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Argus Hydrogen and Future Fuels

Market news, analysis and prices

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Stalled e-methanol plans leave outlook murky

Ambitious plans for e-methanol plants are losing traction as high feedstock costs and an uncertain investment climate deter developers, writes Emmeline Willey

The project pipeline for production of hydrogen and derivatives is growing steadily — and e-methanol plants are no exception. But only a few of the global e-methanol projects *Argus* is tracking are set to meet their ambitious start-up targets and some developers have hit pause, leaving the outlook uncertain.

Argus is currently tracking 66 production sites globally that could together produce more than 9.3mn t/yr of e-methanol by combining electrolytic hydrogen and CO_2, with most due to come on line before the end of the decade. But less than 4pc of this capacity can be considered firm, where projects would have at least reached a final investment decision. Only two of 13 projects slated for start-up in 2025 are considered firm, suggesting that the bulk of facilities due to begin operations next year are increasingly unlikely to meet this deadline.

China has the largest market for fossil fuel-based methanol today and — as with renewable hydrogen projects more generally — has emerged as a clear frontrunner for e-methanol plants. If its planned projects come to fruition, China could have as much as 1.69mn t/yr of e-methanol production on line by the end of the decade, *Argus* data show. Currently, three projects in the country are up and running, with a combined capacity of 211,000 t/yr — equivalent to nearly 98pc of the global capacity that is currently operational.

European countries lag behind, but also have big ambitions. In Denmark, eight projects are planned that would produce upwards of 1.4mn t/yr by 2030, with two already under construction. Spain follows, with six planned projects that could provide 1.5mn t/yr by the late 2020s. Although the bulk of the world's e-methanol projects are planned across Europe, no other countries are on course to exceed 1mn t/yr of production, based on announced projects.

Around the world, several projects have been cancelled, halted indefinitely or downsized, while many developers have fallen silent as start-up dates approach.

Chemical manufacturer Dow says it halted its 200,000 t/yr e-methanol project in Stade, Germany, because of "near-term global volatility, the current investment climate in Germany" and a need to remain competitive. And UK-based Hydrogen Ventures says its planned facility in Iceland is "under consideration" as the firm evaluates the risk of earthquakes and volcanic activity. Several others did not reply to an *Argus* request for comment.

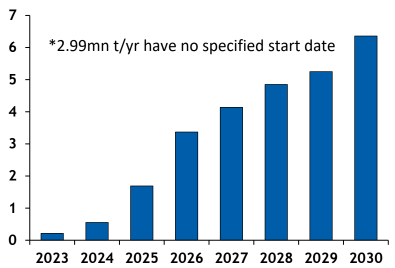
In Canada, Nauticol Energy had planned to produce 3.2mn t/yr of 'blue' methanol using natural gas-based hydrogen with CO_2 capture rather than electrolytic hydrogen. But plans for the site have been scrapped, although the developer has left open the possibility of building a smaller plant at the location.

That said, some momentum continues behind the scenes — even outside China. Carbon Recycling International tells *Argus* that early engineering and design studies and permitting activity is under way at its 100,000 t/yr Finnfjord project in Norway, with a 2025 start date targeted. Grid capacity needed for the project has been reserved and conversations with offtakers continue, the firm says.

Sea double

Fossil methanol today is used in the chemicals sector and sometimes as a direct fuel. Production nearly doubled in the decade to 2019, reaching 98mn t/yr. Overall methanol demand is set to reach 120mn t/yr in 2025, and 500mn t/yr in 2050,

Planned e-methanol capacity* *mn t/yr*



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according to shipping registry Lloyd's Register. That increased demand will be met by a mix of fossil methanol, e-methanol and biomethanol, according to Paris-based energy watchdog the IEA.

The maritime sector is likely to account for a substantial chunk of demand growth, as it turns to alternative fuels to meet decarbonisation targets set by the International Maritime Organisation, which expects a 50pc reduction in emissions by 2050 against a 2008 baseline. To put the numbers into perspective, Danish shipping giant Maersk could decarbonise its entire fleet with 2mn t/yr of e-methanol, according to Lloyd's Register, and as of summer last year, there were 29 methanol-capable vessels in operation and 112 on order. That number continues to grow, although many fleet owners are also looking to renewable ammonia to decarbonise shipping operations. E-methanol and ammonia have an edge over hydrogen in terms of energy content and storage benefits, although neither can match conventional fuels in terms of energy density or cost.

E-methanol database

Subscribers to the *Argus Hydrogen and Future Fuels* service can access a database with operational and planned e-methanol production facilities here.

New fuel, old problems

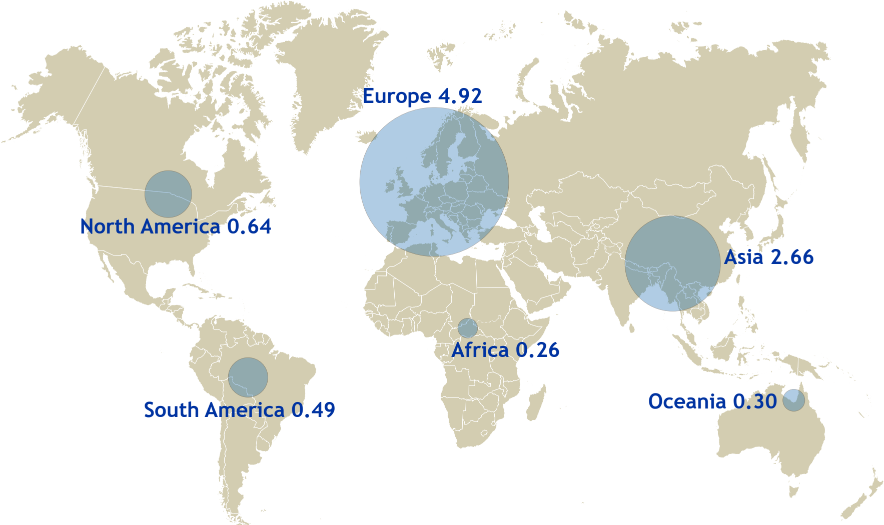
E-methanol comes with the same problems as other low-carbon fuels of the future. Its feedstock is expensive and in low supply — and is likely to be so for quite some time. E-methanol, renewable ammonia and other derivatives, such as e-fuels, will compete for access to low-cost supplies of electrolytic hydrogen. Producing the envisaged 9.3mn t/yr of e-methanol based on announced projects would require nearly 1.9mn t/yr of renewable hydrogen.

Accounting for differences in energy density, a ship would need 2.4 times as much e-methanol as diesel — e-methanol clearly affects operating costs

E-methanol production costs are between $800/t and $1,600/t, according to 2021 data from renewables agency Irena, compared with about $465/t for fuel oil or about $600/t for very low-sulphur fuel oil. Accounting for differences in energy density — a ship would need 2.4 times as much e-methanol as diesel — e-methanol clearly leaves its mark on operating costs. E-methanol will also have to compete with biomethanol, which Lloyd's Register says could be significantly cheaper, although global biomass supplies are also tight.

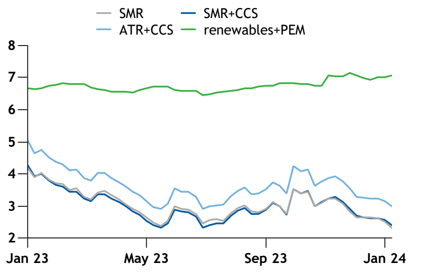
The CO_2 feedstock used for e-methanol production also needs to be factored in. Low-cost carbon used to produce e-methanol is typically captured at fossil fuel-fired plants, leaving questions around its sustainability. Biogenic carbon can be used, but comes at a higher cost and is scarce in some regions, while direct air capture technology is still in its infancy.

Announced e-methanol production capacity by region *mn t/yr*

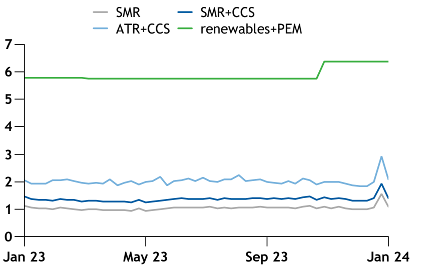


HYDROGEN COSTS

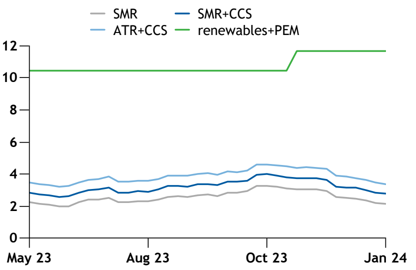
Northwest Europe average cost €/kg



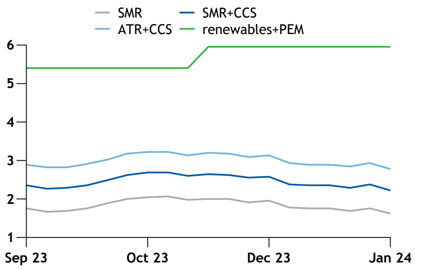
North America average cost $/kg



Northeast Asia average cost $/kg



Exporter average cost $/kg



Regional hydrogen cost markers						23 Jan
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 16 Jan	Cost	± 16 Jan
Baseline						
Northwest Europe	SMR	€/kg	2.33	-0.18	2.04	-0.20
Northwest Europe	SMR	$/kg	2.53	-0.22	2.22	-0.23
North America	SMR	$/kg	1.08	-0.48	0.78	-0.48
Northeast Asia	SMR	$/kg	2.13	-0.08	1.82	-0.08
Middle East	SMR	$/kg	1.90	-0.06	1.59	-0.06
BAT+						
Northwest Europe	SMR+CCS	€/kg	2.41	-0.16	1.91	-0.15
Northwest Europe	SMR+CCS	$/kg	2.62	-0.19	2.08	-0.18
North America	SMR+CCS	$/kg	1.41	-0.52	0.86	-0.53
Northeast Asia	SMR+CCS	$/kg	2.75	-0.08	2.19	-0.09
Middle East	SMR+CCS	$/kg	2.53	-0.06	1.97	-0.07
Low-C						
Northwest Europe	ATR+CCS	€/kg	2.98	-0.18	2.30	-0.17
Northwest Europe	ATR+CCS	$/kg	3.24	-0.22	2.50	-0.21
North America	ATR+CCS	$/kg	2.09	-0.85	1.35	-0.85
Northeast Asia	ATR+CCS	$/kg	3.37	-0.09	2.62	-0.09
Middle East	ATR+CCS	$/kg	3.11	-0.06	2.36	-0.06
No-C						
Northwest Europe	Island renewable+PEM	€/kg	7.07	+0.05	4.96	+0.03
Northwest Europe	Island renewable+PEM	$/kg	7.69	nc	5.40	nc
North America	Island renewable+PEM	$/kg	6.39	nc	4.14	nc
Northeast Asia	Island renewable+PEM	$/kg	11.67	nc	9.43	nc
Middle East	Island renewable+PEM	$/kg	5.81	nc	3.58	nc
Exporter						
Exporter baseline	SMR	$/kg	1.62	-0.14	1.32	-0.13
Exporter BAT+	SMR+CCS	$/kg	2.22	-0.15	1.67	-0.15
Exporter low-C	ATR+CCS	$/kg	2.77	-0.16	2.02	-0.16
Exporter no-C	Island renewable+PEM	$/kg	5.95	nc	3.60	nc

Argus hydrogen taxonomy			
	Purity	Pressure	tCO_2e/tH_2
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

CO_2e emissions on a gate-to-gate basis

Pump prices, 70MPa			5 Jan
	Unit	Price	± 6 Dec
Japan			
Eneos	¥/kg	1,650.00	nc
Iwatani	¥/kg	1,210.00	nc
Germany			
H2Mobility (stations with “green” H2 supply)	€/kg	11.00	nc
H2Mobility (stations with conventional H2 supply)	€/kg	13.85-15.25	nc

MARKET DEVELOPMENTS

Italy eyes CfD scheme to subsidise green H2 output

CfDs would provide support for 10 years and offer subsidies of up to €5/kg, primarily for heavy industry and transport, writes Stephen Jewkes

Italy is planning to introduce a contracts for difference (CfDs) subsidy scheme to boost production of renewable and biogenic hydrogen, primarily for heavy industry and transport.

The energy ministry, in a document that is out for consultation with energy companies and other stakeholders until 4 March, says the CfDs would provide support for 10 years and offer subsidies of up to €5/kg.

Subsidies will be available for production of renewable hydrogen, as defined by the EU last year, and for biohydrogen. The latter refers to hydrogen obtained from biogenic sources, which could include biomass gasification or pyrolysis, reforming of biomethane or biogas or electrolysis that uses power from biogenic sources, the ministry says. Regardless of the production pathway, lifecycle emissions will have to be below 3kg of CO_2 equivalent per 1kg of hydrogen.

Incentives will be awarded through public auctions over the four years to 2027, when Italy aims to have renewable hydrogen production capacity of 250,000 t/yr and a further 50,000 t/yr of biohydrogen capacity, according to the document.

Support for companies will be calculated based on the difference between an award price, determined as the outcome of a competitive tender procedure, and three potential counterfactual prices that depend on the hydrogen's designated use. The counterfactual price could be that of natural gas, of gas-based hydrogen with unabated emissions or — if the green hydrogen is due to be used in the transport sector — of diesel.

But the mean annual incentive will be capped at €5/kg for plants with an electrolyser capacity of less than 10MW, €4/kg for facilities of above 10MW and €3/kg for biohydrogen production sites.

Companies will have to submit bids detailing several parameters and the winning projects will be selected based on these. These include the targeted award price, expected production and planned start-up date. Among other prerequisites, developers would have to show that preliminary purchase agreements are in place for at least 60pc of their output from hard-to-abate sectors or transport.

Projects that receive capital cost support through other mechanisms would be eligible, but subsidies available through the CfD scheme would be lower.

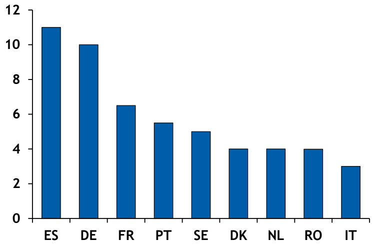
Bridge support

Other countries in Europe and elsewhere are conducting or planning CfD schemes to bridge the cost gap between renewable or low-carbon hydrogen and conventional alternatives. The UK awarded first contracts in December, with 125MW of renewable hydrogen production capacity to be subsidised with more than £2bn ($2.54bn), yielding expected subsidies of close to €10/kg. Other countries planning similar schemes include the Netherlands, France and Japan.

In a 2023 update to its national energy plan, Italy estimated renewable hydrogen demand of around 250,000 t/yr by 2030, of which 115,000 t/yr will be for hard-to-abate industry and 136,000 t/yr for transport. This was partly based on the demand necessary to meet the EU's mandates for 2030, including that 42pc of all hydrogen used in industry comes from renewable sources.

The energy ministry said at the time that it expected 80pc of hydrogen to be produced domestically — using 3GW of electrolyser capacity — with the rest imported. Italy previously aimed for 5GW of electrolyser capacity by 2030, but lowered its targets last year, possibly because of slow renewable power expansions and muted interested in investments. Morocco could be among the countries eventually supplying Italy with renewable hydrogen, as Rome recently decided to finance a feasibility study on a "green corridor" from Morocco to Trieste port.

Minimum 2030 electrolyser goals *GW*



MARKET DEVELOPMENTS

India to subsidise green H2 for refineries, ammonia

The subsidies should help the refining and fertiliser sectors with the cost of switching to cleaner feedstocks, writes Akansha Victor

India is planning to subsidise around 300,000 t/yr of hydrogen production from renewable power or biomass over three years through a competitive tender, with output to be used by crude refineries and in ammonia production.

The government last week announced two new tender rounds. These will follow an initial round through which New Delhi recently allocated three-year subsidies for 412,000 t/yr of green hydrogen without a defined end use.

One of the tenders covers 200,000 t/yr for crude refineries. Suppliers will be responsible for the delivery of product, as well as "storage and transportation", the government says.

The other tender will be for 550,000 t/yr of ammonia. This would correspond to just under 100,000 t/yr of hydrogen, given that each tonne of ammonia contains roughly 176kg of hydrogen. Subsidised ammonia will have to be for supply to consumers and cannot be traded.

The maximum support in the tender for supply to refineries will be capped at 50 rupees/kg ($0.60/kg) in the first year, Rs40/kg in the second year and Rs30/kg in the third year — in line with the recently concluded tender. Support for ammonia production will be limited to Rs8,820/t in the first year, then Rs7,060/t in the second year and Rs5,300/t in the third year. This means that it is effectively the same as in the concluded hydrogen tender and the upcoming procedure for supply to oil refineries, based on the 176kg hydrogen content in ammonia.

As in the first tender round, firms submitting the lowest bids will win, so successful bids will probably again stay well below the ceilings.

Production will only be eligible for subsidies if the hydrogen complies with India's 'national green hydrogen standard'. This classifies 'green hydrogen' as hydrogen "produced using renewable energy including, but not limited to, production through electrolysis or conversion of biomass", provided its well-to-gate emissions do not exceed 2kg of CO_2 equivalent/kg.

The 10 winners of the first tender can apply again (*see table*). But they can only receive incentives for additional capacity — over and above the capacity they have already claimed in the previous round.

The government has not specified the maximum capacity for which individual companies can bid, but says such a cap could still be set. Maximum supported capacity per company had been capped at 90,000 t/yr in the first tender, but caps might have to be lower in the upcoming rounds, given the overall lower volumes that will be supported. The government has not specified a timeline for launching the tender process.

Green H2 tender awards

Bidder	Capacity *t/yr*	Av. incentive *Rs/kg*
Bucket I — technology agnostic pathway		
Reliance Green H2 and Green Chemicals	90,000	18.9
Acme Cleantech solutions	90,000	30.0
Greenko ZeroC	90,000	30.0
HHP Two	75,000	25
Welspun New Energy	20,000	20.0
Torrent Power	18,000	29
UPL	10,000	0.0
CESC Projects	10,500	0.0
JSW Neo Energy*	6,500	34.7
Bucket II — biomass-based pathway		
BPCL	2,000	30.0
Total	**412,000**	

**JSW Neo Energy won 6,500 t/yr of the 10,000 t/yr capacity quoted*

— Solar Energy Corporation of India

Fertile ground

Crude refineries and fertiliser production have been singled out by the government as key early offtakers for cleaner hydrogen supply.

New Delhi is considering drawing up draft regulations requiring refineries to cover 5-15pc of their hydrogen supply with green hydrogen from 2026-27, according to a government source. It is considering similar obligations for the fertiliser sector, although this has been met with pushback from industry participants. Subsidised hydrogen and ammonia production directed specifically at refineries and fertiliser production, respectively, should help these sectors absorb the costs incurred by switching to cleaner supply.

India has seen a steady stream of project announcements for renewable hydrogen and ammonia production. Industrial gas firm Inox Air Products announced last week that it plans to produce 500,000 t/yr of renewable ammonia in the western state of Maharashtra at a $3bn plant that is to be launched within 3-5 years.

NEWS

Australia allocates further regional hydrogen hub funds

Australia's federal government has released more money from the Regional Hydrogen Hubs programme, with A$77mn ($51mn) for Western Australia's (WA) Pilbara hub and A$70mn for Tasmania's Bell Bay.

The Pilbara grant is intended to help develop infrastructure for prospective hydrogen producers considering export markets, with a hydrogen or ammonia pipeline to link the Maitland industrial area to the Burrup Peninsula, road infrastructure to be built at Port Hedland's Lumsden Point, hub expansion studies and a clean energy training school, according to information posted on the federal government's GrantConnect website.

The funding runs until 31 March 2028, with the hub to play a crucial role in positioning the state in the global hydrogen economy, diversifying the state's economy and cutting carbon emissions, according to the grant recipient, WA's department of jobs, tourism, science and innovation.

Four Pilbara region projects are listed as active on the Commonwealth Scientific and Industrial Research Organisation's HyResource website — which tracks the nation's hydrogen proposals — out of 25 in WA and 104 nationally (*see table*).

Pilbara H2 projects	
Name	**Developer**
Australian Renewable Energy Hub	BP
Christmas Creek renewable hydrogen mobility project	Fortescue
Christmas Creek green iron plant	Fortescue
Yuri	Yara

— HyResource

In Tasmania, federal and state government funding alongside private-sector contributions will lead to A$300mn invested at the Bell Bay hub, where construction will start this year and be completed by 2028, according to a joint announcement from federal energy minister Chris Bowen and his Tasmanian Liberal Party counterpart Nick Duigan.

The hub is likely to produce up to 45,000 t/yr of green hydrogen and support manufacturing of green metals and alloys such as iron, aluminium and steel, the ministers said on 18 January. Four projects had previously been announced for Bell Bay, aiming to produce hydrogen, green ammonia and methanol for export. But development has stalled, with power grid constraints likely to be the reason for flagging interest.

By Tom Major

EU to advance H2 plans with €170mn funding round

EU hydrogen-focused research body the Clean Hydrogen Partnership (CHP) has opened applications for its annual funding competition for research projects — for which it has earmarked €113.5mn ($123.3mn) — and for an additional €60mn pot dedicated solely to "hydrogen valleys".

The group will dispense the €113.5mn across 20 categories, with the largest tranche — €29mn — for two hydrogen valleys, considered "flagship projects" (*see table*). CHP has defined hydrogen valleys as projects involving all stages of the value chain — production, transport, storage and consumption — in the same location. Last year, the partnership awarded up to €20mn for a new "large-scale" valley with more than 4,000 t/yr of renewable hydrogen production capacity and up to €9mn for a "small-scale" valley of at least 500 t/yr.

Areas covered under CHP funding		
Area	**No of projects**	***€mn***
Renewable H2 production	5	25.0
H2 storage and distribution	5	27.0
Transport	4	19.0
Heat and power	2	9.0
Cross-cutting issues	2	4.5
Hydrogen valleys	2	29.0

— CHP

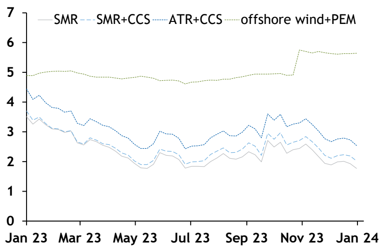
But this time, besides the €29mn from its annual call, CHP will be able to offer another €60mn dedicated solely for hydrogen valleys, thanks to a separate funding stream. This will allow it to fund more than the one large and one small valley that received support last year. Of the €60mn, €12.5mn will be used to set up a hydrogen valleys facility to provide project development assistance and knowledge-sharing for the EU's valley projects.

Projects can submit applications for €1.5mn-20mn until 17 April. CHP will provide more information regarding applications on 26 January.

By Roxana Lazar

NEWS

UK H2 costs £/kg



UK should make H2 with curtailed wind: Think-tank

The UK could reduce costly curtailment of wind power by using the surplus to make renewable hydrogen, according to a study by think-tank Policy Exchange.

Most curtailment occurs in Scotland, but grid constraints are forecast to increase elsewhere, such as in Wales and East Anglia. The UK paid £350mn ($446mn) to renewable firms to curtail power output because of downstream constraints in 2021-22, and this could rise to £3.5bn/yr by 2030, the report said.

Renewable curtailment in the UK is forecast to hit nearly 18TWh in 2029, up from about 4.7TWh in 2022, which would be enough to make 456,000 t/yr and 119,000 t/yr of renewable hydrogen, respectively, based on 70pc-efficient electrolysers operating 15pc of the time, the study found.

Hydrogen output of 456,000 t/yr would be enough to displace nearly two thirds of the UK's 700,000 t/yr of demand for conventional hydrogen from fossil fuels, it added. It would also be enough to make 9mn t/yr of green steel — more than the UK's current 7mn t/yr of steel production — or 1.1mn t/yr of sustainable aviation fuel, more than 90pc of the UK's 2030 goal.

The government should create a policy so that the hydrogen is delivered to industrial consumers, according to Policy Exchange. But in the near term, most hydrogen is likely to be blended into the natural gas grid as production would probably outweigh demand for hydrogen in power-constrained areas and because the UK has no hydrogen transmission pipelines to reach offtakers elsewhere, it said.

While the report focused on the maximum potential production of hydrogen and derivatives utilising the UK's entire curtailed power, it did not say what volumes might be achievable in practice. Electrolysers using surplus power would only run a fraction of the time, significantly raising the overall cost of hydrogen production. The report said electrolysers could be fed directly from "behind-the-meter" renewable power generation onshore or offshore, or rather connected to the grid with a power purchase agreement, but it did not estimate costs for the resulting hydrogen from the different scenarios.

The study recommends that the UK should prioritise power companies that partner with electrolyser projects for subsidies, and suggests a subsidy mechanism for electrolysers in constrained zones. This would be separate from the existing subsidy schemes for hydrogen, although this already rewards electrolyser projects which offer "wider system benefits", such as grid balancing in constrained areas.
By Aidan Lea

OX2, Ingka lift offshore H2 projections for Swedish site

Swedish renewable power developer OX2 and the investment arm of Netherlands-based Ingka Group, Ingka Investments, are aiming to produce up to 370,000 t/yr of hydrogen offshore in Swedish waters.

OX2 had announced plans for the Neptunus facility, about 50km off the southern coast of Sweden, last year, saying at the time that it would aim to produce 225,000 t/yr of hydrogen from offshore wind. Ingka Group bought a 49pc share in the planned Neptunus and Pleione offshore wind farms in November and the developers have applied for an environmental permit for Neptunus. They aim to start construction in 2030, subject to obtaining the necessary permits, OX2 says.

The project will consist of 207 wind turbines to produce 13-15 TWh/yr of electricity, some of which would be used to make hydrogen. The firms intend to use by-product oxygen from the electrolysis process "to oxygenate the Baltic Sea", which could "contribute to restoring the marine life in an area with oxygen deficiency".
By Makani Joinville

NEWS

EIB, NIB to finance H2 Green Steel plant in Sweden

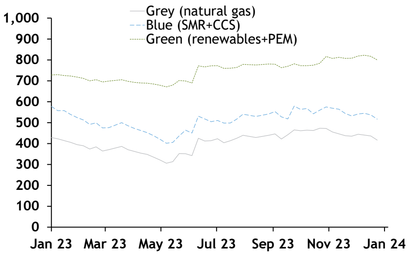
Swedish steelmaker H2 Green Steel has signed project financing agreements of more than €4.2bn ($4.6bn) for its flagship steel plant in Boden, including €371mn from the European Investment Bank (EIB) and Nordic Investment Bank (NIB).

Funding from the two banks will be backed by the InvestEU programme. The EIB is set to contribute €314mn, including €200mn guaranteed by the European Commission and €114mn through commercial banks. The NIB will add €57mn, with €9mn coming under InvestEU.

H2 Green Steel says it has now "secured funding of close to €6.5bn" for the plant, including €2.1bn of equity funding and support from the EU Innovation Fund.

When H2 Green Steel first announced plans to build the facility in 2021, it had estimated that total investment of €2.5bn would be required. The company says this has had to be revised up because of a combination of factors, including front-loading the costs for the project's first two phases, rather than separating them. Also, "[we are] covering not only capital expenditure, but also some infrastructure, financing costs, ramp-up costs and the contingency the banks require", the firm says. The investment estimate has also risen because of external factors, such as regional conflicts, the energy crisis and inflation.

NW Europe DRI costs $/t



The new plant will use hydrogen from an electrolyser with more than 700MW of capacity fed by renewable power, and this will cut CO_2 emissions from steel production by up to 95pc, H2 Green Steel says. The company aims to start operations next year, with initial steel output of 2.5mn t/yr, which could rise to 5mn t/yr in a second phase. H2 Green Steel has signed offtake agreements for its steel with several companies, especially in the automotive and construction sectors, including German firms Bilstein, Kirchhoff Automotive and Porsche, Italy's Marcegaglia and the UK's Steel Processing Midlands.

By Elif Eyuboglu

Tough race for green H2 projects in India's Tamil Nadu

India's southern state of Tamil Nadu has received strong interest from renewable hydrogen and ammonia project developers. But the government expects to give the go-ahead to less than 20pc of proposed facilities, and shortlisted developers face a race to move ahead with planning and to secure land for renewable power.

The state has received proposals for 17 renewable hydrogen and ammonia projects, according to a government official. But the administration has signed preliminary agreements with just five companies and only three of these are due to get the green light because of land constraints, the official says (*see table*).

Shortlisted NH3 projects in Tamil Nadu

Company	Capacity *mn t/yr*	Potential offtakers
Gentari	1.00	Petronas refinery, Malaysia
Gentari + AM Green	1.00	Europe, Japan, South Korea, Singapore
Acme	1.00	Japan, South Korea
Sembcorp	1.00	_
Leap Green	0.66	_

— Government source

Tamil Nadu will provide land for the three projects that implement their plans first. But it will not allocate public space for solar and wind assets, according to the official, and companies will have to acquire land for renewable power assets privately. Whichever company manages to do this first is likely to have an edge in terms of securing government land for hydrogen — and potentially ammonia — production sites.

Unlike many other Indian states, Tamil Nadu does not have a specific green hydrogen policy with incentives or a production target. But hydrogen and ammonia projects stand to benefit from regulations under Tamil Nadu's industrial policy. This will provide a "structural package of incentives" for the three projects that are selected, including exemptions for electricity tax, stamp duty, flexible capital subsidy or turnover-based subsidy. The subsidies will be disbursed only when commercial production begins and will be customised for individual projects.

By Akansha Victor

ANALYSIS

Spate of elections spells uncertainty for hydrogen

The pace and extent of hydrogen development could hinge on the outcome of a record number of elections this year

Voters head to the polls this year in many of the world's largest democracies, including the US, India, the EU, the UK, South Korea and more. Hydrogen is not foremost among voters' concerns, but the election results stand to indirectly shape the industry's development.

The backdrop for these elections — in many countries marked by high inflation and the cost of living crisis — has spurred politicians to chase quick wins by rowing back on expensive and unpopular energy transition measures. This tendency could sap the momentum that has been building for hydrogen, and will worry project developers, which prize political stability. Paradoxically, advocates for green spending are also claiming ownership of the economic case — albeit over a longer time frame. The idea that spending on green technology will yield growth is manifest in measures such as the US' Inflation Reduction Act, the EU's Green Deal Industrial Plan and the UK's Green Industries Growth Accelerator.

These democracies not only compete with each other for a slice of the hydrogen pie, but also with China — which is pressing ahead decisively with investment in technologies of the future — and Middle Eastern monarchies plotting megaprojects that are only likely to pay off in decades' time, without having to worry about short-term election cycles. With companies deliberating where to make their billion-dollar investments, there is much at stake.

Selected countries with 2024 elections

Country	Expected date
Algeria	December
Belgium	9 June
Finland	28 January
India	April-May
Indonesia	14 February
Mexico	2 June
Panama	5 May
Portugal	10 March
Russia	17 March
South Africa	Latest by August
South Korea	11 April
Tunisia	TBC
UK	TBC
Uruguay	27 October
US	5 November

Party rules

The possibility of a new president in the US has industry participants considering the future of the Biden administration's vaunted 45V hydrogen tax credits.

Advocates have been left wondering how to safeguard the scheme in the event of a power shift, and might decide to leave open ends in the final guidance that would enable a Republican administration to relax restrictions later, rather than repeal the entire provision. The 45V rules continue to cause debate and industry groups and politicians are pushing for change, but all generally agree on one detail — that it is best to finalise the guidance sooner rather than later. The Treasury is expected to issue the final rules in summer.

Even if there is a shift in power, it is unlikely that the 45V provisions would be rolled back entirely. Many of the benefits for energy and manufacturing are flowing to red states, so Republican representatives have little incentive to scrap the credit. The same applies for the US hydrogen hubs, many of which are in Republican districts. That said, hydrogen could become collateral damage if campaigns focused on spending cuts shift public opinion against green spending.

Whichever administration prevails will be under pressure to reduce its fiscal debt, which could restrict monetary flow and result in understaffed permitting agencies, reducing the speed of a clean energy infrastructure build-out.

But "hydrogen in general has very broad support across party lines", Fuel Cell and Hydrogen Energy Association chief executive Frank Wolak says. Expediting permitting is high on the list of priorities for both parties, and the national security benefits offered by hydrogen have wide appeal, he adds.

Elections this year for several other hydrogen hopefuls in the Americas — Mexico, Uruguay and Panama — could shape development in these nations. But industry participants and observers do not expect major dents in support for hydrogen, regardless of the outcomes.

Model candidate

India's government emerged in 2023 as one of the busiest on the hydrogen policy front as the launch of its national green hydrogen mission triggered some strong

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ANALYSIS

The BJP is expected to remain in power in India, but the election itself could delay the roll-out of policies and subsidy competitions

investor interest. The upcoming elections might not change the long-term trajectory — the BJP is expected to remain in power — but they could delay the roll-out of policies and subsidy competitions.

India's "model code of conduct" requires that new schemes are paused during election campaigns to prevent the incumbent government from using them to win support unfairly. The code will be enforced as soon as the election schedule is finalised, probably in mid-February. From that time, New Delhi cannot set out new initiatives until after the elections, which are expected to take place in April-May.

South Korea's national assembly elections take place on 10 April, with neck-and-neck approval ratings so far for the ruling People Power party (PPP) and main opposition Democratic party (DP). Current president Yoon Suk Yeol is from the PPP, although the DP currently has a majority in the national assembly, with 168 of 298 seats. The Yoon administration has been expanding the nuclear power fleet and cut 2030 targets for hydrogen use in power generation — in contrast with former president Moon Jae-in's nuclear phase-out plan and ambitious renewable targets. Should the PPP win in the general elections, the country is likely to see a continued emphasis on nuclear power, while the DP is more in favour of new renewable energy, including hydrogen.

ID parade

The EU will hold parliamentary elections in June, with the European People's party (EPP) still polling ahead as the largest group, ahead of the centre-left socialists.

That could enable it to retain the presidency of the European Commission, with or without the incumbent Ursula von der Leyen. The EPP is discussing a draft manifesto calling for a "rapid ramp-up of international hydrogen production and functioning transport infrastructure". And it wants "strong support for clean tech" to provide jobs and "strategic sovereignty" for Europe. Hydrogen has broad support — also through more ambitious climate and renewable goals — across the main parliamentary groups. But if conservative groups increase their share of votes, this could open up the possibility of right-wing coalitions against climate action. The Identity and Democracy (ID) group wants "pragmatism in the transition" and the protection of business interests from "unilateral and utopic goals set by this commission", its president, Marco Zanni, says.

In the EU, an increase in conservative groups' share of the votes could open up the possibility of right-wing coalitions against climate action

Pollsters see UK voters ending the Labour Party's 14-year spell in opposition in a general election expected sometime in the second half of 2024. The party wants to make the UK a "clean energy superpower" and raise the 2030 aim for electrolysis capacity to 10GW from about 6GW, particularly to supply "flexible power generation, storage and industry such as green steel". Otherwise, specific hydrogen measures are thin, but certain manifesto pledges — massively scaling up renewables to hit 100pc "clean power" by 2030 and protecting the future of heavy industry and manufacturing jobs — could bolster the industry's outlook. The party's other flagship policies are a new state-owned energy company and a national wealth fund, both of which would invest in hydrogen, Labour says.

Even if the election delivers a surprise win for the Conservatives, hydrogen progress is not likely to suffer. The incumbents have been supportive of hydrogen, even while rowing back on other areas of the energy transition, such as delaying the phase-out of new internal combustion engines and gas boilers.

In the EU, national elections will take place this year in Portugal — following a presidential resignation that involved a hydrogen project last year — Belgium, Austria and Finland. Meanwhile, the Netherlands still needs to form a government after elections last year, and it remains to be seen whether climate-sceptic Geert Wilders, who has vowed to scrap the Netherlands' climate fund, under which €9bn is reserved for hydrogen, will take the reins.

IN BRIEF

German e-SAF site gets last-minute funding commitment

Last-minute changes to Germany's 2024 budget mean that a flagship project for renewable hydrogen-based sustainable aviation fuels (e-SAF) can be built, but with a smaller scope than initially planned. Germany will support the e-SAF research and production facility in Leuna with €135mn ($146.8mn) over four years, according to its developer, the aviation research centre DLR. Berlin had previously scrapped plans to support the project with public money as it had to significantly cut its budget because of a ruling by the federal constitutional court. Before the ruling, the Leuna facility had been expected to receive €500mn of German government and EU funds. DLR says it would not have built the plant without public money, but now plans to start construction this year.

India's Adani targets 1mn t/yr renewable H2 by 2027

India's Adani aims to produce 1mn t/yr of renewable hydrogen by 2027 in the western state of Gujarat, according to company sources. Adani is planning to bring production capacity to 3mn t/yr in the next 10 years, with overall investment of about $50bn. Adani initially wants to set up 3.15GW electrolyser capacity, aiming to produce 1mn t/yr of renewable hydrogen which could be converted to 5.6mn t/yr of ammonia for exports. The project will be powered by 4.4GW of combined wind and solar sources, with plans for expansion to up to 45GW in subsequent phases. Adani has been allotted 85,000 hectares of land in the Kutch district under Gujarat's wasteland policy for green hydrogen projects.

Indian firms plan green H2 index

India is looking to launch a global hydrogen trading mechanism by 2026 to facilitate growth of a green hydrogen economy. The International Financial Services Centre (IFSC) — a government agency in Gandhinagar, Gujarat — is planning to establish the mechanism with a view to eventually launching a hydrogen price index. IFSC has signed a preliminary agreement to establish the mechanism with the Indian Gas Exchange and state-owned Gujarat State Petroleum.

Japan's KHI to issue transition bonds for H2 businesses

Japanese engineering and shipbuilding company Kawasaki Heavy Industries (KHI) plans to issue 10bn yen ($67.6mn) of five-year transition bonds in February to raise funding for its hydrogen businesses. KHI will use the funds to advance technologies, including those used in liquified hydrogen carrier vessels and storage tanks, and hydrogen-fuelled power generation turbines. KHI established its fundraising framework in November and the company hopes the scheme will raise the ratio of sustainability finance in its long-term debts to 50pc by 2030, and then 100pc by 2050. KHI has also received subsidies from the ministry of economy, trade and industry to issue the bonds.

China's Hainan eyes 100,000 t/yr hydrogen by 2025

China's Hainan province aims to produce 100,000 t/yr of renewable hydrogen by 2025 and 400,000 t/yr by 2030, according to its 2023-35 hydrogen development plan. This will be in addition to maintaining steady output of 100,000 t/yr from natural gas or as a by-product of other processes in 2025-30. The government plans to use renewable hydrogen to make methanol and ammonia, primarily as fuel for ships, and will carry out pilot projects for carbon capture in cement and petrochemical sectors, which could provide the CO_2 for methanol production. Hainan and the nearby state of Guangdong are studying sub-sea hydrogen pipelines, and Hainan says it will offer "preferential tariff policies" for hydrogen companies.

COMPLETE HYDROGEN PRODUCTION COSTS

No-C Hydrogen									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands	Wind + PEM	Green	€/kg	6.32	6.88	nc	4.24	4.61	nc
Netherlands	Grid + GOO + ALK	Green	€/kg	8.27	9.00	-0.79	6.43	7.00	-0.79
UK	Wind + PEM	Green	£/kg	5.64	7.16	nc	3.88	4.93	nc
UK	Grid + GOO + ALK	Green	£/kg	8.68	11.02	-0.70	7.14	9.06	-0.69
Germany	Wind + PEM	Green	€/kg	7.34	7.99	nc	5.23	5.69	nc
Germany	Grid + GOO + ALK	Green	€/kg	8.51	9.26	-0.83	6.64	7.23	-0.83
France	Wind + PEM	Green	€/kg	7.54	8.20	nc	5.43	5.91	nc
France	Grid + GOO + ALK	Green	€/kg	9.02	9.82	-0.92	7.17	7.80	-0.92
Spain	Diurnal + PEM	Green	€/kg	5.31	5.78	nc	3.22	3.50	nc
Spain	Grid + GOO + ALK	Green	€/kg	8.24	8.97	-0.05	6.33	6.89	-0.04
US west coast	Diurnal + PEM	Green	$/kg	5.70	5.70	nc	3.50	3.50	nc
Canada	Wind + PEM	Green	C$/kg	9.53	7.07	nc	6.43	4.77	nc
Oman	Diurnal + PEM	Green	$/kg	5.80	5.80	nc	3.50	3.50	nc
Saudi Arabia	Diurnal + PEM	Green	$/kg	5.88	5.88	nc	3.58	3.58	nc
UAE	Diurnal + PEM	Green	$/kg	5.64	5.64	nc	3.50	3.50	nc
Qatar	Diurnal + PEM	Green	$/kg	5.90	5.90	nc	3.72	3.72	nc
Namibia	Diurnal + PEM	Green	$/kg	6.47	6.47	nc	3.69	3.69	nc
South Africa	Diurnal + PEM	Green	$/kg	6.41	6.41	nc	3.80	3.80	nc
Japan	Wind + PEM	Green	¥/kg	2,329	15.74	nc	1,984	13.41	nc
China	Diurnal + PEM	Green	Yn/kg	36.93	5.15	nc	22.09	3.08	nc
India	Diurnal + PEM	Green	Rs/kg	478.77	5.76	nc	280.11	3.37	nc
South Korea	Wind + PEM	Green	W/kg	18,878	14.11	nc	15,774	11.79	nc
Vietnam	Wind + PEM	Green	$/kg	8.59	8.59	nc	6.07	6.07	nc
Australia	Diurnal + PEM	Green	A$/kg	8.50	5.59	nc	5.12	3.37	nc
Brazil	Diurnal + PEM	Green	$/kg	5.97	5.97	nc	3.37	3.37	nc
Chile	Diurnal + PEM	Green	$/kg	6.26	6.26	nc	3.96	3.96	nc

Low-C hydrogen									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands	ATR + CCS	Blue	€/kg	2.99	3.25	-0.21	2.32	2.52	-0.20
UK	ATR + CCS	Blue	£/kg	2.54	3.22	-0.25	1.97	2.50	-0.25
Germany	ATR + CCS	Blue	€/kg	3.02	3.29	-0.21	2.34	2.55	-0.21
Spain	ATR + CCS	Blue	€/kg	2.94	3.20	-0.16	2.21	2.41	-0.16
France	ATR + CCS	Blue	€/kg	2.92	3.18	-0.23	2.24	2.44	-0.22
US Gulf coast	ATR + CCS	Blue	$/kg	2.09	2.09	-0.43	1.35	1.35	-0.44
Canada	ATR + CCS	Blue	C$/kg	2.82	2.09	-1.26	1.81	1.34	-1.26
Japan	ATR + CCS	Blue	¥/kg	506	3.42	-0.09	395	2.67	-0.09
South Korea	ATR + CCS	Blue	W/kg	4,442	3.32	-0.09	3,425	2.56	-0.09
Australia	ATR + CCS	Blue	A$/kg	4.23	2.78	-0.06	3.09	2.03	-0.07
Trinidad	ATR + CCS	Blue	$/kg	3.14	3.14	-0.11	2.03	2.03	-0.11
Qatar	ATR + CCS	Blue	$/kg	3.04	3.04	-0.06	2.28	2.28	-0.06
UAE	ATR + CCS	Blue	$/kg	3.18	3.18	-0.06	2.43	2.43	-0.07
Russia west	ATR + CCS	Blue	$/kg	1.85	1.85	+0.01	0.99	0.99	nc
Russia east	ATR + CCS	Blue	$/kg	1.80	1.80	nc	0.94	0.94	nc

COMPLETE HYDROGEN PRODUCTION COSTS

BAT+ hydrogen									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands	SMR + CCS	Blue	€/kg	2.43	2.64	-0.19	1.93	2.10	-0.19
UK	SMR + CCS	Blue	£/kg	2.02	2.56	-0.22	1.61	2.04	-0.22
Germany	SMR + CCS	Blue	€/kg	2.45	2.67	-0.18	1.96	2.13	-0.18
Spain	SMR + CCS	Blue	€/kg	2.37	2.58	-0.17	1.85	2.01	-0.16
France	SMR + CCS	Blue	€/kg	2.33	2.54	-0.20	1.84	2.00	-0.19
US Gulf coast	SMR + CCS	Blue	$/kg	1.48	1.48	-0.46	0.94	0.94	-0.46
Canada	SMR + CCS	Blue	C$/kg	1.79	1.33	-0.59	1.05	0.78	-0.60
Japan	SMR + CCS	Blue	¥/kg	408	2.76	-0.09	327	2.21	-0.09
South Korea	SMR + CCS	Blue	W/kg	3,653	2.73	-0.08	2,903	2.17	-0.09
Australia	SMR + CCS	Blue	A$/kg	3.54	2.33	-0.02	2.72	1.79	-0.02
Trinidad	SMR + CCS	Blue	$/kg	2.56	2.56	-0.12	1.75	1.75	-0.12
Qatar	SMR + CCS	Blue	$/kg	2.53	2.53	-0.06	1.97	1.97	-0.07
UAE	SMR + CCS	Blue	$/kg	2.52	2.52	-0.07	1.97	1.97	-0.07
Russia west	SMR + CCS	Blue	$/kg	1.31	1.31	nc	0.68	0.68	nc
Russia east	SMR + CCS	Blue	$/kg	1.27	1.27	nc	0.64	0.64	nc

BAT+ hydrogen						23 Jan
				Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan
Netherlands	SMR + CCS retrofit	Blue	€/kg	2.03	2.21	-0.19
UK	SMR + CCS retrofit	Blue	£/kg	1.64	2.08	-0.23
Germany	SMR + CCS retrofit	Blue	€/kg	2.05	2.23	-0.20
Spain	SMR + CCS retrofit	Blue	€/kg	1.94	2.11	-0.18
France	SMR + CCS retrofit	Blue	€/kg	1.93	2.10	-0.20
US Gulf coast	SMR + CCS retrofit	Blue	$/kg	0.92	0.92	-0.45
Canada	SMR + CCS retrofit	Blue	C$/kg	1.15	0.85	-0.60
Japan	SMR + CCS retrofit	Blue	¥/kg	324	2.19	-0.09
South Korea	SMR + CCS retrofit	Blue	W/kg	2,890	2.16	-0.09
Australia	SMR + CCS retrofit	Blue	A$/kg	2.68	1.76	-0.02
Trinidad	SMR + CCS retrofit	Blue	$/kg	1.73	1.73	-0.12
Qatar	SMR + CCS retrofit	Blue	$/kg	1.95	1.95	-0.07
UAE	SMR + CCS retrofit	Blue	$/kg	1.95	1.95	-0.07
Russia west	SMR + CCS retrofit	Blue	$/kg	0.66	0.66	nc
Russia east	SMR + CCS retrofit	Blue	$/kg	0.62	0.62	nc

BAT+ hydrogen										23 Jan
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Australia	Coal gasification + CCS	5,500	Blue	A$/kg	4.73	3.11	-0.02	2.99	1.97	-0.03
Australia	Coal gasification + CCS	6,000	Blue	A$/kg	5.18	3.41	-0.05	3.45	2.27	-0.05
China	Coal gasification + CCS	3,800	Blue	Yn/kg	25.39	3.54	nc	17.14	2.39	nc
China	Coal gasification + CCS	5,500	Blue	Yn/kg	24.81	3.46	nc	16.57	2.31	nc
Indonesia	Coal gasification + CCS	5,500	Blue	$/kg	3.27	3.27	+0.01	2.04	2.04	nc
Indonesia	Coal gasification + CCS	3,800	Blue	$/kg	3.15	3.15	nc	1.92	1.92	-0.01
South Africa	Coal gasification + CCS	4,800	Blue	$/kg	3.30	3.30	-0.02	1.88	1.88	-0.02
South Africa	Coal gasification + CCS	6,000	Blue	$/kg	3.41	3.41	-0.02	1.98	1.98	-0.03
Russia west	Coal gasification + CCS	6,000	Blue	$/kg	2.80	2.80	-0.01	1.55	1.55	-0.01
US east coast	Coal gasification + CCS	6,000	Blue	$/kg	3.18	3.18	-0.05	2.07	2.07	-0.04

COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands	SMR	Grey	€/kg	2.34	2.55	-0.22	2.07	2.25	-0.22
UK	SMR	Grey	£/kg	1.77	2.24	-0.22	1.53	1.94	-0.23
Germany	SMR	Grey	€/kg	2.37	2.58	-0.21	2.09	2.27	-0.22
Spain	SMR	Grey	€/kg	2.29	2.49	-0.19	1.99	2.16	-0.20
France	SMR	Grey	€/kg	2.26	2.46	-0.22	1.98	2.15	-0.23
US Gulf coast	SMR	Grey	$/kg	0.96	0.96	-0.41	0.66	0.66	-0.41
Canada	SMR	Grey	C$/kg	1.62	1.20	-0.55	1.21	0.90	-0.54
Japan	SMR	Grey	¥/kg	314	2.12	-0.08	268	1.81	-0.08
South Korea	SMR	Grey	W/kg	2,863	2.14	-0.07	2,448	1.83	-0.07
Australia	SMR	Grey	A$/kg	2.63	1.73	-0.02	2.16	1.42	-0.02
Trinidad	SMR	Grey	$/kg	1.85	1.85	-0.10	1.39	1.39	-0.11
Qatar	SMR	Grey	$/kg	1.90	1.90	-0.06	1.59	1.59	-0.06
UAE	SMR	Grey	$/kg	1.90	1.90	-0.06	1.59	1.59	-0.06
Russia west	SMR	Grey	$/kg	0.77	0.77	nc	0.42	0.42	nc
Russia east	SMR	Grey	$/kg	0.73	0.73	nc	0.38	0.38	nc

Baseline hydrogen									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands	Grid + ALK	Yellow	€/kg	8.10	8.81	-0.74	6.26	6.81	-0.73
Netherlands	Grid + PEM	Yellow	€/kg	7.96	8.66	-0.69	5.96	6.48	-0.69
UK	Grid + ALK	Yellow	£/kg	7.75	9.84	-0.79	6.20	7.87	-0.79
UK	Grid + PEM	Yellow	£/kg	7.57	9.61	-0.73	5.89	7.47	-0.73
Germany	Grid + ALK	Yellow	€/kg	8.34	9.07	-0.78	6.47	7.04	-0.78
Germany	Grid + PEM	Yellow	€/kg	8.19	8.91	-0.72	6.16	6.70	-0.72
France	Grid + ALK	Yellow	€/kg	8.85	9.63	-0.87	6.99	7.61	-0.86
France	Grid + PEM	Yellow	€/kg	8.67	9.43	-0.80	6.64	7.22	-0.81
Spain	Grid + ALK	Yellow	€/kg	8.07	8.78	+0.01	6.15	6.69	nc
Spain	Grid + PEM	Yellow	€/kg	7.95	8.65	+0.01	5.85	6.37	nc
US west coast	Grid + ALK	Yellow	$/kg	9.40	9.40	-0.84	7.38	7.38	-0.85
US west coast	Grid + PEM	Yellow	$/kg	9.21	9.21	-0.79	7.02	7.02	-0.78
US Midwest	Grid + ALK	Yellow	$/kg	6.90	6.90	-1.62	4.88	4.88	-1.62
US Midwest	Grid + PEM	Yellow	$/kg	6.88	6.88	-1.51	4.69	4.69	-1.51
US east coast	Grid + ALK	Yellow	$/kg	7.58	7.58	-1.60	5.56	5.56	-1.61
US east coast	Grid + PEM	Yellow	$/kg	7.52	7.52	-1.49	5.32	5.32	-1.50
Japan	Grid + ALK	Yellow	¥/kg	1,391	9.40	-0.03	1,087	7.35	-0.03
Japan	Grid + PEM	Yellow	¥/kg	1,364	9.22	-0.03	1,034	6.99	-0.02

COMPLETE HYDROGEN PRODUCTION COSTS

Hydrogen decarbonisation spreads				23 Jan
	Incl. capex		Excl. capex	
	$/kg	± 16 Jan	$/kg	± 16 Jan
Northwest Europe				
No-C to BAT+	5.07	+0.19	3.32	+0.18
Low-C to BAT+	0.62	-0.03	0.42	-0.03
BAT+ to baseline	0.09	+0.03	-0.14	+0.05
North America				
No-C to BAT+	4.98	+0.52	3.28	+0.53
Low-C to BAT+	0.68	-0.33	0.49	-0.32
BAT+ to baseline	0.33	-0.04	0.08	-0.05
Northeast Asia				
No-C to BAT+	8.92	+0.08	7.24	+0.09
Low-C to BAT+	0.62	-0.01	0.43	nc
BAT+ to baseline	0.62	nc	0.37	-0.01
Middle East				
No-C to BAT+	3.28	+0.06	1.61	+0.07
Low-C to BAT+	0.58	nc	0.39	+0.01
BAT+ to baseline	0.63	nc	0.38	-0.01
Net exporter				
No-C to BAT+	3.73	+0.15	1.93	+0.15
Low-C to BAT+	0.55	-0.01	0.35	-0.01
BAT+ to baseline	0.60	-0.01	0.35	-0.02

Decarbonisation spreads relevant for subsidy mechanisms							23 Jan
		Incl. capex			Excl. capex		
	Unit	Spread	Spread in $/kg	± 16 Jan	Spread	Spread in $/kg	± 16 Jan
France							
No-C to Baseline[1]	€/kg	5.28	5.74	+0.22	3.46	3.76	+0.23
Germany							
No-C to BAT+[2]	€/kg	4.89	5.32	+0.18	3.27	3.56	+0.18
Netherlands							
No-C to baseline[3]	€/kg	3.98	4.33	+0.22	2.17	2.36	+0.22

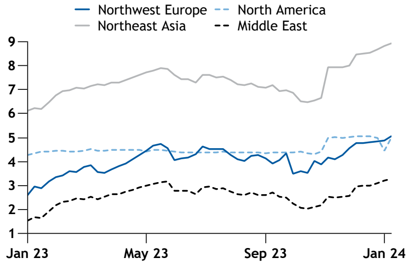
Differentials between the costs of renewable and natural gas-based hydrogen are used in subsidy mechanisms to establish the cost of switching to supply with a lower emissions intensity. The spreads above are relevant for the following:

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

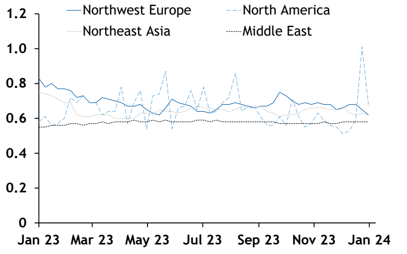
2 Future supply to Thyssenkrupp's direct reduced iron plant in Duisburg

3 Operational support granted to selected projects in Dutch subsidy scheme

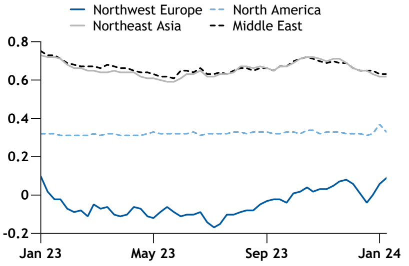
Decarb spread No-C to BAT+ *$/kg*



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



Decarb spread BAT+ to baseline *$/kg*

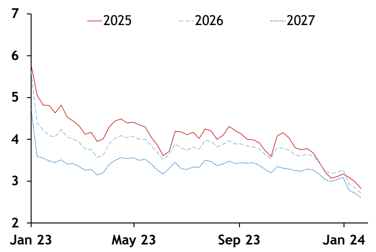


COMPLETE HYDROGEN PRODUCTION COSTS

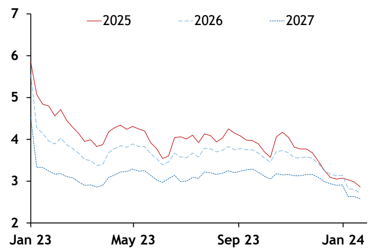
Low-C hydrogen forward									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands									
2025	ATR + CCS	Blue	€/kg	3.20	3.48	-0.13	2.53	2.75	-0.13
2026	ATR + CCS	Blue	€/kg	3.05	3.32	-0.10	2.38	2.59	-0.10
2027	ATR + CCS	Blue	€/kg	2.91	3.17	-0.07	2.24	2.44	-0.07
UK									
2025	ATR + CCS	Blue	£/kg	2.79	3.54	-0.13	2.22	2.82	-0.13
2026	ATR + CCS	Blue	£/kg	2.70	3.43	-0.09	2.14	2.71	-0.10
Germany									
2025	ATR + CCS	Blue	€/kg	3.27	3.56	-0.13	2.18	2.81	-0.14
2026	ATR + CCS	Blue	€/kg	3.12	3.40	-0.11	2.58	2.65	-0.12
2027	ATR + CCS	Blue	€/kg	2.99	3.25	-0.08	2.44	2.51	-0.08
France									
2025	ATR + CCS	Blue	€/kg	3.19	3.47	-0.14	2.50	2.72	-0.14
Spain									
2025	ATR + CCS	Blue	€/kg	3.12	3.40	-0.13	2.40	2.61	-0.13

BAT+ hydrogen forward									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands									
2025	SMR + CCS	Blue	€/kg	2.63	2.86	-0.12	2.14	2.33	-0.11
2026	SMR + CCS	Blue	€/kg	2.49	2.71	-0.09	1.99	2.17	-0.09
2027	SMR + CCS	Blue	€/kg	2.37	2.58	-0.05	1.87	2.04	-0.05
UK									
2025	SMR + CCS	Blue	£/kg	2.25	2.86	-0.12	1.84	2.34	-0.11
2026	SMR + CCS	Blue	£/kg	2.17	2.75	-0.09	1.76	2.23	-0.08
Germany									
2025	SMR + CCS	Blue	€/kg	2.68	2.92	-0.12	2.18	2.37	-0.12
2026	SMR + CCS	Blue	€/kg	2.55	2.77	-0.09	2.05	2.23	-0.09
2027	SMR + CCS	Blue	€/kg	2.43	2.64	-0.06	1.93	2.10	-0.05
France									
2025	SMR + CCS	Blue	€/kg	2.58	2.81	-0.12	2.09	2.27	-0.12
Spain									
2025	SMR + CCS	Blue	€/kg	2.60	2.83	-0.10	2.07	2.25	-0.11

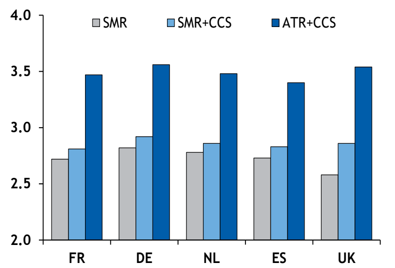
German SMR forward costs *$/kg*



Dutch SMR+CCS forward costs *$/kg*



2025 forward costs *$/kg*



COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen forward									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 16 Jan	Cost	Cost in $/kg	± 16 Jan
Netherlands									
2025	SMR	Grey	€/kg	2.55	2.78	-0.15	2.28	2.48	-0.15
2026	SMR	Grey	€/kg	2.44	2.66	-0.12	2.17	2.36	-0.12
2027	SMR	Grey	€/kg	2.35	2.56	-0.09	2.07	2.25	-0.10
UK									
2025	SMR	Grey	£/kg	2.03	2.58	-0.13	1.80	2.28	-0.14
2026	SMR	Grey	£/kg	1.97	2.50	-0.11	1.73	2.20	-0.11
Germany									
2025	SMR	Grey	€/kg	2.59	2.82	-0.16	2.32	2.52	-0.15
2026	SMR	Grey	€/kg	2.49	2.71	-0.13	2.21	2.41	-0.13
2027	SMR	Grey	€/kg	2.40	2.61	-0.10	2.12	2.31	-0.09
France									
2025	SMR	Grey	€/kg	2.50	2.72	-0.16	2.22	2.42	-0.16
Spain									
2025	SMR	Grey	€/kg	2.51	2.73	-0.14	2.21	2.40	-0.15

Direct reduction iron costs (19 Jan)		$/t
Specification	**Cost**	**±**
Natural gas DRI, ex-works NW Europe	416.34	-19.73
DRI spread No-C hydrogen (renewables+PEM) vs natural gas NW Europe	383.52	+2.71
DRI spread BAT+ hydrogen (SMR+CCS) vs natural gas NW Europe	100.48	-0.19

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

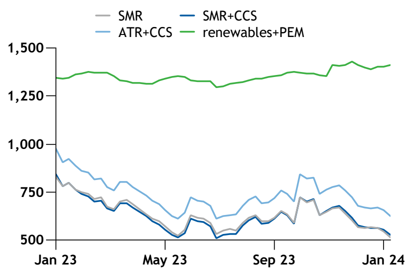
COMPLETE AMMONIA PRODUCTION COSTS

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

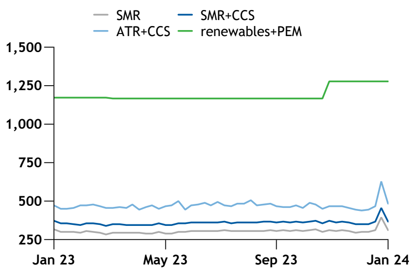
CO2e emissions on a gate-to-gate basis; purity >99.5pc; temperature -33°C

Regional ammonia cost markers						23 Jan
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 16 Jan	Cost	± 16 Jan
Baseline						
Northwest Europe	SMR	€/t	513	-30	400	-33
Northwest Europe	SMR	$/t	558	-37	435	-39
North America	SMR	$/t	311	-82	189	-82
Northeast Asia	SMR	$/t	477	-13	352	-13
Middle East	SMR	$/t	418	-10	298	-11
BAT+						
Northwest Europe	SMR+CCS	€/t	527	-26	377	-27
Northwest Europe	SMR+CCS	$/t	573	-33	410	-32
North America	SMR+CCS	$/t	367	-90	203	-90
Northeast Asia	SMR+CCS	$/t	582	-15	415	-16
Middle East	SMR+CCS	$/t	525	-11	363	-12
Low-C						
Northwest Europe	ATR+CCS	€/t	624	-30	444	-30
Northwest Europe	ATR+CCS	$/t	679	-37	483	-36
North America	ATR+CCS	$/t	484	-144	286	-145
Northeast Asia	ATR+CCS	$/t	689	-16	488	-15
Middle East	ATR+CCS	$/t	625	-10	429	-11
No-C						
Northwest Europe	Island renewable+PEM	€/t	1,412	+10	981	+6
Northwest Europe	Island renewable+PEM	$/t	1,536	nc	1,068	nc
North America	Island renewable+PEM	$/t	1,280	nc	823	nc
Northeast Asia	Island renewable+PEM	$/t	2,269	nc	1,809	nc
Middle East	Island renewable+PEM	$/t	1,136	nc	681	nc
Exporter						
Exporter baseline	SMR	$/t	389	-23	268	-23
Exporter BAT+	SMR+CCS	$/t	490	-26	328	-26
Exporter low-C	ATR+CCS	$/t	586	-26	389	-27
Exporter no-C	Island renewable+PEM	$/t	1,175	nc	696	nc

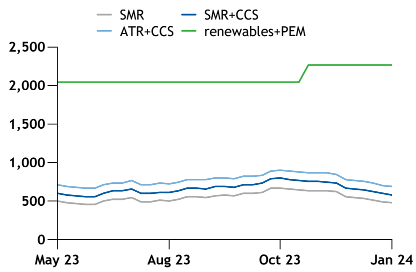
NW Europe ammonia average €/t



North America ammonia average $/t



Northeast Asia ammonia average $/t



COMPLETE AMMONIA PRODUCTION COSTS

No-C ammonia — 23 Jan

	Process	Legacy colour	Unit	Incl. capex			Excl. capex		
				Cost	Cost in $/t	± 16 Jan	Cost	Cost in $/t	± 16 Jan
Netherlands	Wind + PEM	Green	€/t	1,276	1,389	nc	849	924	nc
UK	Wind + PEM	Green	£/t	1,121	1,423	nc	760	965	nc
Germany	Wind + PEM	Green	€/t	1,456	1,584	nc	1,024	1,114	nc
France	Wind + PEM	Green	€/t	1,502	1,634	nc	1,071	1,165	nc
Spain	Diurnal + PEM	Green	€/t	1,055	1,148	nc	630	686	nc
US west coast	Diurnal + PEM	Green	$/t	1,142	1,142	nc	700	700	nc
Canada	Wind + PEM	Green	C$/t	1,911	1,418	nc	1,275	946	nc
Oman	Diurnal + PEM	Green	$/t	1,135	1,135	nc	665	665	nc
Saudi Arabia	Diurnal + PEM	Green	$/t	1,148	1,148	nc	679	679	nc
UAE	Diurnal + PEM	Green	$/t	1,105	1,105	nc	668	668	nc
Qatar	Diurnal + PEM	Green	$/t	1,155	1,155	nc	711	711	nc
Namibia	Diurnal + PEM	Green	$/t	1,279	1,279	nc	699	699	nc
South Africa	Diurnal + PEM	Green	$/t	1,258	1,258	nc	717	717	nc
Japan	Wind + PEM	Green	¥/t	450,668	3,046	nc	380,094	2,569	nc
China	Diurnal + PEM	Green	Yn/t	7,257	1,012	nc	4,202	586	nc
India	Diurnal + PEM	Green	Rs/t	93,261	1,122	nc	52,698	634	nc
South Korea	Wind + PEM	Green	W/t	3,676,593	2,748	nc	3,039,745	2,272	nc
Vietnam	Wind + PEM	Green	$/t	1,677	1,677	nc	1,150	1,150	nc
Australia	Diurnal + PEM	Green	A$/t	1,712	1,126	nc	1,034	680	nc
Brazil	Diurnal + PEM	Green	$/t	1,173	1,173	nc	636	636	nc
Chile	Diurnal + PEM	Green	$/t	1,218	1,218	nc	752	752	nc

Low-C ammonia — 23 Jan

	Process	Legacy colour	Unit	Incl. capex			Excl. capex		
				Cost	Cost in $/t	± 16 Jan	Cost	Cost in $/t	± 16 Jan
Netherlands	ATR + CCS	Blue	€/t	630	686	-36	452	492	-35
UK	ATR + CCS	Blue	£/t	522	662	-42	372	472	-43
Germany	ATR + CCS	Blue	€/t	627	682	-36	445	484	-36
Spain	ATR + CCS	Blue	€/t	611	665	-27	418	455	-27
France	ATR + CCS	Blue	€/t	616	670	-39	435	473	-37
US Gulf coast	ATR + CCS	Blue	$/t	484	484	-74	288	288	-75
Canada	ATR + CCS	Blue	C$/t	651	483	-215	383	284	-215
Japan	ATR + CCS	Blue	¥/t	102,532	693	-16	72,793	492	-15
South Korea	ATR + CCS	Blue	W/t	915,135	684	-16	646,213	483	-15
Australia	ATR + CCS	Blue	A$/t	926	609	-10	622	409	-12
Trinidad	ATR + CCS	Blue	$/t	672	672	-19	373	373	-19
Qatar	ATR + CCS	Blue	$/t	615	615	-10	417	417	-10
UAE	ATR + CCS	Blue	$/t	634	634	-10	441	441	-12
Russia west	ATR + CCS	Blue	$/t	419	419	+1	192	192	nc
Russia east	ATR + CCS	Blue	$/t	411	411	nc	183	183	nc

COMPLETE AMMONIA PRODUCTION COSTS

BAT+ ammonia									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 16 Jan	Cost	Cost in $/t	± 16 Jan
Netherlands	SMR + CCS	Blue	€/t	535	582	-33	387	421	-32
UK	SMR + CCS	Blue	£/t	433	549	-37	310	394	-37
Germany	SMR + CCS	Blue	€/t	529	576	-31	379	412	-31
Spain	SMR + CCS	Blue	€/t	514	559	-29	356	387	-27
France	SMR + CCS	Blue	€/t	516	561	-34	366	398	-32
US Gulf coast	SMR + CCS	Blue	$/t	380	380	-79	218	218	-78
Canada	SMR + CCS	Blue	C$/t	476	353	-101	253	188	-102
Japan	SMR + CCS	Blue	¥/t	85,813	580	-16	61,105	413	-16
South Korea	SMR + CCS	Blue	W/t	781,343	584	-13	556,573	416	-16
Australia	SMR + CCS	Blue	A$/t	809	532	-3	559	368	-3
Trinidad	SMR + CCS	Blue	$/t	573	573	-20	325	325	-21
Qatar	SMR + CCS	Blue	$/t	528	528	-10	364	364	-12
UAE	SMR + CCS	Blue	$/t	521	521	-12	362	362	-12
Russia west	SMR + CCS	Blue	$/t	327	327	nc	139	139	nc
Russia east	SMR + CCS	Blue	$/t	320	320	nc	132	132	nc

BAT+ ammonia										23 Jan
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/t	± 16 Jan	Cost	Cost in $/t	± 16 Jan
Australia	Coal gasification + CCS	5,500	Blue	A$/t	947	623	-3	553	364	-5
Australia	Coal gasification + CCS	6,000	Blue	A$/t	1,024	674	-8	631	415	-9
China	Coal gasification + CCS	3,800	Blue	Yn/t	4,891	682	nc	3,019	421	nc
China	Coal gasification + CCS	5,500	Blue	Yn/t	4,790	668	nc	2,926	408	nc
Indonesia	Coal gasification + CCS	5,500	Blue	$/t	638	638	+2	359	359	nc
Indonesia	Coal gasification + CCS	3,800	Blue	$/t	618	618	nc	339	339	-2
South Africa	Coal gasification + CCS	4,800	Blue	$/t	657	657	-3	332	332	-4
South Africa	Coal gasification + CCS	6,000	Blue	$/t	676	676	-3	349	349	-6
Russia west	Coal gasification + CCS	6,000	Blue	$/t	561	561	-2	278	278	-1
US east coast	Coal gasification + CCS	6,000	Blue	$/t	631	631	-9	379	379	-7

Baseline ammonia									23 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 16 Jan	Cost	Cost in $/t	± 16 Jan
Netherlands	SMR	Grey	€/t	521	567	-37	410	446	-38
UK	SMR	Grey	£/t	389	494	-38	296	376	-40
Germany	SMR	Grey	€/t	516	561	-36	401	436	-38
Spain	SMR	Grey	€/t	500	544	-32	379	412	-35
France	SMR	Grey	€/t	503	547	-38	389	423	-40
US Gulf coast	SMR	Grey	$/t	291	291	-70	170	170	-70
Canada	SMR	Grey	C$/t	446	331	-94	280	208	-93
Japan	SMR	Grey	¥/t	69,686	471	-14	51,044	345	-14
South Korea	SMR	Grey	W/t	646,213	483	-12	478,974	358	-12
Australia	SMR	Grey	A$/t	652	429	-4	462	304	-4
Trinidad	SMR	Grey	$/t	451	451	-17	264	264	-18
Qatar	SMR	Grey	$/t	420	420	-10	299	299	-10
UAE	SMR	Grey	$/t	415	415	-10	297	297	-11
Russia west	SMR	Grey	$/t	235	235	nc	94	94	nc
Russia east	SMR	Grey	$/t	228	228	nc	88	88	nc

COMPLETE AMMONIA PRODUCTION COSTS

Ammonia decarbonisation spreads				23 Jan
	Incl. capex		Excl. capex	
	$/t	± 16 Jan	$/t	± 16 Jan
Northwest Europe				
No-C to BAT+	963	+33	658	+32
Low-C to BAT+	106	-4	73	-4
BAT+ to baseline	15	+4	-25	+7
North America				
No-C to BAT+	913	+90	620	+90
Low-C to BAT+	117	-54	83	-55
BAT+ to baseline	56	-8	14	-8
Northeast Asia				
No-C to BAT+	1,687	+15	1,394	+16
Low-C to BAT+	107	-1	73	+1
BAT+ to baseline	105	-2	63	-3
Middle East				
No-C to BAT+	611	+11	318	+12
Low-C to BAT+	100	+1	66	+1
BAT+ to baseline	107	-1	65	-1
Net exporter				
No-C to BAT+	685	+26	368	+26
Low-C to BAT+	96	nc	61	-1
BAT+ to baseline	101	-3	60	-3

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