/t	397	-1	205	-1
Northeast Asia	SMR+CCS	$/t	753	-16	541	-15
Middle East	SMR+CCS	$/t	595	-16	418	-16
Low-C						
Northwest Europe	ATR+CCS	€/t	777	-11	509	-13
Northwest Europe	ATR+CCS	$/t	881	-17	577	-17
North America	ATR+CCS	$/t	548	+1	252	+1
Northeast Asia	ATR+CCS	$/t	986	-20	658	-20
Middle East	ATR+CCS	$/t	770	-16	497	-16
No-C						
Northwest Europe	Island renewable+PEM	€/t	1,500	+7	923	+5
Northwest Europe	Island renewable+PEM	$/t	1,701	nc	1,046	nc
North America	Island renewable+PEM	$/t	1,480	nc	902	nc
Northeast Asia	Island renewable+PEM	$/t	2,390	nc	1,799	nc
Middle East	Island renewable+PEM	$/t	1,179	nc	641	nc
Exporter						
Exporter baseline	SMR	$/t	475	nc	307	nc
Exporter BAT+	SMR+CCS	$/t	546	-1	361	nc
Exporter low-C	ATR+CCS	$/t	721	-3	435	-3
Exporter no-C	Island renewable+PEM	$/t	1,287	nc	701	nc

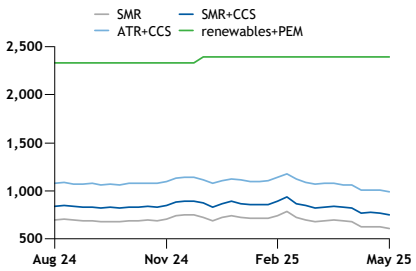
NW Europe ammonia average €/t



North America ammonia average $/t



Northeast Asia ammonia average $/t



COMPLETE AMMONIA PRODUCTION COSTS

No-C ammonia									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 29 Apr	Cost	Cost in $/t	± 29 Apr
Netherlands	Wind + PEM	Green	€/t	1,481	1,679	nc	919	1,042	nc
UK	Wind + PEM	Green	£/t	1,232	1,640	nc	728	969	nc
Germany	Wind + PEM	Green	€/t	1,473	1,670	nc	901	1,021	nc
France	Wind + PEM	Green	€/t	1,548	1,755	nc	949	1,076	nc
Spain	Diurnal + PEM	Green	€/t	1,133	1,285	nc	613	695	nc
US west coast	Diurnal + PEM	Green	$/t	1,309	1,309	nc	793	793	nc
Canada	Wind + PEM	Green	C$/t	2,280	1,651	nc	1,395	1,010	nc
Oman	Diurnal + PEM	Green	$/t	1,246	1,246	nc	633	633	nc
Saudi Arabia	Diurnal + PEM	Green	$/t	1,179	1,179	nc	642	642	nc
UAE	Diurnal + PEM	Green	$/t	1,103	1,103	nc	615	615	nc
Qatar	Diurnal + PEM	Green	$/t	1,186	1,186	nc	673	673	nc
Namibia	Diurnal + PEM	Green	$/t	1,474	1,474	nc	702	702	nc
South Africa	Diurnal + PEM	Green	$/t	1,392	1,392	nc	717	717	nc
Japan	Wind + PEM	Green	¥/t	462,493	3,212	nc	360,548	2,504	nc
China	Diurnal + PEM	Green	Yn/t	6,631	912	nc	3,803	523	nc
India	Diurnal + PEM	Green	Rs/t	109,924	1,299	nc	56,274	665	nc
South Korea	Wind + PEM	Green	W/t	4,291,887	3,046	nc	3,337,978	2,369	nc
Vietnam	Wind + PEM	Green	$/t	1,957	1,957	nc	1,083	1,083	nc
Australia	Diurnal + PEM	Green	A$/t	1,947	1,251	nc	1,136	730	nc
Brazil	Diurnal + PEM	Green	$/t	1,358	1,358	nc	669	669	nc
Chile	Diurnal + PEM	Green	$/t	1,263	1,263	nc	705	705	nc

Low-C ammonia									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 29 Apr	Cost	Cost in $/t	± 29 Apr
Netherlands	ATR + CCS	Blue	€/t	785	890	-13	527	598	-13
UK	ATR + CCS	Blue	£/t	674	897	-18	442	589	-19
Germany	ATR + CCS	Blue	€/t	792	898	-15	526	596	-15
Spain	ATR + CCS	Blue	€/t	811	920	-4	482	547	-4
France	ATR + CCS	Blue	€/t	755	856	-22	474	537	-22
US Gulf coast	ATR + CCS	Blue	$/t	575	575	+11	279	279	+11
Canada	ATR + CCS	Blue	C$/t	720	521	-8	311	225	-9
Japan	ATR + CCS	Blue	¥/t	143,701	998	-26	94,889	659	-26
South Korea	ATR + CCS	Blue	W/t	1,370,980	973	-14	925,729	657	-14
Australia	ATR + CCS	Blue	A$/t	1,198	770	+9	727	467	+8
Trinidad	ATR + CCS	Blue	$/t	952	952	-12	481	481	-13
Qatar	ATR + CCS	Blue	$/t	763	763	-16	476	476	-16
UAE	ATR + CCS	Blue	$/t	777	777	-16	517	517	-16
Russia west	ATR + CCS	Blue	$/t	735	735	nc	206	206	nc
Russia east	ATR + CCS	Blue	$/t	730	730	-1	201	201	-1

Low-carbon ammonia benchmarks			6 May
	Unit	Cost	± 29 Apr
JKLAB CFR Ulsan, South Korea, incl. US 45Q tax credit	$/t	568.00	+9.09
JKLAB CFR Ulsan, South Korea, excl. US 45Q tax credit	$/t	704.00	+9.09
JKLAB CFR Niihama, Japan, differential	$/t	+0.22	+0.03
EULAB CFR ARA, incl. 45Q US tax credit	$/t	498.87	+9.84
EULAB CFR ARA, excl. 45Q US tax credit	$/t	634.87	+9.84

The low-carbon ammonia benchmarks include the US Gulf coast Low-C ATR+CCS ammonia production cost (with and without the US' 45Q tax credit for carbon sequestration) and freight costs. Freight costs are for delivery to Ulsan, South Korea, for JKLAB and to Amsterdam-Rotterdam-Antwerp (ARA) for EULAB. For JKLAB, the Niihama differential reflects the cost difference for delivery to Niihama in Japan, rather than to Ulsan.

COMPLETE AMMONIA PRODUCTION COSTS

BAT+ ammonia										6 May
				Incl. capex			Excl. capex			
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 29 Apr	Cost	Cost in $/t	± 29 Apr	
Netherlands	SMR + CCS	Blue	€/t	632	716	-13	465	527	-13	
UK	SMR + CCS	Blue	£/t	523	697	-17	373	497	-17	
Germany	SMR + CCS	Blue	€/t	638	723	-14	465	527	-14	
Spain	SMR + CCS	Blue	€/t	654	742	-8	441	500	-8	
France	SMR + CCS	Blue	€/t	621	704	-20	438	497	-20	
US Gulf coast	SMR + CCS	Blue	$/t	404	404	+7	212	212	+8	
Canada	SMR + CCS	Blue	C$/t	537	389	-10	272	197	-10	
Japan	SMR + CCS	Blue	¥/t	109,432	760	-18	77,898	541	-17	
South Korea	SMR + CCS	Blue	W/t	1,049,723	745	-14	760,873	540	-14	
Australia	SMR + CCS	Blue	A$/t	918	590	+21	613	394	+21	
Trinidad	SMR + CCS	Blue	$/t	723	723	-12	418	418	-12	
Qatar	SMR + CCS	Blue	$/t	600	600	-16	414	414	-16	
UAE	SMR + CCS	Blue	$/t	590	590	-16	422	422	-16	
Russia west	SMR + CCS	Blue	$/t	497	497	nc	154	154	nc	
Russia east	SMR + CCS	Blue	$/t	490	490	nc	147	147	nc	

BAT+ ammonia											6 May
					Incl. capex			Excl. capex			
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/t	± 29 Apr	Cost	Cost in $/t	± 29 Apr	
Australia	Coal gasification + CCS	5,500	Blue	A$/t	1,147	737	-7	702	451	-7	
Australia	Coal gasification + CCS	6,000	Blue	A$/t	1,192	766	-5	747	480	-7	
China	Coal gasification + CCS	3,800	Blue	Yn/t	5,846	804	-2	3,636	500	-2	
China	Coal gasification + CCS	5,500	Blue	Yn/t	5,671	780	-2	3,461	476	nc	
Indonesia	Coal gasification + CCS	5,500	Blue	$/t	796	796	nc	452	452	nc	
Indonesia	Coal gasification + CCS	3,800	Blue	$/t	774	774	nc	430	430	-2	
South Africa	Coal gasification + CCS	4,800	Blue	$/t	841	841	nc	442	442	nc	
South Africa	Coal gasification + CCS	6,000	Blue	$/t	861	861	+2	463	463	+4	
Russia west	Coal gasification + CCS	6,000	Blue	$/t	798	798	nc	358	358	+1	
US east coast	Coal gasification + CCS	6,000	Blue	$/t	725	725	-4	443	443	-3	

Baseline ammonia									6 May
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 29 Apr	Cost	Cost in $/t	± 29 Apr
Netherlands	SMR	Grey	€/t	627	711	-12	475	539	-13
UK	SMR	Grey	£/t	500	666	-17	365	486	-16
Germany	SMR	Grey	€/t	632	717	-13	475	539	-14
Spain	SMR	Grey	€/t	646	732	-7	452	513	-7
France	SMR	Grey	€/t	615	697	-19	449	509	-20
US Gulf coast	SMR	Grey	$/t	338	338	+8	164	164	+8
Canada	SMR	Grey	C$/t	551	399	-10	312	226	-10
Japan	SMR	Grey	¥/t	88,121	612	-17	59,467	413	-17
South Korea	SMR	Grey	W/t	852,460	605	-14	590,381	419	-15
Australia	SMR	Grey	A$/t	778	500	+21	503	323	+21
Trinidad	SMR	Grey	$/t	623	623	-12	347	347	-12
Qatar	SMR	Grey	$/t	534	534	-16	366	366	-15
UAE	SMR	Grey	$/t	526	526	-16	374	374	-15
Russia west	SMR	Grey	$/t	416	416	nc	106	106	nc
Russia east	SMR	Grey	$/t	409	409	nc	99	99	nc

COMPLETE AMMONIA PRODUCTION COSTS

Ammonia decarbonisation spreads				6 May
	Incl. capex		Excl. capex	
	$/t	± 29 Apr	$/t	± 29 Apr
Northwest Europe				
No-C to BAT+	987	+16	529	+16
Low-C to BAT+	167	-1	60	-1
BAT+ to baseline	6	-1	-12	nc
North America				
No-C to BAT+	1,083	+1	697	+1
Low-C to BAT+	151	+2	47	+2
BAT+ to baseline	28	nc	10	nc
Northeast Asia				
No-C to BAT+	1,637	+16	1,258	+15
Low-C to BAT+	233	-4	117	-5
BAT+ to baseline	144	-1	125	+1
Middle East				
No-C to BAT+	584	+16	223	+16
Low-C to BAT+	175	nc	79	nc
BAT+ to baseline	65	nc	48	-1
Net exporter				
No-C to BAT+	741	+1	340	nc
Low-C to BAT+	175	-2	74	-3
BAT+ to baseline	71	-1	54	nc

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