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Argus Hydrogen and Future Fuels

Market news, analysis and prices

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Germany opts against green H2 mandates

Other EU countries might follow suit, lest they disadvantage their domestic industries, writes Stefan Krumpelmann

Germany will not set company-specific mandates to meet EU targets for renewable hydrogen use in industry, economy and climate protection ministry BMWK says — a decision that is bound to have knock-on effects for other member states.

"BMWK has decided that in Germany the RFNBO [renewable fuels of non-biological origin] industrial targets will not be passed on to companies through a corresponding company obligation or company-specific quota," the ministry tells *Argus*. Germany will instead aim to reach the binding goals through a number of subsidy measures targeting the demand side, it says.

The EU's revised Renewable Energy Directive (RED III) obliges member states to ensure that 42pc of all hydrogen used in industry is renewable by 2030, and 60pc by 2035, although certain exemptions apply for some sectors.

But these binding country-level goals do not have to be translated into company-specific targets and BMWK stresses that the directive gives countries leeway on how they intend to reach the targets. It named several mechanisms that would be deployed in pursuit of the targets, including carbon contracts-for-difference, H2Global auctions and direct subsidies for steel producers.

These mechanisms would arguably need to be bankrolled with billions of additional euros to help meet the RED III targets, given that the cost gap between renewable hydrogen and fossil-based supply is still very wide.

Germany could require over 250,000 t/yr of renewable hydrogen by 2030 to meet the 42pc industrial target, based on existing natural gas-based hydrogen consumption only, *Argus Consulting* forecasts. New use cases for hydrogen, such as in steelmaking, would lift this further. And Germany would also need to make sure that 1pc of all transport fuels used are RFNBOs under EU rules by 2030.

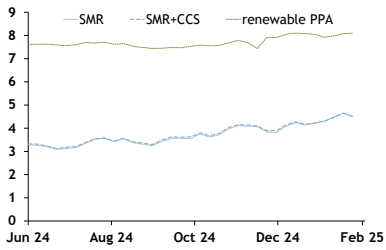
BMWK's decision against setting company-specific obligations follows recommendations from Germany's national hydrogen council, which has argued that such quotas could drive up renewable hydrogen costs and that many firms might not have physical access to supply by 2030.

Germany will hold federal elections on 23 February, but several German industry participants have indicated that they expect the current administration's decision to stand. They say the conservative CDU/CSU alliance, which is ahead in the polls, would probably not be inclined to change the approach.

The decision to not set mandates by the bloc's largest consumer of fossil-based hydrogen could steer other EU countries down the same path. Governments across Europe will not want to disadvantage their own domestic industries — specifically methanol and ammonia producers. Member states must transpose the RED III targets into national law by 21 May but the process is expected to be delayed in many countries, as governments have been hesitant to move first.

The Netherlands put forward a proposal for achieving the RED III renewable hydrogen use targets late last year, suggesting a combination of company-specific obligations and subsidy mechanisms. But The Hague left it open as to whether 2030 obligations should be set at 8pc or 24pc, noting that a final decision would take into account routes taken by other EU states, especially those in its immediate vicinity. If the Netherlands is the only country to introduce company-specific mandates, the lower 8pc obligation would be favourable as a higher limit could harm the competitive position of its industry, the government said at the time.

German H2 costs €/kg



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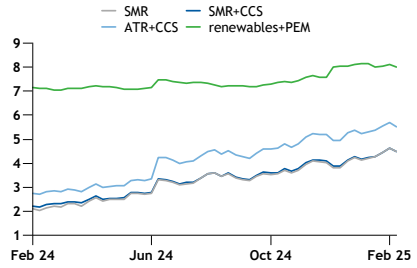
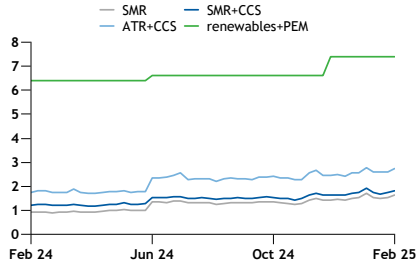
HYDROGEN COSTS

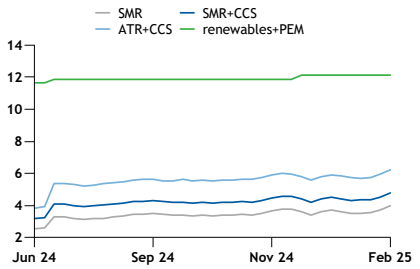
Northwest Europe average cost €/kg



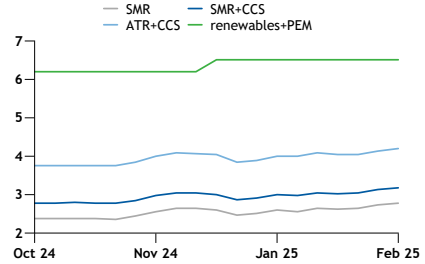
North America average cost $/kg



Northeast Asia average cost $/kg



Exporter average cost $/kg



Regional hydrogen cost markers						18 Feb
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 11 Feb	Cost	± 11 Feb
Baseline						
Northwest Europe	SMR	€/kg	4.48	-0.15	3.92	-0.15
Northwest Europe	SMR	$/kg	4.68	-0.11	4.10	-0.11
North America	SMR	$/kg	1.63	+0.10	1.07	+0.11
Northeast Asia	SMR	$/kg	3.98	+0.26	3.35	+0.26
Middle East	SMR	$/kg	3.57	+0.01	3.01	+0.01
BAT+						
Northwest Europe	SMR+CCS	€/kg	4.48	-0.14	3.82	-0.13
Northwest Europe	SMR+CCS	$/kg	4.68	-0.10	3.99	-0.10
North America	SMR+CCS	$/kg	1.83	+0.10	1.16	+0.11
Northeast Asia	SMR+CCS	$/kg	4.78	+0.26	4.04	+0.26
Middle East	SMR+CCS	$/kg	3.94	+0.01	3.28	+0.01
Low-C						
Northwest Europe	ATR+CCS	€/kg	5.52	-0.17	4.33	-0.15
Northwest Europe	ATR+CCS	$/kg	5.77	-0.12	4.52	-0.12
North America	ATR+CCS	$/kg	2.73	+0.12	1.51	+0.12
Northeast Asia	ATR+CCS	$/kg	6.19	+0.23	4.86	+0.24
Middle East	ATR+CCS	$/kg	4.98	+0.01	3.77	+0.01
No-C						
Northwest Europe	Island renewable+PEM	€/kg	8.02	-0.08	5.02	-0.05
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	2.77	+0.03	2.21	+0.04
Exporter BAT+	SMR+CCS	$/kg	3.18	+0.04	2.51	+0.04
Exporter low-C	ATR+CCS	$/kg	4.20	+0.06	2.99	+0.06
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			4 Feb
	Unit	Price	± 9 Jan
Japan			
Eneos	¥/kg	2,200.00	nc
Iwatani	¥/kg	1,650.00	nc
Germany			
H2Mobility (stations with “green” H2 supply)	€/kg	13.00	nc
H2Mobility (stations with conventional H2 supply)	€/kg	15.05-19.25	-1.35

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MARKET DEVELOPMENTS

EU's draft state aid rules underpin renewable H2 focus

Projects would no longer have to start up within 36 months of receiving state aid, giving developers more breathing space, writes Stefan Krumpelmann

The EU is planning to introduce permanent rules to simplify state aid for renewable hydrogen production and use and for electrolyser manufacturing, but a leaked communication document on the issue leaves out low-carbon hydrogen almost entirely.

The European Commission's draft document for the Clean Industry State Aid Framework (CISAF), seen by *Argus*, sets out "simplified compatibility rules" compared with existing guidelines.

Many provisions are in line with rules established in temporary measures drawn up in 2022 in response to the escalation of the Russia-Ukraine conflict — these were designed to accelerate the process and provide higher aid ceilings.

The 2022 framework expired last year and many of its provisions had set a 31 December 2025 deadline for the aid to be granted, while the new CISAF would be permanent and would not specify deadlines, according to the draft.

In line with the temporary measures, projects producing renewable fuels of non-biological origin (RFNBOs) — effectively renewable hydrogen and derivatives — could receive aid for up to 45pc of their eligible costs, including through direct grants, tax credits and reduced interest rates on new loans. This increases to 55pc for medium-sized companies and 65pc for small firms. It would also apply to storage sites, as long as they receive at least 75pc of their hydrogen from a directly connected production site.

In contrast to the temporary framework, the new rules would no longer require renewable hydrogen projects to start operations within 36 months of the aid being granted. Many hydrogen projects have taken longer to develop than initially planned and the rule change provides them with more flexibility.

Projects focused on generating electricity from hydrogen will continue to be considered ineligible under the CISAF.

The framework also features clauses that allow state aid for decarbonising industrial processes, including through use of hydrogen — such as using hydrogen as a replacement for natural gas. This would primarily be for RFNBOs but a sub-clause allows for some use of low-carbon hydrogen, which could include hydrogen produced with nuclear power or natural gas with carbon capture and storage. Projects involving low-carbon hydrogen use would still have "to use a share of renewable hydrogen equal to at least the average share of electricity from renewable sources in the member state concerned, as measured two years before the year in question plus 25 percentage points, or 90pc, whichever is lower", according to the document. This is the only reference to low-carbon hydrogen in the document.

Industrial decarbonisation projects could receive aid for up to half of their eligible costs — specifically capital expenditure on new equipment or machinery to facilitate the transition to hydrogen — rising to 55pc for medium-sized firms and 60pc for small companies.

Regeneration aim

The extent of potential state aid for electrolyser manufacturing would depend on where the factories are built, with the most generous support available in so-called assisted areas — those deemed economically disadvantaged. Support in these areas could reach 35pc of eligible costs, up to a maximum of €175mn ($183mn), while it is capped at 15pc and €75mn in non-assisted areas.

The CISAF would form part of the EU's Clean Industrial Deal, which is expected to be revealed on 26 February. But the rules still need to be put up for consultation and could change. Hydrogen industry participants have long called for state aid procedures to be accelerated, to help get the industry off the ground.

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MARKET DEVELOPMENTS

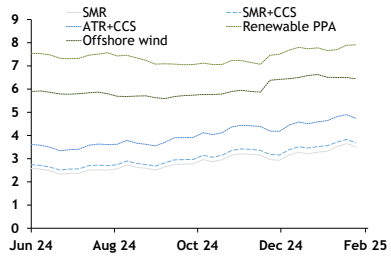
Frustration over delays to UK CCS and H2 programmes

The government's vague timetable — and failure to put its money where its mouth is — risks deterring vital private-sector investment, writes Aidan Lea

Firms are growing frustrated with the UK government over unclear timelines and inadequate funding for carbon capture and storage (CCS) and clean hydrogen projects. And while the UK has won praise for the design of its contracts-for-difference subsidies for electrolytic hydrogen and CCS systems to underpin low-carbon hydrogen from gas, not enough firms have been able to access the schemes.

"It's like building a great motorway with five lanes but few or no junctions," industry body OEUK head of policy Enrique Cornejo told the UK CCUS and Hydrogen Decarbonisation Summit in Leeds this month. "We have a great policy framework but we don't have access, apart from a very small number of projects." Cornejo welcomed a recent final investment decision (FID) for Teesside's CCS system, and progress on northwest England's HyNet cluster, which is due to reach an FID this year. But he urged London to set out funding and timelines for the Scottish Acorn and Humberside Viking CCS projects, which are supposed to be next in line. "It's been a really long wait for these projects and the risk is very clear that if we don't hear some positive news from the government" there could be "lost investment", he said.

UK H2 costs £/kg



It is a view shared by Norway's state-controlled Equinor, which owns 45pc of the Teesside CCS project and a portfolio of Humberside hydrogen proposals that are in limbo, having been overlooked in initial government selections. "Keeping projects on life support costs a lot of money," Equinor's UK low-carbon solutions director, Dan Sadler, said. The firm has spent "hundreds of millions" on its proposals for CCS-based and electrolytic hydrogen production, transport and storage infrastructure, he said. Sadler made the same appeal 12 months earlier and has still had no update on the process to let its CCS-hydrogen project advance.

Optimism about the "fantastic" Teesside FID and contracts signed with three electrolytic projects is tempered by concern that neither HyNet, nor any of the UK's CCS-based hydrogen plants, have reached an FID yet, Sadler said.

The UK missed its deadline to shortlist winners of its second hydrogen allocation round (HAR2) in 2024. Developers complain of a "standstill", while financiers echo the importance of HAR2's shortlist. "We're waiting with bated breath for HAR2 so we know which projects we can look to finance," the UK National Wealth Fund's banking and investment managing director, Emily Sidhu, said.

Applications for the UK's pipeline and storage scheme have slipped to the end of 2025, so it might be well into 2026 before projects are selected and years more until they are built. UK pipeline operators envy the government support that peers in continental Europe have enjoyed, a UK pipeline operator told *Argus*.

Emperor's new clothes

The funding appeals come as the Labour government that was elected last year reviews spending across all departments. Total costs for the UK's CCS and hydrogen ambitions are several times higher than the £21.7bn ($27.3bn) and £2bn, respectively, confirmed for the first rounds. Raising funds from the Treasury, the emissions trading system, or the gas shipper obligation are possibilities, but that is not enough certainty to reassure investors, Equinor's Sadler said.

Moreover, Labour has not said it will stick to the former Conservative government's targets. "People quote 10GW [of hydrogen production], four [CCS] clusters, and 30mn t/yr [of CO_2 sequestration] by 2030. That's the [Conservative] policy. Labour hasn't got a policy at the moment," Sadler said. Like "the *Emperor's New Clothes*", investors' belief in the UK cannot be sustained forever, he warned.

The UK's Department for Energy Security and Net Zero had not responded to *Argus*' questions about current hydrogen targets by the time of publication.

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MARKET DEVELOPMENTS

Second wind for Swedish e-fuels hopes

Plans are afoot for an e-methanol plant on the east coast and an e-SAF plant in the centre of the country, write Jethro Robathan, Pamela Machado and Aidan Lea

Fresh plans for e-fuels plants have emerged in Sweden, breathing new life into the country's hopes of becoming a production hub following a string of setbacks.

Swedish developer Liquid Wind and utility Ovik Energi announced on 13 February that they plan to develop a new e-methanol site at Ornskoldsvik, on the country's east coast, where Danish renewables firm Orsted halted development of the 50,000 t/yr FlagshipOne project last year.

The new facility is due to produce 100,000 t/yr of e-methanol, with biogenic CO_2 provided by Ovik Energi, Liquid Wind says. Plant development will begin in the first half of this year but the company has not disclosed any further timeline details. The complex will be developed on the same site as FlagshipOne, as the land is owned by Ovik Energi, Liquid Wind tells *Argus*. But the project developer stresses that the new venture has no connection to FlagshipOne or Orsted.

Orsted bought FlagshipOne from Liquid Wind in late 2022 and took a final investment decision at the time. But it cancelled the project in August last year, citing difficulties in securing agreements for long-term offtake.

Liquid Wind is developing several other e-fuels plants in Sweden and sees "a very strong desire from customers and fuel users to transition to sustainable fuels", chief executive Claes Fredriksson says. The company points to a "significant [construction] pipeline of ships" that will run on e-fuels, as well as prospective demand from the aviation and chemicals sectors. Regulations and targets for e-fuels use set by industry bodies such as the International Maritime Organisation could drive demand, Liquid Wind says.

The company is not alone in its ambitions for the region. Norwegian developer Norsk e-Fuel said on 13 February that it plans to produce 80,000 t/yr of renewable hydrogen-based sustainable aviation fuel (e-SAF) at Ange in central Sweden. Norsk e-Fuel will develop the project with German fund Prime Capital and renewables firm RES, and will start operations "in line with" the EU's ReFuelEU Aviation regulations, it says. ReFuelEU will introduce mandates for e-SAF use from 2030. Norsk e-Fuel has previously announced plans for projects in Finland and Norway.

EU e-SAF mandates*	%
Timeframe	**Minimum share**
2030-31	1.2 on average, minimum 0.7 each year
2032-34	2 on average, minimum 1.2 from 2032, 2 from 2034
From 2035	5
From 2040	10
From 2045	15
From 2050	35

**required e-SAF share in overall jet fuel consumption*
— EU

Right place, wrong time?

Sweden has a largely decarbonised grid that makes compliance with EU rules easier than elsewhere, and it has ample availability of biogenic CO_2, making it highly favourable for e-fuels production. But FlagshipOne is not the only project to have been called off recently, which should raise questions for the newcomer projects.

Swedish state-owned utility Vattenfall and Finnish energy company St1 said last month that they have paused their joint e-SAF project in western Sweden, after a feasibility study found that "the e-SAF market is likely to mature later than previously expected — a bit into the 2030s", Vattenfall said. St1 explained that e-SAF "production costs are too high to compete with conventional fossil fuels or other renewable fuels under current market conditions". But the company said it "still believes in e-fuels in the long term and will monitor developments closely". The project envisaged around 80,000 t/yr of e-SAF production by 2029, with a tenfold scale-up within 10 years, St1 said in 2022.

German utility Uniper cancelled development of a 100,000 t/yr e-SAF project at Solleftea, central Sweden, in October. A "challenging market situation, sharply rising costs and continued uncertain effects of the regulatory frameworks" meant the venture was "no longer commercially viable", Uniper says. And Shell exited an e-SAF project with Vattenfall in July, with the firms deciding not to take up a €80.2mn ($84mn) grant from the EU Innovation Fund — although Vattenfall says it intends to review the project plans and seek new partners.

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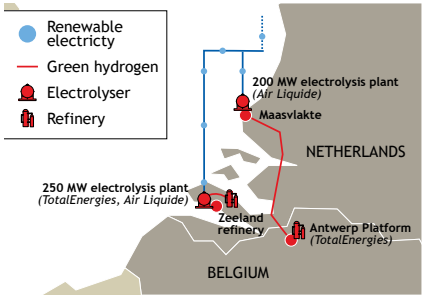
NEWS

TotalEnergies, Air Liquide ink 45,000 t/yr green H2 deal

TotalEnergies, Air Liquide plans



TotalEnergies has signed a deal with French industrial gas firm Air Liquide for the supply of 45,000 t/yr of renewable hydrogen to its European refineries, including from a jointly developed facility in the Netherlands,.

The two French firms are planning to build a 250MW electrolysis plant near TotalEnergies' Dutch Zeeland refinery through a 50:50 joint venture. The new plant could produce up to 30,000 t/yr of renewable hydrogen from 2029, the firms say. But "final authorisations and [an] investment decision" are pending, Air Liquide says.

TotalEnergies will also take 15,000 t/yr of renewable hydrogen from Air Liquide's planned 200MW Dutch ELYgator electrolysis plant near Rotterdam. TotalEnergies "has signed a tolling agreement for 130MW" of the project's capacity to secure the supply, which will be delivered to its Belgian Antwerp refinery, it says.

The contract will start by late 2027, when the project is due to be commissioned. The remainder of the plant's output will be distributed to industrial and heavy-mobility customers in Belgium and the Netherlands, Air Liquide says.

Under the firms' agreement, TotalEnergies will supply renewable power from the 795MW OranjeWind project off the Dutch coast to power the two electrolysis plants. TotalEnergies acquired a 50pc stake in OranjeWind from German utility RWE last year.

The joint initiatives will require more than €1bn ($1.1bn) of investment from the two firms, and could reduce CO_2 emissions by 450,000 t/yr, TotalEnergies says.

The projects will "contribute to European renewable energy targets in transport", TotalEnergies says. EU member states must make sure that 1pc of all transport fuels used in their countries are renewable fuels of non-biological origin (RFNBOs) — effectively renewable hydrogen and derivatives. The Netherlands and Belgium are planning to allow fuel suppliers to reach domestic quotas for RFNBO use in transport through the use of renewable hydrogen in refineries.

TotalEnergies previously signed deals with Air Liquide to reduce the carbon footprint of its French La Mede biorefinery. The firm says it has procured over 170,000 t/yr of renewable hydrogen to decarbonise refining in France, Germany, Belgium and the Netherlands. This is approximately one third of the 500,000 t/yr sought by the company in a tender process launched in 2023.

By Pamela Machado and Stefan Krumpelmann

South Australia halts Whyalla electrolyser procurement

Whyalla, South Australia

The state government of South Australia (SA) has delayed its decision on whether to invest in a planned 250MW electrolyser — the centrepiece of its A$593mn ($378mn) Hydrogen Jobs Plan — owing to problems at a nearby steelworks.

SA's Labor government is focusing on the current challenges at UK firm GFG Alliance's 1.2mn t/yr Whyalla steelworks, leaving the government's planned 200MW hydrogen-ready power station and associated electrolysers in limbo.

"We have a responsibility as the custodian of taxpayers' funds to not build a piece of equipment that isn't yet ready for an offtake agreement that is commercial in the first instance or in the long term," SA premier Peter Malinauskas says.

No final decision has been made and there is no formal timeline for selecting the electrolyser supplier, a spokeswoman for energy minister Tom Koutsantonis tells *Argus*. Procurement was initially expected to be completed late last year.

The power plant will still be built and can run on natural gas if the hydrogen is not available, with Malinauskas saying he has "no regrets" regarding the outlay.

By Tom Major

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NEWS

Spanish subsidy list puts H2 bank funds in question

Spain has shortlisted the Catalina 500MW renewable hydrogen project for potential capital cost subsidies, raising questions over whether the project developers might eventually turn down €230mn ($240mn) in EU funds granted through the European hydrogen bank's pilot auction.

The Spanish government earlier this month published a list of 16 projects that are in the running for a total of €1.32bn in combined subsidies under a scheme that opened last summer. Among these is Catalina, planned by Danish investment firm Copenhagen Infrastructure Partners and Spanish gas system operator Enagas, which had already been selected last year as one of seven winners in the European hydrogen bank's pilot auction.

Projects subsidised from the hydrogen bank cannot receive state aid for capital or operating expenses associated with their hydrogen production.

This raises questions over whether the Catalina developers will eventually decline the hydrogen bank support, given that the Spanish subsidies could be more lucrative. Final selections for the Spanish subsidies are expected in March.

Under the Spanish scheme, individual projects could receive up to €400mn in direct grants. Catalina's subsidies from the European hydrogen bank would amount to just €230.5mn, as it bid €0.48/kg for 48,000 t/yr of production over 10 years.

The developers would have had to provide a completion guarantee, which may be payable if the funds are not used. This was set at 4pc of the overall subsidy sum, so it would amount to €9.2mn.

The Catalina developers did not respond to requests for comments on the subsidy question by the time of publication.

If the developers decide not to take the EU hydrogen bank funding, it would be a setback for the mechanism. Funds could be reallocated through future rounds, but it would be a missed chance to help another project — or multiple smaller ones — get off the ground earlier. One of the six other winners of the hydrogen pilot pulled out in October, before it was due to sign the final grant agreement.

Many hydrogen industry participants have called for a more streamlined approach to subsidies in the EU, with some asking for more flexibility around the cumulation of hydrogen bank subsidies with other mechanisms. Germany last year failed to allocate €300mn planned for a national pot during the hydrogen bank's pilot auction, because of "very strict" rules around stacking subsidies.

The Catalina project could require some €2.13bn in capital investment, according to documents from the Aragon regional government released last year.

By Stefan Krumpelmann

Projects with hydrogen bank subsidies*

Project (co-ordinator)	H2 output t/yr	Electro. capacity MW	Bid price €/kg	Funding sought €mn
Finland				
eNRG Lahti (Nordic Ren-Gas)	12,200	90	0.37	45.2
Portugal				
Grey2Green-II (Petrogal — part of Galp)	21,600	200	0.39	84.2
MP2X (Madoqua Power2X)	51,100	500	0.48	245.2
Spain				
Hysencia (Angus)	1,700	35	0.48	8.1
Catalina (Renato PtX consortium: CIP and Enagas)	48,000	500	0.48	230.5
Norway				
Skiga (Fuella)	16,900	117	0.48	81.3

**excludes Benbros project, which was initially selected but withdrew before signing the grant agreement*

— European Commission

EU approves €111.7mn for Greek renewable H2 project

The European Commission has approved Greece's plan to provide refiner Motor Oil Hellas (MOH) with €111.7mn ($117mn) to build a renewable hydrogen production facility. MOH intends to use the funds to expand planned capacity at its Agioi Theodoroi refinery near Corinth by 20MW to 50MW, which could allow it to produce 7,500 t/yr of renewable hydrogen for industry and the transport sector. The initial 30MW — which will provide 4,500 t/yr of renewable hydrogen — is already under development. The additional funds will allow MOH "to build vital infrastructure in order to establish a hydrogen market in Greece, starting in 2026", the firm says.

MOH secured €127mn from the EU's Innovation Fund last year, for its plans to capture carbon from the Agioi Theodoroi refinery's hydrogen unit and lay the groundwork for e-methanol production.

By Jasmina Kelemen

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NEWS

Countries eligible for second PtX round
Brazil
Colombia
Egypt
India
Kenya
Morocco
South Africa

— PtX Development Fund

Moroccan green H2, NH3 project bags €30mn grant

A Moroccan renewable hydrogen and ammonia project linked to state-owned fertiliser company OCP has secured a €30mn ($31mn) grant from Germany's €270mn state-financed Power-to-X Development Fund.

The grant for the HydroJeel project was announced by the German programme and Morocco-based developer Innovx. HydroJeel aims to start producing 100,000 t/yr of renewable ammonia at the port of El Jadida by the end of 2026.

Innovx — a subsidiary of Morocco's UM6P university — is developing the facility "on behalf of the OCP group", which will take the all of the ammonia produced by an initial phase, as a feedstock for its green fertilisers.

The statement implied further phases are being considered, and this would chime with the funding programme's preference for supporting scalable projects. But the Power-to-X Development Fund says it is too early to confirm any expansion plans, or the timing for an investment decision or construction.

This is the second €30mn grant from the Power-to-X Fund, following an award made to an Egyptian renewable ammonia project last year. There will be no more grant agreements from the first round, the Power-to-X Development Fund tells *Argus*. A second round of applications runs until 5 March, and this should yield more grant agreements within 10-12 months, it says.

By Aidan Lea

Ammonia Europe starts internal NH3 certificate scheme

Recently launched business association Ammonia Europe has unveiled its voluntary certification scheme for ammonia within the European single market.

The Ammonia Europe certification scheme will offer ammonia producers or importers the ability to certify the carbon footprint and energy origin of their product for each individual tonne of ammonia.

Product certificates are digital documents issued at the time of production for each tonne and will be held within a company's own registry. Pathways covered by the scheme include ammonia produced from hydrogen using renewable power and electrolysis, from steam reforming of biomethane, and from steam reforming of natural gas — with or without carbon capture, utilisation and storage. These could be expanded to include further pathways in the future.

The scheme will use a mass-balance chain of custody system, with optional book-and-claim practices allowed for individual companies within the European single market only. EU legislation stipulates that mass-balance chain of custody methods are employed within the bloc to comply with regulatory markets for renewable fuels of non-biological origin.

Producers using the scheme will be able to choose their own production window or timeframe for the carbon footprint calculation. At present, the scheme is available only to Ammonia Europe members as a membership benefit. Participants will be required to undergo an on-site audit every 12 months.

Norway's Yara and Spain's Fertiberia are already members of the association. The two are first movers in the European renewable ammonia industry, and both have 20,000 t/yr of renewable ammonia production capacity in Europe.

Ammonia Europe hopes the certification scheme will allow producers to tap into a growing voluntary market by offering transparency over emissions and origins, helping to attract voluntary market players that are willing to pay premiums for low-carbon or renewable attributes. The group was launched this year as a spin-off from industry body Fertilizers Europe.

By Lizzy Lancaster

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ANALYSIS

Colombia shifts H2 focus as export demand lags

Blending mandates for the natural gas grid and use in fertilisers are seen as possibilities for stimulating demand at home, writes Pamela Machado

Colombia's nascent hydrogen industry is shifting its focus towards exploring domestic consumption opportunities, in an acknowledgement that demand from abroad could take longer to develop than previously expected.

Like many Latin American countries, Colombia harbours ambitions to leverage its favourable renewable power generation conditions to produce clean hydrogen for export to key demand centres — although it has yet to see the same flurry of project announcements as peers with longer coastlines, notably Brazil and Chile.

But demand from key regions, especially Europe, has not emerged on the scale developers had hoped for, and it is unlikely to surface any time soon, industry body H2 Colombia director Monica Gasca said at the recent Hyvolution event in Paris.

This has prompted a change in approach, Gasca said, adding that her association is now in discussions with industry participants and government officials about possibilities for promoting domestic offtake. Mandates for blending renewable hydrogen in the natural gas grid and for use in fertiliser production could be a way to stimulate early demand.

The first small-scale projects are already up and running. Colombian firms Hevolucion and Opex have started operations at a 2.3MW renewable hydrogen and ammonia project in northwestern Antioquia department, with the output set to be used for fertilisers, including for growing coffee.

And state-controlled Ecopetrol took a final investment decision in December for a hydrogen project with a 5MW electrolyser, with the output intended to help decarbonise some of its refining operations in Cartagena. The firm has delayed plans for project with a larger 60MW electrolyser, citing high development costs.

Progress on export-oriented projects has been comparatively slow, but such projects are still in the pipeline, including plants planned by Japanese firm Sumitomo and Canadian renewables developer Electryon Power.

Large export-orientated projects can struggle with social acceptance and environmental planning. The lessons learnt from oil and gas projects in the country is that developers cannot simply "prepare the project in your office" and expect communities involved and land licensing to fall into line, Gasca said. Developers must engage with communities from the start to prevent disputes, she said — something that has not always been the case in Latin America.

Bogota to launch $1bn fund

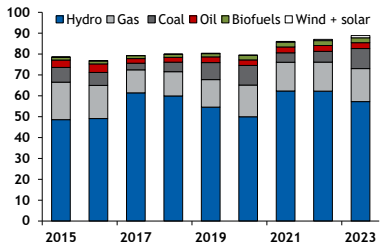
The government in Bogota is doing what it can to stimulate hydrogen industry development. Together with H2 Colombia, it is working towards the launch of a $1bn investment fund to catalyse projects — an initiative that mirrors efforts in other countries with hydrogen ambitions, including Chile, Namibia and South Africa.

The energy ministry is expected to shortly establish greenhouse gas emissions standards for defining renewable and low-carbon hydrogen, as well as a certification scheme. The CO_2 threshold should be close to European standards, Gasca said. The EU has set a ceiling of 3.38kg of CO_2 equivalent per kg of hydrogen.

And Bogota issued a decree in late December to allow energy and gas regulator Creg to set up special schemes that will allow hydrogen projects to take power from the national grid at a reduced tariff.

But grid-connected electrolysis plants could face a limit on how much electricity they can take at a given time. Colombia relies heavily on hydroelectricity — it accounted for 70pc of the country's electricity generation in 2023, based on data from Paris-based energy watchdog the IEA. Anticipated power consumption by large electrolysis plants is a key concern, particularly when El Nino weather conditions cause reservoir levels to drop and energy prices to rise, Gasca noted.

Colombia power mix (IEA data) *TWh/yr*



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INTERVIEW

Omani H2 resources 'phenomenal': InterContinental

Singapore-headquartered InterContinental Energy is planning three large projects for producing renewable hydrogen and derivatives — Australian Renewable Energy Hub (AREH), Western Green Energy Hub (WGEH), also in Australia, and Green Energy Oman (GEO). InterContinental Energy is developing all three alongside major partners and plans to build them in several stages. The projects could together produce nearly 7mn t/yr when fully developed — although this is expected to take several decades. Argus spoke to InterContinental chief executive Alexander Tancock about the firm's approach to scaling up, the need for government support, and why Oman is a prime location for major projects. Edited highlights follow:

How are your projects progressing?

We have the AREH project in Australia, with BP as the operator. That is in an area called the Pilbara, which is the world's largest iron ore exporter. So it just made so much sense to make that project about green steel. A domestic green steel project means you don't have to worry about exporting losses, conversions… you use the hydrogen right there to make green steel.

At our second Australian project, WGEH, with support from the government we can now achieve somewhere around $3/kg of hydrogen, which is really cost effective. That project will probably be focused on methanol and ammonia exports.

Then in the Middle East, we are in Oman, where the government is really strongly behind hydrogen. It is probably one of the most — if not the most — forward-looking hydrogen governments on the planet. And the resources that we have in Oman are phenomenal. The only issue now in Oman is that the domestic play is a bit harder. The resources are there, but there are not many people. What we need to figure out is where that cheap green hydrogen goes — to find a domestic market or work with points overseas in a strategic manner. The Omani government is taking a huge role there, and we are fortunate with our project in Oman as Shell and OQ are co-investors. With OQ being the domestic energy company and Shell being the largest foreign investor — if anybody can figure this out, it would be them.

When it comes to Oman — are things on track?

We're on track, broadly speaking. With these large projects, time will tell if there will be slippage. But if I look at the discussions we're having with our partners and offtakers, I'd still see these projects reaching a final investment decision (FID) towards the end of this decade.

What time lag do you expect between FID and construction or start-up?

With our projects, the timelines are going to be a few years from FID to product, because of their scale. And then full construction will take decades. If you take our largest project, WGEH — that's 30 nodes. A node a year would be a good run rate. So WGEH will grow with the offtake market to 2050 and beyond.

What exactly do you mean by 'nodes'?

The onus has to be on government to help the sector along. But the onus also has to be on us as an industry to drive our costs down, as the government is not there to just shell out money. There are a few ways of achieving that. One is to make the equipment better and cheaper, and there are good companies doing that. Then on the project side, you have to go to scale and develop architecture that allows you to make the entire project more efficient — i.e. less capital expenditure (capex) and less equipment, but the same or higher output.

'The onus also has to be on us as an industry to drive our costs down, as the government is not there to just shell out money'

InterContinental Energy H2 projects

Project	AREH	WEGH	GEO
Location	Pilbara, Australia	Goldfields, Australia	Al Wusta, Oman
InterContinental Energy *share %*	26.39	46	21.16
Other partners (*share %*)	BP (63.57); CWP Global (10.04)	CWP Global (44); Mining Green Energy (10)	Shell (35); OQ (25); EnerTech (18.84)
Planned H2 output *mn t/yr**	1.6	3.5	1.8
Planned renewable capacity *GW**	26	50	25

**at final development stage*

— InterContinental Energy

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INTERVIEW

If you have these huge projects that are the size of small European countries, you can't build them in one go. They are just too big and no one will finance them. So you have to build them in stages. So what our team did, a couple of years ago, is to say that if we eliminate all of the high-voltage equipment, we save a lot of money and time. But that means that you have to put all your wind and solar within a certain distance of the hydrogen production. So the team optimised that, and what you end up with is this nodal unit, where you have 1-2GW of electrolysers surrounded by twice as much upstream generation capacity. And all of that wind and solar connects to this hub in the middle, where you have your electrolysers, and so all of that electricity stays at distribution voltage. With this, you save a lot of capex. Hydrogen generation takes place there and connects by pipeline to your downstream use — methanol, ammonia, green steel.

'If you have these huge projects the size of small European countries, you can't build them in one go. They are just too big and no one will finance them'

Then you build a second node that has its own pipeline, and so on, like building blocks. And just like in a natural gas network, that pipeline network becomes a battery. So rather than having to pay for additional batteries, your battery comes with the pipelines you're building anyway. So for us, we think in units of nodes. That's how we develop our projects. And each node can be a standalone phase. We're working with our project partners and others, using this as the baseline. If you look at Oman's entire process, it has adopted the node as the base unit.

Are you interested in participating in Oman's upcoming bid round for land?
We don't need to because our first-round project is a legacy project. It is the only project that was given expansion rights, because we were a legacy player. The GEO project can go up to 25GW.

Beyond Oman, I think Saudi Arabia was on your radar at some point?
We had been looking over the past few years at different markets beyond our three projects, and we continue to look at other projects. But we have three incredible projects that are very, very large. So the need to deliver and focus is more where we are today, rather than expansion. Having said that, if the right project and the right partners were to come along, we would be open-minded. But we have a lot to deliver, so our focus is on that.

Oman's model of auctioning off land through bidding rounds is somewhat unique. What makes the approach suitable for Oman, but not others?
The Oman approach is better suited to markets where the government has more control over land. It would be difficult to implement that model in places that are full of freehold land. The Middle Eastern approach in general is one of looking for master planning and delivery, and that is something the region has done so well. You look at the infrastructure projects they've delivered across this region. Does anybody do it better? No. So that model is really well suited to environments like this.

'The most important factor is government policy and support... the market will not solve everything. If you can help bridge the gap between where we are now and what people are wiling to pay, the solutions are all there'

In terms of infrastructure, what do you think is most needed today? Pipelines? Import-export facilities? Storage?
None of the above. The most important factor is government policy and support, because the market will not solve everything. If you can help bridge the gap between where we are now and what people are wiling to pay, the solutions are all there already. None of this really requires new technology. It just requires architecture that is optimised. So that's all solvable. Government legislation and support — that's the critical piece of the puzzle I think we're missing in most markets at this point in the industry's development cycle.

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IN BRIEF

Winners in Portuguese auction	GW/yr
Project	**Blending amount**
Blending into transport network	
WINPTX	30.0
Ptsunhydrogen	11.0
Marte Boemio	7.0
Blending into distribution network	
Hychem	30.0
WP2X	17.5
CME	7.7
Essential Advantage	5.0

— Portugal general directorate of energy DGEG

Portugal renewable H2 auction clears at €127/MWh

Portugal's auction for subsidised injections of renewable hydrogen into its natural gas grid cleared at the maximum starting price of €127/MWh ($132/MWh), or about €5/kg. The auction was for 120 GWh/yr — or about 3,000 t/yr of grid injection capacity, based on hydrogen's higher heating value of 39.41kWh/kg, as referred to by the government. This was split into two 60 GWh/yr tranches — for injection into the gas transport network and to the distribution grid. The winners will share about €140mn of public funding over the course of 10 years, with the gas being acquired by Portuguese energy firm Galp's Transgas affiliate for grid injection, as a tool to promote and finance nascent hydrogen production projects. A separate auction of 150 GWh/yr of biomethane grid injection capacity — scheduled alongside the hydrogen auction — only attracted one bidder, which was awarded 1.99 GWh/yr at the €62/MWh maximum price.

Fertiberia exits CCS-NH3 Barents Blue project in Norway

Spanish fertiliser company Fertiberia will leave the Barents Blue ammonia production with carbon capture and storage (CCS) project in Norway on 28 February, Barents Blue lead developer Horisont Energi says. Horisont is working to find new partners, with front-end engineering work imminent. Fertiberia joined the project in 2023, when Norway's state-controlled Equinor and independent Var Energi quit the initiative. Horisont Energi announced the signing of a non-binding preliminary agreement earlier this month, to secure gas for the project from the Snohvit LNG facility at Melkoya.

Germany opens €400mn tender for e-SAF plant in Lusatia

The German government is seeking a developer for a synthetic aviation fuel (e-SAF) production plant in Lusatia, eastern Germany, offering up to €400mn ($420mn) in state aid. The capital cost subsidy is intended to support construction of a demonstration plant and help the market ramp-up for e-SAF products, according to the economy and climate protection ministry. Tender rules stipulate that the developer would have to operate the plant at least until the end of 2038. Interested companies must register by 3 March and will be able to submit an application until 14 April. The government plans to grant the award in 2026.

BP picks Accelera for 100MW German electrolysis plant

US engine maker Cummins' Accelera unit is to provide a 100MW proton exchange membrane electrolyser for BP's Lingen hydrogen project in Germany. BP's plant will use 20 Accelera proprietary electrolyser modules, which will be fed by offshore wind power, Accelera says. Accelera will manufacture the electrolyser at its factory in Guadalajara, Spain, which opened in October. BP took a final investment decision on the Lingen plant in December, encouraged by German subsidies allocated under the EU Important Project of Common European Interest framework.

South Korea to launch next H2-to-power tender in May

South Korea will open the next round of its clean hydrogen power generation bidding market in May, according to the trade, industry and energy ministry. Further details, including the certification process, will be announced later this month, the ministry says. A May launch would follow last year's pattern, which might mean that the scheme could again be open for bids until November. Industry participants expect Seoul to make changes to the tender parameters for the upcoming round, after the allocated power generation capacity last year stayed well below the government's target.

COMPLETE HYDROGEN PRODUCTION COSTS

No-C Hydrogen									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands	Wind + PEM	Green	€/kg	7.88	8.23	nc	4.96	5.18	nc
Netherlands	Grid + PPA + ALK	Green	€/kg	8.40	8.78	+0.11	5.70	5.96	+0.11
UK	Wind + PEM	Green	£/kg	6.45	8.09	nc	3.91	4.91	nc
UK	Grid + PPA + ALK	Green	£/kg	7.91	9.92	+0.11	5.57	6.99	+0.11
Germany	Wind + PEM	Green	€/kg	7.91	8.27	nc	4.94	5.16	nc
Germany	Grid + PPA + ALK	Green	€/kg	8.10	8.46	+0.10	5.35	5.59	+0.10
France	Wind + PEM	Green	€/kg	8.26	8.63	nc	5.17	5.40	nc
France	Grid + PPA + ALK	Green	€/kg	8.32	8.69	+0.04	5.46	5.71	+0.05
Spain	Diurnal + PEM	Green	€/kg	6.19	6.47	nc	3.42	3.57	nc
Spain	Grid + PPA + ALK	Green	€/kg	6.68	6.98	+0.02	3.78	3.95	+0.02
Italy	Grid + PPA + ALK	Green	€/kg	9.32	9.74	+0.09	5.97	6.24	+0.09
Portugal	Grid + PPA + ALK	Green	€/kg	6.69	6.99	+0.02	3.93	4.11	+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	11.56	8.13	nc	7.20	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	2,501	16.39	nc	1,988	13.03	nc
China	Diurnal + PEM	Green	Yn/kg	32.75	4.50	nc	19.79	2.72	nc
India	Diurnal + PEM	Green	Rs/kg	573.36	6.61	nc	305.33	3.52	nc
South Korea	Wind + PEM	Green	W/kg	22,363	15.48	nc	17,711	12.26	nc
Vietnam	Wind + PEM	Green	$/kg	9.72	9.72	nc	5.68	5.68	nc
Australia	Diurnal + PEM	Green	A$/kg	9.95	6.30	nc	5.81	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									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands	ATR + CCS	Blue	€/kg	5.55	5.80	-0.11	4.39	4.59	-0.11
UK	ATR + CCS	Blue	£/kg	4.74	5.95	-0.15	3.71	4.65	-0.16
Germany	ATR + CCS	Blue	€/kg	5.55	5.80	-0.11	4.37	4.57	-0.11
Spain	ATR + CCS	Blue	€/kg	5.45	5.69	-0.10	3.99	4.17	-0.10
France	ATR + CCS	Blue	€/kg	5.47	5.72	-0.13	4.22	4.41	-0.13
US Gulf coast	ATR + CCS	Blue	$/kg	2.91	2.91	+0.20	1.69	1.69	+0.20
Canada	ATR + CCS	Blue	C$/kg	3.61	2.54	+0.04	1.89	1.33	+0.05
Japan	ATR + CCS	Blue	¥/kg	964	6.32	+0.20	755	4.95	+0.21
South Korea	ATR + CCS	Blue	W/kg	8,754	6.06	+0.27	6,876	4.76	+0.27
Australia	ATR + CCS	Blue	A$/kg	6.23	3.94	+0.01	4.28	2.71	+0.01
Trinidad	ATR + CCS	Blue	$/kg	5.55	5.55	-0.10	3.69	3.69	-0.11
Qatar	ATR + CCS	Blue	$/kg	4.89	4.89	+0.01	3.65	3.65	+0.01
UAE	ATR + CCS	Blue	$/kg	5.06	5.06	+0.01	3.89	3.89	+0.01
Russia west	ATR + CCS	Blue	$/kg	3.14	3.14	+0.03	1.06	1.06	+0.03
Russia east	ATR + CCS	Blue	$/kg	3.07	3.07	+0.02	0.99	0.99	+0.02

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COMPLETE HYDROGEN PRODUCTION COSTS

BAT+ hydrogen									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands	SMR + CCS	Blue	€/kg	4.47	4.67	-0.10	3.84	4.01	-0.09
UK	SMR + CCS	Blue	£/kg	3.69	4.63	-0.13	3.12	3.91	-0.14
Germany	SMR + CCS	Blue	€/kg	4.50	4.70	-0.10	3.85	4.02	-0.10
Spain	SMR + CCS	Blue	€/kg	4.44	4.64	-0.11	3.64	3.80	-0.11
France	SMR + CCS	Blue	€/kg	4.46	4.66	-0.10	3.76	3.93	-0.11
US Gulf coast	SMR + CCS	Blue	$/kg	1.95	1.95	+0.17	1.28	1.28	+0.17
Canada	SMR + CCS	Blue	C$/kg	2.43	1.71	+0.04	1.48	1.04	+0.05
Japan	SMR + CCS	Blue	¥/kg	735	4.82	+0.25	619	4.06	+0.25
South Korea	SMR + CCS	Blue	W/kg	6,847	4.74	+0.27	5,807	4.02	+0.27
Australia	SMR + CCS	Blue	A$/kg	4.57	2.89	-0.03	3.49	2.21	-0.03
Trinidad	SMR + CCS	Blue	$/kg	4.30	4.30	-0.10	3.27	3.27	-0.11
Qatar	SMR + CCS	Blue	$/kg	3.94	3.94	+0.02	3.25	3.25	+0.01
UAE	SMR + CCS	Blue	$/kg	3.94	3.94	+0.01	3.30	3.30	+0.01
Russia west	SMR + CCS	Blue	$/kg	1.88	1.88	+0.02	0.73	0.73	+0.01
Russia east	SMR + CCS	Blue	$/kg	1.84	1.84	+0.02	0.69	0.69	+0.02

BAT+ hydrogen							18 Feb
				Excl. capex			
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	
Netherlands	SMR + CCS retrofit	Blue	€/kg	4.18	4.37	-0.09	
UK	SMR + CCS retrofit	Blue	£/kg	3.34	4.19	-0.13	
Germany	SMR + CCS retrofit	Blue	€/kg	4.17	4.36	-0.10	
Spain	SMR + CCS retrofit	Blue	€/kg	3.95	4.13	-0.11	
France	SMR + CCS retrofit	Blue	€/kg	4.11	4.29	-0.10	
US Gulf coast	SMR + CCS retrofit	Blue	$/kg	1.53	1.53	+0.16	
Canada	SMR + CCS retrofit	Blue	C$/kg	1.96	1.38	+0.04	
Japan	SMR + CCS retrofit	Blue	¥/kg	636	4.17	+0.25	
South Korea	SMR + CCS retrofit	Blue	W/kg	6,010	4.16	+0.27	
Australia	SMR + CCS retrofit	Blue	A$/kg	3.86	2.44	-0.03	
Trinidad	SMR + CCS retrofit	Blue	$/kg	3.44	3.44	-0.11	
Qatar	SMR + CCS retrofit	Blue	$/kg	3.45	3.45	+0.01	
UAE	SMR + CCS retrofit	Blue	$/kg	3.50	3.50	+0.01	
Russia west	SMR + CCS retrofit	Blue	$/kg	0.93	0.93	+0.02	
Russia east	SMR + CCS retrofit	Blue	$/kg	0.88	0.88	+0.01	

BAT+ hydrogen										18 Feb
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Australia	Coal gasification + CCS	5,500	Blue	A$/kg	6.05	3.83	+0.02	4.09	2.59	+0.02
Australia	Coal gasification + CCS	6,000	Blue	A$/kg	6.38	4.04	-0.04	4.42	2.80	-0.04
China	Coal gasification + CCS	3,800	Blue	Yn/kg	30.49	4.19	-0.01	20.88	2.87	nc
China	Coal gasification + CCS	5,500	Blue	Yn/kg	30.13	4.14	-0.01	20.52	2.82	-0.01
Indonesia	Coal gasification + CCS	5,500	Blue	$/kg	4.12	4.12	-0.01	2.63	2.63	-0.01
Indonesia	Coal gasification + CCS	3,800	Blue	$/kg	3.94	3.94	nc	2.46	2.46	nc
South Africa	Coal gasification + CCS	4,800	Blue	$/kg	4.21	4.21	-0.01	2.49	2.49	-0.01
South Africa	Coal gasification + CCS	6,000	Blue	$/kg	4.40	4.40	-0.04	2.69	2.69	-0.03
Russia west	Coal gasification + CCS	6,000	Blue	$/kg	4.00	4.00	+0.01	2.12	2.12	+0.01
US east coast	Coal gasification + CCS	6,000	Blue	$/kg	3.69	3.69	-0.02	2.47	2.47	-0.01

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COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands	SMR	Grey	€/kg	4.48	4.68	-0.11	3.94	4.12	-0.10
UK	SMR	Grey	£/kg	3.51	4.41	-0.13	3.04	3.81	-0.13
Germany	SMR	Grey	€/kg	4.51	4.71	-0.11	3.96	4.14	-0.10
Spain	SMR	Grey	€/kg	4.43	4.63	-0.11	3.75	3.92	-0.12
France	SMR	Grey	€/kg	4.46	4.66	-0.11	3.88	4.05	-0.11
US Gulf coast	SMR	Grey	$/kg	1.57	1.57	+0.16	1.01	1.01	+0.17
Canada	SMR	Grey	C$/kg	2.40	1.69	+0.05	1.61	1.13	+0.05
Japan	SMR	Grey	¥/kg	609	3.99	+0.25	511	3.35	+0.25
South Korea	SMR	Grey	W/kg	5,721	3.96	+0.27	4,839	3.35	+0.27
Australia	SMR	Grey	A$/kg	3.78	2.39	-0.03	2.86	1.81	-0.03
Trinidad	SMR	Grey	$/kg	3.74	3.74	-0.11	2.88	2.88	-0.10
Qatar	SMR	Grey	$/kg	3.56	3.56	+0.01	2.98	2.98	+0.01
UAE	SMR	Grey	$/kg	3.57	3.57	+0.01	3.03	3.03	+0.01
Russia west	SMR	Grey	$/kg	1.43	1.43	+0.02	0.46	0.46	+0.01
Russia east	SMR	Grey	$/kg	1.39	1.39	+0.02	0.42	0.42	+0.02

Baseline hydrogen									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands	Grid + ALK	Yellow	€/kg	11.96	12.50	-0.35	9.58	10.01	-0.35
Netherlands	Grid + PEM	Yellow	€/kg	11.65	12.17	-0.33	9.08	9.49	-0.32
UK	Grid + ALK	Yellow	£/kg	11.03	13.84	-0.43	8.99	11.28	-0.43
UK	Grid + PEM	Yellow	£/kg	10.69	13.41	-0.40	8.49	10.65	-0.40
Germany	Grid + ALK	Yellow	€/kg	11.20	11.70	-0.33	8.77	9.16	-0.34
Germany	Grid + PEM	Yellow	€/kg	10.92	11.41	-0.31	8.31	8.68	-0.31
France	Grid + ALK	Yellow	€/kg	9.97	10.42	-0.56	7.48	7.82	-0.56
France	Grid + PEM	Yellow	€/kg	9.81	10.25	-0.52	7.12	7.44	-0.52
Spain	Grid + ALK	Yellow	€/kg	8.09	8.45	+0.18	5.37	5.61	+0.17
Spain	Grid + PEM	Yellow	€/kg	8.08	8.44	+0.17	5.14	5.37	+0.16
US west coast	Grid + ALK	Yellow	$/kg	7.47	7.47	-0.23	4.96	4.96	-0.23
US west coast	Grid + PEM	Yellow	$/kg	7.48	7.48	-0.22	4.78	4.78	-0.21
US Midwest	Grid + ALK	Yellow	$/kg	7.15	7.15	+0.08	4.64	4.64	+0.07
US Midwest	Grid + PEM	Yellow	$/kg	7.19	7.19	+0.07	4.48	4.48	+0.07
US east coast	Grid + ALK	Yellow	$/kg	7.77	7.77	+0.09	5.26	5.26	+0.09
US east coast	Grid + PEM	Yellow	$/kg	7.76	7.76	+0.08	5.06	5.06	+0.08
Japan	Grid + ALK	Yellow	¥/kg	1,758	11.52	-1.01	1,347	8.83	-1.01
Japan	Grid + PEM	Yellow	¥/kg	1,718	11.26	-0.94	1,276	8.36	-0.94

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COMPLETE HYDROGEN PRODUCTION COSTS

Hydrogen decarbonisation spreads	Incl. capex		Excl. capex	18 Feb
	$/kg	± 11 Feb	$/kg	± 11 Feb
Northwest Europe				
No-C to BAT+	3.70	+0.10	1.26	+0.10
Low-C to BAT+	1.09	-0.02	0.53	-0.02
BAT+ to baseline	0.00	+0.01	-0.11	+0.01
North America				
No-C to BAT+	5.55	-0.10	3.39	-0.11
Low-C to BAT+	0.90	+0.02	0.35	+0.01
BAT+ to baseline	0.20	nc	0.09	nc
Northeast Asia				
No-C to BAT+	7.34	-0.26	5.30	-0.26
Low-C to BAT+	1.41	-0.03	0.82	-0.02
BAT+ to baseline	0.80	nc	0.69	nc
Middle East				
No-C to BAT+	2.08	-0.01	0.08	-0.01
Low-C to BAT+	1.04	nc	0.49	nc
BAT+ to baseline	0.37	nc	0.27	nc
Net exporter				
No-C to BAT+	3.34	-0.04	1.13	-0.04
Low-C to BAT+	1.02	+0.02	0.48	+0.02
BAT+ to baseline	0.41	+0.01	0.30	nc

Decarbonisation spreads relevant for subsidy mechanisms		Incl. capex			Excl. capex		18 Feb
	Unit	Spread	Spread in $/kg	± 11 Feb	Spread	Spread in $/kg	± 11 Feb
France							
No-C to Baseline[1]	€/kg	3.80	3.97	+0.11	1.29	1.35	+0.11
Germany							
No-C to BAT+[2]	€/kg	3.42	3.57	+0.10	1.09	1.14	+0.10
Netherlands							
No-C to baseline[3]	€/kg	3.40	3.55	+0.11	1.01	1.06	+0.10

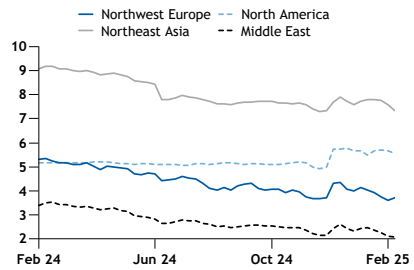
Differentials between the costs of renewable and natural gas-based hydrogen are used in subsidy mechanisms to establish the cost of switching to supply with a lower emissions intensity. The spreads above are relevant for the following:

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

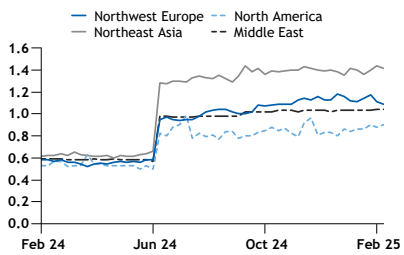
2 Future supply to Thyssenkrupp's direct reduced iron plant in Duisburg

3 Operational support granted to selected projects in Dutch subsidy scheme

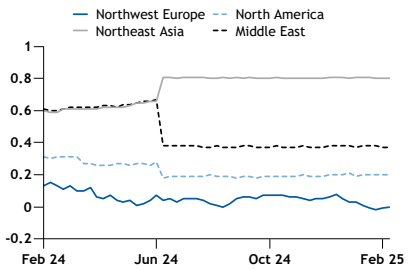
Decarb spread No-C to BAT+ *$/kg*



Decarb spread Low-C to BAT+ *$/kg*



Decarb spread BAT+ to baseline *$/kg*



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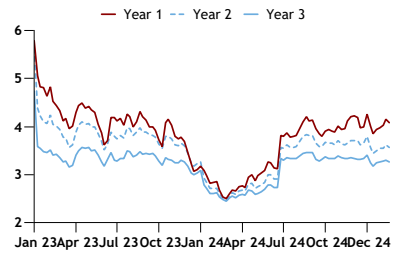
COMPLETE HYDROGEN PRODUCTION COSTS

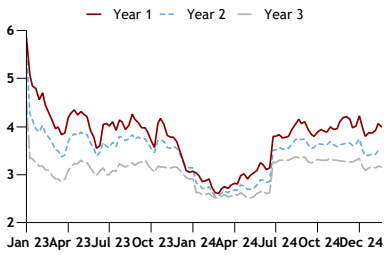
Low-C hydrogen forward									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands									
2026	ATR + CCS	Blue	€/kg	4.84	5.06	-0.08	3.68	3.85	-0.08
2027	ATR + CCS	Blue	€/kg	4.26	4.45	-0.04	3.10	3.24	-0.04
2028	ATR + CCS	Blue	€/kg	3.92	4.10	-0.02	2.77	2.89	-0.02
UK									
2026	ATR + CCS	Blue	£/kg	4.14	5.19	-0.08	3.10	3.89	-0.09
2027	ATR + CCS	Blue	£/kg	3.68	4.62	-0.05	2.65	3.33	-0.05
Germany									
2026	ATR + CCS	Blue	€/kg	4.89	5.11	-0.08	3.23	3.88	-0.08
2027	ATR + CCS	Blue	€/kg	4.32	4.51	-0.04	3.71	3.28	-0.04
2028	ATR + CCS	Blue	€/kg	3.98	4.16	-0.02	3.14	2.93	-0.02
France									
2026	ATR + CCS	Blue	€/kg	4.75	4.96	-0.07	3.49	3.65	-0.07
Spain									
2026	ATR + CCS	Blue	€/kg	4.89	5.11	-0.07	3.44	3.59	-0.07

BAT+ hydrogen forward									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands									
2026	SMR + CCS	Blue	€/kg	3.83	4.00	-0.07	3.19	3.33	-0.07
2027	SMR + CCS	Blue	€/kg	3.31	3.46	-0.04	2.67	2.79	-0.04
2028	SMR + CCS	Blue	€/kg	3.01	3.15	-0.02	2.37	2.48	-0.02
UK									
2026	SMR + CCS	Blue	£/kg	3.19	4.00	-0.08	2.62	3.29	-0.07
2027	SMR + CCS	Blue	£/kg	2.81	3.52	-0.04	2.23	2.80	-0.05
Germany									
2026	SMR + CCS	Blue	€/kg	3.89	4.06	-0.07	3.23	3.38	-0.07
2027	SMR + CCS	Blue	€/kg	3.38	3.53	-0.03	2.73	2.85	-0.03
2028	SMR + CCS	Blue	€/kg	3.08	3.22	-0.02	2.43	2.54	-0.02
France									
2026	SMR + CCS	Blue	€/kg	3.80	3.97	-0.07	3.10	3.24	-0.08
Spain									
2026	SMR + CCS	Blue	€/kg	3.88	4.05	-0.07	3.07	3.21	-0.07

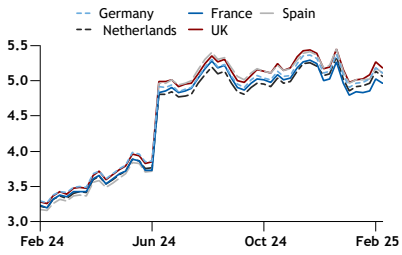
German SMR costs $/kg



Dutch SMR+CCS costs $/kg



European year 1 ATR+CCS costs $/kg



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COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen forward									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 11 Feb	Cost	Cost in $/kg	± 11 Feb
Netherlands									
2026	SMR	Grey	€/kg	3.85	4.02	-0.08	3.30	3.45	-0.09
2027	SMR	Grey	€/kg	3.35	3.50	-0.05	2.80	2.93	-0.05
2028	SMR	Grey	€/kg	3.07	3.21	-0.03	2.53	2.64	-0.03
UK									
2026	SMR	Grey	£/kg	3.08	3.86	-0.07	2.60	3.26	-0.07
2027	SMR	Grey	£/kg	2.70	3.39	-0.05	2.22	2.79	-0.04
Germany									
2026	SMR	Grey	€/kg	3.90	4.08	-0.08	3.36	3.51	-0.08
2027	SMR	Grey	€/kg	3.41	3.56	-0.05	2.86	2.99	-0.05
2028	SMR	Grey	€/kg	3.13	3.27	-0.03	2.58	2.70	-0.03
France									
2026	SMR	Grey	€/kg	3.81	3.98	-0.08	3.23	3.37	-0.08
Spain									
2026	SMR	Grey	€/kg	3.88	4.05	-0.07	3.20	3.34	-0.08

Direct reduction iron costs (14 Feb)		*$/t*
Specification	**Cost**	**±**
Natural gas DRI, ex-works NW Europe	442.74	-13.62
DRI spread No-C hydrogen (renewables+PEM) vs natural gas NW Europe	367.79	+7.96
DRI spread BAT+ hydrogen (SMR+CCS) vs natural gas NW Europe	158.99	+17.24

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
- H2Global tenders for 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

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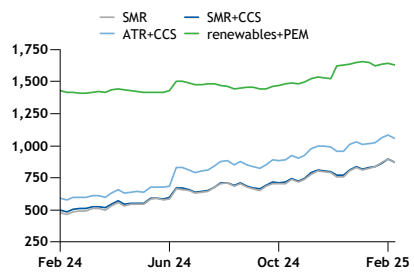
COMPLETE AMMONIA PRODUCTION COSTS

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

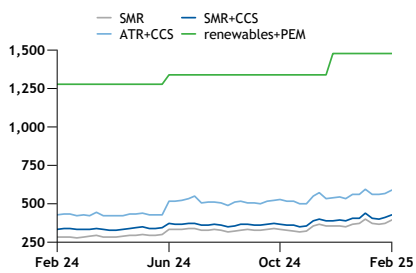
CO2e emissions on a gate-to-gate basis; purity >99.5pc; temperature -33°C

Regional ammonia cost markers						18 Feb
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 11 Feb	Cost	± 11 Feb
Baseline						
Northwest Europe	SMR	€/t	871	-26	701	-24
Northwest Europe	SMR	$/t	910	-19	732	-18
North America	SMR	$/t	394	+20	220	+19
Northeast Asia	SMR	$/t	788	+44	596	+44
Middle East	SMR	$/t	694	+2	534	+2
BAT+						
Northwest Europe	SMR+CCS	€/t	870	-25	681	-23
Northwest Europe	SMR+CCS	$/t	909	-17	712	-17
North America	SMR+CCS	$/t	429	+20	237	+19
Northeast Asia	SMR+CCS	$/t	932	+44	719	+44
Middle East	SMR+CCS	$/t	759	+2	582	+2
Low-C						
Northwest Europe	ATR+CCS	€/t	1,055	-29	764	-26
Northwest Europe	ATR+CCS	$/t	1,102	-20	798	-20
North America	ATR+CCS	$/t	589	+21	294	+22
Northeast Asia	ATR+CCS	$/t	1,180	+41	853	+42
Middle East	ATR+CCS	$/t	938	+2	664	+1
No-C						
Northwest Europe	Island renewable+PEM	€/t	1,628	-15	1,001	-9
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	568	+7	400	+6
Exporter BAT+	SMR+CCS	$/t	639	+6	454	+7
Exporter low-C	ATR+CCS	$/t	819	+10	533	+10
Exporter no-C	Island renewable+PEM	$/t	1,287	nc	701	nc

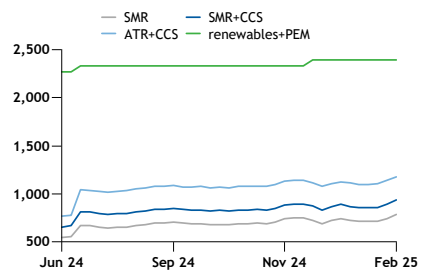
NW Europe ammonia average €/t



North America ammonia average $/t



Northeast Asia ammonia average $/t



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COMPLETE AMMONIA PRODUCTION COSTS

No-C ammonia									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 11 Feb	Cost	Cost in $/t	± 11 Feb
Netherlands	Wind + PEM	Green	€/t	1,607	1,679	nc	997	1,042	nc
UK	Wind + PEM	Green	£/t	1,307	1,640	nc	772	969	nc
Germany	Wind + PEM	Green	€/t	1,598	1,670	nc	977	1,021	nc
France	Wind + PEM	Green	€/t	1,680	1,755	nc	1,030	1,076	nc
Spain	Diurnal + PEM	Green	€/t	1,230	1,285	nc	665	695	nc
US west coast	Diurnal + PEM	Green	$/t	1,309	1,309	nc	793	793	nc
Canada	Wind + PEM	Green	C$/t	2,348	1,651	nc	1,436	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	490,081	3,212	nc	382,055	2,504	nc
China	Diurnal + PEM	Green	Yn/t	6,637	912	nc	3,806	523	nc
India	Diurnal + PEM	Green	Rs/t	112,678	1,299	nc	57,683	665	nc
South Korea	Wind + PEM	Green	W/t	4,400,294	3,046	nc	3,422,291	2,369	nc
Vietnam	Wind + PEM	Green	$/t	1,957	1,957	nc	1,083	1,083	nc
Australia	Diurnal + PEM	Green	A$/t	1,977	1,251	nc	1,153	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									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 11 Feb	Cost	Cost in $/t	± 11 Feb
Netherlands	ATR + CCS	Blue	€/t	1,055	1,102	-19	775	810	-19
UK	ATR + CCS	Blue	£/t	897	1,126	-27	652	818	-27
Germany	ATR + CCS	Blue	€/t	1,059	1,107	-19	770	805	-18
Spain	ATR + CCS	Blue	€/t	1,061	1,109	-16	704	736	-16
France	ATR + CCS	Blue	€/t	1,051	1,098	-22	745	778	-23
US Gulf coast	ATR + CCS	Blue	$/t	609	609	+33	313	313	+34
Canada	ATR + CCS	Blue	C$/t	809	569	+10	390	274	+10
Japan	ATR + CCS	Blue	¥/t	184,162	1,207	+35	132,438	868	+36
South Korea	ATR + CCS	Blue	W/t	1,664,195	1,152	+46	1,209,142	837	+47
Australia	ATR + CCS	Blue	A$/t	1,250	791	+2	773	489	+2
Trinidad	ATR + CCS	Blue	$/t	1,121	1,121	-18	651	651	-18
Qatar	ATR + CCS	Blue	$/t	931	931	+2	643	643	+1
UAE	ATR + CCS	Blue	$/t	945	945	+2	685	685	+2
Russia west	ATR + CCS	Blue	$/t	725	725	+4	196	196	+4
Russia east	ATR + CCS	Blue	$/t	722	722	+4	193	193	+4

Japan and Korea low-carbon ammonia benchmark (JK LAB)			18 Feb
	Unit	Cost	± 11 Feb
CFR Ulsan, South Korea, incl. US 45Q tax credit	$/t	614.40	+32.10
CFR Ulsan, South Korea, excl. US 45Q tax credit	$/t	750.40	+32.10
CFR Niihama, Japan, differential	$/t	+0.25	-0.05

The JKLAB includes 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 for delivery to Ulsan, South Korea. The Niihama differential reflects the cost difference for delivery to Niihama in Japan, rather than to Ulsan.

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COMPLETE AMMONIA PRODUCTION COSTS

BAT+ ammonia									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 11 Feb	Cost	Cost in $/t	± 11 Feb
Netherlands	SMR + CCS	Blue	€/t	866	905	-16	685	716	-16
UK	SMR + CCS	Blue	£/t	714	896	-23	556	697	-22
Germany	SMR + CCS	Blue	€/t	874	913	-16	686	717	-16
Spain	SMR + CCS	Blue	€/t	881	921	-18	650	679	-18
France	SMR + CCS	Blue	€/t	871	910	-18	673	703	-18
US Gulf coast	SMR + CCS	Blue	$/t	437	437	+28	245	245	+28
Canada	SMR + CCS	Blue	C$/t	597	420	+11	324	228	+10
Japan	SMR + CCS	Blue	¥/t	143,728	942	+43	110,161	722	+43
South Korea	SMR + CCS	Blue	W/t	1,330,489	921	+45	1,034,344	716	+45
Australia	SMR + CCS	Blue	A$/t	951	602	-6	641	406	-6
Trinidad	SMR + CCS	Blue	$/t	888	888	-18	583	583	-18
Qatar	SMR + CCS	Blue	$/t	764	764	+2	578	578	+2
UAE	SMR + CCS	Blue	$/t	754	754	+2	586	586	+2
Russia west	SMR + CCS	Blue	$/t	490	490	+3	147	147	+4
Russia east	SMR + CCS	Blue	$/t	484	484	+3	140	140	+2

BAT+ ammonia										18 Feb
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/t	± 11 Feb	Cost	Cost in $/t	± 11 Feb
Australia	Coal gasification + CCS	5,500	Blue	A$/t	1,196	757	+3	746	472	+4
Australia	Coal gasification + CCS	6,000	Blue	A$/t	1,253	793	-7	803	508	-7
China	Coal gasification + CCS	3,800	Blue	Yn/t	5,887	809	-2	3,675	505	nc
China	Coal gasification + CCS	5,500	Blue	Yn/t	5,829	801	-2	3,617	497	-2
Indonesia	Coal gasification + CCS	5,500	Blue	$/t	807	807	-1	462	462	-2
Indonesia	Coal gasification + CCS	3,800	Blue	$/t	776	776	nc	433	433	nc
South Africa	Coal gasification + CCS	4,800	Blue	$/t	839	839	-2	439	439	-1
South Africa	Coal gasification + CCS	6,000	Blue	$/t	871	871	-7	473	473	-5
Russia west	Coal gasification + CCS	6,000	Blue	$/t	817	817	+2	377	377	+2
US east coast	Coal gasification + CCS	6,000	Blue	$/t	730	730	-4	450	450	-1

Baseline ammonia									18 Feb
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 11 Feb	Cost	Cost in $/t	± 11 Feb
Netherlands	SMR	Grey	€/t	868	907	-18	704	736	-18
UK	SMR	Grey	£/t	684	858	-22	540	678	-22
Germany	SMR	Grey	€/t	875	914	-18	705	737	-18
Spain	SMR	Grey	€/t	878	917	-21	668	698	-21
France	SMR	Grey	€/t	871	910	-20	692	723	-19
US Gulf coast	SMR	Grey	$/t	371	371	+28	197	197	+28
Canada	SMR	Grey	C$/t	592	416	+11	346	243	+11
Japan	SMR	Grey	¥/t	121,147	794	+43	90,784	595	+43
South Korea	SMR	Grey	W/t	1,129,688	782	+46	860,990	596	+45
Australia	SMR	Grey	A$/t	811	513	-5	531	336	-5
Trinidad	SMR	Grey	$/t	788	788	-18	512	512	-18
Qatar	SMR	Grey	$/t	698	698	+2	530	530	+2
UAE	SMR	Grey	$/t	690	690	+2	538	538	+2
Russia west	SMR	Grey	$/t	409	409	+3	98	98	+3
Russia east	SMR	Grey	$/t	403	403	+3	92	92	+3

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COMPLETE AMMONIA PRODUCTION COSTS

Ammonia decarbonisation spreads				18 Feb
	Incl. capex		Excl. capex	
	$/t	± 11 Feb	$/t	± 11 Feb
Northwest Europe				
No-C to BAT+	792	+17	334	+17
Low-C to BAT+	193	-3	86	-3
BAT+ to baseline	-1	+2	-20	+1
North America				
No-C to BAT+	1,051	-20	665	-19
Low-C to BAT+	160	+1	57	+3
BAT+ to baseline	35	nc	17	nc
Northeast Asia				
No-C to BAT+	1,458	-44	1,080	-44
Low-C to BAT+	248	-3	134	-2
BAT+ to baseline	144	nc	123	nc
Middle East				
No-C to BAT+	420	-2	59	-2
Low-C to BAT+	179	nc	82	-1
BAT+ to baseline	65	nc	48	nc
Net exporter				
No-C to BAT+	648	-6	247	-7
Low-C to BAT+	180	+4	79	+3
BAT+ to baseline	71	-1	54	+1

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