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Argus Hydrogen and Future Fuels

Market news, analysis and prices

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Appetite grows for US electrolysers

The IRA could supercharge US electrolyser manufacturing capacity, as demand for US-made equipment is poised to rise, write Emmeline Willey and Stefan Krumpelmann

The US' Inflation Reduction Act (IRA) has been widely seen as a gamechanger for the global hydrogen landscape, making the country one of the most attractive for renewable hydrogen production. But it is not just project developers that expect to reap the benefits — US-based electrolyser manufacturers also hope to profit as they see increased demand for domestically produced equipment.

The hydrogen production tax credit introduced as part of the IRA omitted the domestic content requirement tacked onto many of the law's other clean energy offerings. But developers are wary that using foreign components could lessen their chances of obtaining the federal and state funding upon which many clean hydrogen projects depend, says Traci Kraus, director of government relations at US engineering firm Cummins. They are therefore turning to US manufacturers to supply equipment for their plants, Kraus says.

Other US firms also expect significant traction for their electrolyser business. These includes Plug Power which — besides manufacturing electrolysers and other equipment — also develops its own hydrogen production projects. "We're American-made — that's important to the rules and regulations, whatever happens," chief executive Andy Marsh said during a business update last week, adding that the company expects more detail on the IRA provisions by the end of the second quarter. Stronger demand for electrolysers on the back of the bill could help US firms achieve higher prices. "We have found opportunities to manage pricing of our products to be able to capture higher growth margins," Marsh said.

Marsh did not say whether Plug would focus more heavily on producing electrolysers in the US because of the bill, but he announced that the firm would no longer be involved in a planned 2 GW/yr manufacturing site in Australia. Plug had planned to jointly develop the factory with green energy company Fortescue Future Industries (FFI), but decided not to go ahead "because we saw the economics", Marsh said, adding that "we could do better".

There is not yet any clear global frontrunner in electrolyser manufacturing — countries are "neck and neck", Kraus says. The US was behind as of last year, until the IRA "supercharged" its capacity, she adds. But other countries have recently also pushed ahead, with a focus on building domestic capacity. India's initial outlay for its national green hydrogen mission earmarked 45bn rupees ($550mn) for electrolyser manufacturing, while there has been a flurry of new product launches in China. Europe will also see major capacity expansions this year, including by Cummins, which is adding capacity in Spain and Belgium.

In the US, Cummins is building out manufacturing capacity at its site in Fridley, Minnesota, with an initial goal of 500 MW/yr that could eventually be lifted to 1 GW/yr. The company hopes to access federal funding to automate and scale up capacity, Kraus says. Cummins makes proton exchange membrane (PEM) and alkaline electrolysers, but expects that PEM will ultimately be more efficient for many industries and applications, she says.

Even with a boost from recent legislation, it is not all smooth sailing for US electrolyser firms. Like manufacturers around the world, Cummins faces supply chain challenges, such as accessing iridium, Kraus says. And Plug's overall growth last year fell well short of expectations, partly because of delayed product launches, plant cancellations and increasingly complex supply chains.

Argus launches calculated ammonia production costs

Argus has launched calculated ammonia production costs for a range of countries and production pathways, building on our existing hydrogen production costs. The full range of costs is published on pages 13-16 alongside a taxonomy detailing carbon intensities. Costs, including historic series starting from January 2021, can also be accessed through Argus Direct. For any queries contact hydrogen@argusmedia.com

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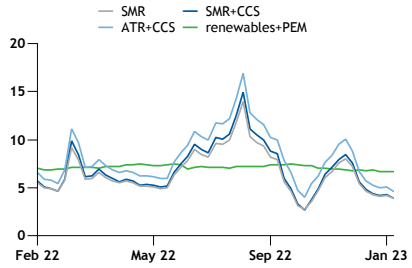
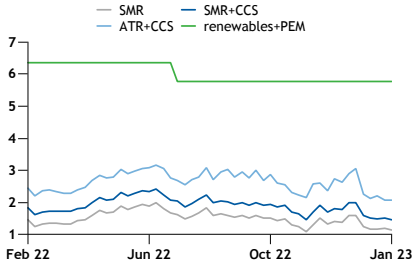
PRODUCTION COSTS OVERVIEW

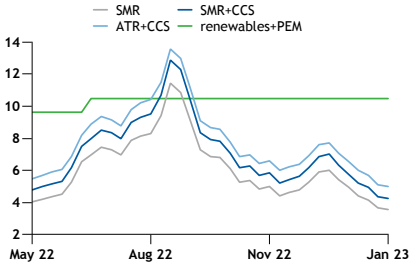
Northwest Europe average cost €/kg



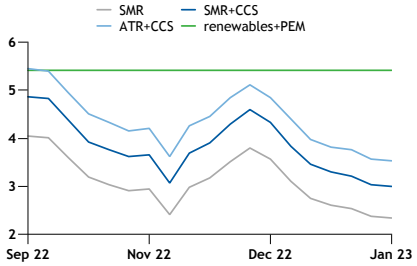
North America average cost $/kg



Northeast Asia average cost $/kg



Exporter average cost $/kg



Regional hydrogen cost markers					31 Jan
		Incl. capex		Excl. capex	
	Process	$/kg	± 24 Jan	$/kg	± 24 Jan
Baseline					
Northwest Europe	SMR	4.24	-0.30	3.95	-0.30
North America	SMR	1.13	-0.05	0.84	-0.05
Northeast Asia	SMR	3.54	-0.10	3.24	-0.10
Middle East	SMR	3.15	-0.13	2.85	-0.13
BAT+					
Northwest Europe	SMR+CCS	4.26	-0.38	3.74	-0.38
North America	SMR+CCS	1.45	-0.05	0.93	-0.05
Northeast Asia	SMR+CCS	4.26	-0.11	3.73	-0.11
Middle East	SMR+CCS	3.88	-0.15	3.35	-0.15
Low-C					
Northwest Europe	ATR+CCS	5.04	-0.43	4.34	-0.43
North America	ATR+CCS	2.06	-0.02	1.36	-0.02
Northeast Asia	ATR+CCS	5.00	-0.12	4.28	-0.13
Middle East	ATR+CCS	4.43	-0.15	3.72	-0.14
No-C					
Northwest Europe	Island renewable+PEM	7.23	nc	5.32	nc
North America	Island renewable+PEM	5.78	nc	3.90	nc
Northeast Asia	Island renewable+PEM	10.48	nc	8.57	nc
Middle East	Island renewable+PEM	5.55	nc	3.69	nc
Exporter					
Exporter baseline	SMR	2.33	-0.04	2.04	-0.04
Exporter BAT+	SMR+CCS	2.99	-0.04	2.46	-0.05
Exporter low-C	ATR+CCS	3.53	-0.03	2.82	-0.03
Exporter no-C	Island renewable+PEM	5.41	nc	3.45	nc

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

CO2e emissions on a gate-to-gate basis

Pump prices, 70MPa			6 Jan
	Unit	Price	± 7 Dec
Japan			
Eneos	¥/kg	1,650.00	+440.00
Iwatani	¥/kg	1,210.00	nc
Germany			
H2Mobility	€/kg	12.85	nc

MARKET DEVELOPMENTS

Namibia lures investors to H2 projects

Namibia hopes early involvement in projects with foreign partners will give it the expertise to get future undertakings off the ground, writes Aidan Lea

Namibia is drawing foreign investment into renewable hydrogen projects as it seeks to capitalise on its ample landmass and strong wind and solar power generation potential.

The country expects to commission its first small-scale projects this year. Among these is the Daures Green Hydrogen Village, where the developing consortium — led by Namibian energy company Enersense — signed an agreement in January granting Australian green energy company Fortescue Future Industries (FFI) a period of exclusivity to study and perform due diligence on the project, with a view to becoming involved in subsequent phases. Daures will start with a 500kWh electrolyser in a pilot phase, but could eventually produce 350,000 t/yr of ammonia using 1GW of renewable energy and 420MW of electrolyser capacity, the consortium says. The developer last month signed a deal to export 40,000 t/yr of ammonia to Zimbabwe-based Sable Chemicals for fertiliser production.

FFI's involvement in Namibia might not remain restricted to Daures. The company is also considering setting up an electrolyser manufacturing site in the country, with a view to potentially supplying projects across Africa, Namibia's presidential economic adviser and green hydrogen commissioner, James Mnyupe, said on the sidelines of an African Energy Chamber investment event in London last week. The Germany-headquartered DSE consortium had already late last year announced plans to build an electrolyser factory in the country, and aims to make this the largest of its kind globally. Namibia is considering offering land or attractive tax rates to encourage such projects, Mnyupe said.

Namibia's flagship Hyphen project is also attracting interest from international companies, according to Mnyupe. One of the largest producers of industrial hydrogen globally could join the project — which is a joint venture between German renewables developer Enertrag and UK investment group Nicholas Holdings — and could provide it with electrolysers, Mnyupe said. Hyphen could eventually produce 300,000 t/yr of renewable hydrogen and 1.7mn t/yr of ammonia. German utility RWE last month signed an agreement for 300,000 t/yr of ammonia offtake from the site from 2027 onwards. The project's estimated total cost of $9.5bn would not be far off Namibia's 2021 GDP of $12.3bn, which demonstrates its gargantuan scale.

Hyphen project plan

	H_2 output t/yr	NH_3 output t/yr	Total cost
Phase 1	120,000	700,000	$4.5bn
Phase 2	300,000	1.7mn	$9.5bn

— Hyphen Hydrogen Energy

Neighbourhood group

A key part of Namibia's strategy to attract investment is regional co-operation, partly because international lenders such as the World Bank prefer cross-border projects, Mnyupe said. Co-operation with South Africa — itself a country with huge hydrogen ambitions — is a particular focus. Namibia and South Africa are looking at several cross-border energy projects including a hydrogen transport network to connect planned renewable hydrogen production sites, Mnyupe said.

Although private investment will be key, the government in Windhoek is eager to be as involved as possible in the development of early projects. Besides reaping the expected benefits once projects are up and running, early involvement would enable the state to gain valuable expertise that could be useful for future undertakings. The contract for Hyphen — in which the government is targeting a 24pc share — "will become a case study around the world and Namibians will have the details from helping develop it", Mnyupe said. More control over projects could also make it easier to encourage synergies with other industries. Namibia could, for example, decide to accept lower margins on its hydrogen business and use this to attract pig iron plants, with the output from these sites then sold to steelmakers in Zambia, Mnyupe said.

MARKET DEVELOPMENTS

South Korea commits more funds to H2, slashes targets

Seoul has bolstered its plan to become the world's leading hydrogen economy, while sounding a more cautious note on infrastructure build-out, write Yongli Tng and Stefan Krumpelmann

South Korea has earmarked 205.9bn won ($170mn) for development of hydrogen technology in this year's budget, but Seoul's recent downward revision of 2030 targets for hydrogen use in power generation demonstrates that fostering demand will be a challenging task.

The funding is intended to underpin South Korea's ambition to develop the "world's number 1 hydrogen economy" — as outlined in November last year — the country's trade, industry and energy ministry said on 26 January. It is part of a W1.2 trillion energy technology investment package that includes renewable electricity generation, nuclear power and carbon capture and storage.

Hydrogen investments will be made across the production, usage and transport spheres. Some W28bn has been set aside for developing ammonia co-firing technology, with a demonstration project to be conducted over 2023-27, while another W25bn has been earmarked for studying hydrogen use in gas turbines for power generation. Planned projects also include development of a 10MW alkaline electrolysis system for renewable hydrogen production and a study of the feasibility of hydrogen blending in city gas pipeline networks.

The funding is in addition to other programmes aimed at facilitating a ramp-up of hydrogen production and demand, such as the hydrogen cities scheme, which was recently expanded. Seoul this month set aside W240bn for six additional hydrogen cities, building on a first phase that introduced pilot projects for three cities in 2019.

But while South Korea is striving to establish a world-leading hydrogen economy, it has faced setbacks. The government recently confirmed its 10th long-term basic electricity plan, which entails a sharp downward revision of targets for hydrogen and ammonia use in power generation, compared with a previous plan from November 2021. Seoul lowered its goal for hydrogen power generation in 2030 to 29TWh, comprising 16TWh from fuel cells and 13TWh from hydrogen and ammonia co-firing at existing gas or coal-fired power plants. This was down from 49TWh — split into 27TWh from fuel cells and 22TWh from hydrogen and ammonia co-firing — previously. The adjustments were made based on considerations related to the feasibility of required technology and the necessary construction of fuel supply infrastructure, the ministry says, indicating that it is now taking a much more conservative outlook on how quickly these can be developed.

Co-firing on all cylinders

Hydrogen and ammonia co-firing could serve as a key demand anchor for the build out of a hydrogen economy in South Korea

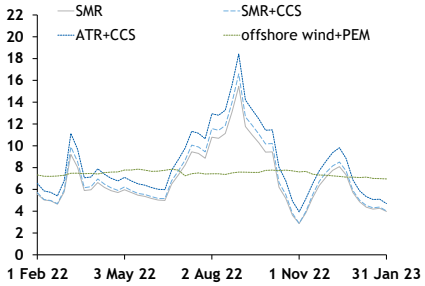
That said, a considerable ramp-up is still expected early in the next decade. The ministry envisages that hydrogen and ammonia power generation will increase to 47.4TWh in 2036 following a significant expansion of infrastructure.

Hydrogen and ammonia co-firing could serve as a key demand anchor for the build out of a hydrogen economy in South Korea while reducing emissions from existing power plants. Meanwhile, fuel cells for power generation are to be installed closed to key demand points in city centres, based on the ministry's plans, to capitalise on their advantages of being relatively small in size, while producing little noise and environmentally harmful substances. Fuel cells could help minimise the burden on transmission and distribution networks, Motie says.

The targets for hydrogen use were not the only ones to be reduced sharply in the most recent long-term electricity plan. Seoul also cut the 2030 target for the share of renewable power in South Korea's generation mix to 21.6pc from a previous goal of 30.2pc as this was no longer deemed feasible — although the revised target will still require a marked increase from the 9.2pc in 2022. Expectations for nuclear power were revised up considerably to plug the gap.

NEWS

German H2 costs incl. capex *€/kg*



Germany's HH2E plans second 1GW H2 plant, eyes more

German hydrogen project developer HH2E is leading a consortium to develop a 100MW hydrogen plant in the state of Saxony by 2025, which could be expanded to 1GW by 2030.

The plant will be located near Borna in the Leipzig district of Saxony in eastern Germany, and is intended to supply offtakers in the chemical industry and commercial air and road transport operators, HH2E says. The first 100MW phase is supported by energy-focused institutional investors Foresight Group and HydrogenOne, which last year became minority shareholders in HH2E and signed a framework agreement to provide €500mn ($544mn) to help HH2E develop five "major projects" at industrial locations in Germany. This is the first time that HydrogenOne has invested directly in a hydrogen project. Its nine previous forays have involved taking equity in hydrogen companies. Germany is attractive to investors as it leads the way in green hydrogen in Europe, HydrogenOne says. The country recently announced plans to develop a 1,800km hydrogen pipeline by 2027.

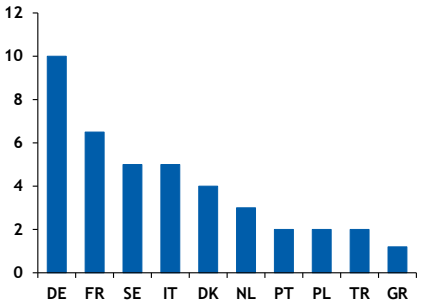
The Borna plant could produce around 6,000 t/yr in the initial stage, rising to 60,000 t/yr at 1GW capacity, according to Foresight. A final investment decision is expected this year and construction will begin shortly after, HH2E says.

HH2E is planning a similar-sized project in Lubmin and says it has identified 15 other "ideal locations" for renewable hydrogen production in Germany. The company aims to install 4GW of electrolyser capacity in Germany by 2030, equivalent to 40pc of the country's 10GW target.

The technology mix developed by HH2E combines an alkaline electrolyser with a high-capacity battery to enable constant hydrogen production without permanent supply of power. Earlier this month, HH2E agreed to buy 120MW of alkaline electrolysers from Norway's Nel, which will partly be used in Lubmin.

By Aidan Lea

2030 minimum electrolyser goals *GW*



Power association urges France to accelerate H2 plans

French electricity industry association UFE has urged the government to take steps to attract new investment and accelerate the development of zero-carbon hydrogen projects in the country.

France's hydrogen strategy sets a goal of having 6.5GW of electrolyser capacity by 2030. This would require a 700-fold increase of current capacity, UFE says, adding that several measures are needed to make this possible. Paris should provide clarity on project tenders up until 2027, and tenders for support could cover the entire range of electrolysers, UFE says. In an upcoming tender mechanism, the eligibility threshold for electrolysis projects should be lowered to 20MW from 30MW, it says. The association also wants the government to accelerate and simplify the process of connecting electrolysers to the grid and to assess how much electricity will be needed to feed future electrolysis capacity.

France published an ordinance in early 2021 aimed at determining how hydrogen will be defined under the French energy code. Now Paris needs to quickly formalise the support mechanisms and texts concerning guarantees of origin and traceability without waiting for the EU to release its framework, UFE says. France should also introduce contracts for difference, it says.

The association urges Paris to analyse the first results of the US' hydrogen production tax credit to modify its own systems and increase its support for capital and operating expenditure. France's current aid focused on capital investment and repayable advances is not sufficient to support the sector, UFE says.

By Emmeline Willey

NEWS

GreenGo picks site for 2GW Danish PtX plant

Danish renewables firm GreenGo has secured a site for a 2GW power-to-X (PtX) facility in western Denmark and expects the plant to reach full capacity in 2030.

GreenGo has formed a partnership with the Ringkobing-Skjern municipality for access to land near the city of Tarm and plans to build 2GW of electrolysis capacity on the site by 2030, which could produce over 1mn t/yr of "green fuels". The company will scale up to this total during the 2020s, but has not yet decided details for each phase.

The first phase will be dedicated to e-methanol production, the most "concrete" option, the firm's PtX and offshore wind director Anders Heine Jensen, says. GreenGo is talking to potential offtakers in shipping, including compatriot Maersk, to understand requirements such as fuel specification and volumes. The firm expects to use CO_2 from biogas farms as feedstock for methanol synthesis. GreenGo might later produce renewable hydrogen and ammonia depending on prices for these fuels. Hydrogen production will additionally depend on development of the Danish section of the European Hydrogen Backbone, which could connect the plant to offtakers in Germany and central Europe. It is expected by 2030, Jensen says.

The project will cost 60bn Danish kroner ($8.8bn), which GreenGo says will come from clients and partners. Selecting investors is the next milestone, Jensen says, and the firm will continue dialogue with the municipality to secure land for its required 4GW of renewable power assets.

Jensen says the project is unique compared with other PtX projects in Denmark because GreenGo wants to fully own the renewable assets as well as the downstream electrolysis and fuel production. This enables control over its power supply and eliminates the need for power purchase agreements, which could fluctuate in price and erode the margins for fuel production, Jensen says.

Its 2GW electrolysis capacity would account for at least a third of Denmark's 4-6GW national target for 2030.

By Aidan Lea

Plug exits FFI's Australian electrolyser factory plan

US hydrogen firm Plug Power has withdrawn its participation in a planned 2GW/yr electrolyser manufacturing site in Australia, but green energy company Fortescue Future Industries (FFI) says its plans for building the factory are unchanged.

Plug has decided not to build the site with FFI "because we saw the economics, we could do better", according to chief executive Andy Marsh. "We really didn't think this was worthwhile to move ahead," Marsh says.

But FFI's chief executive, Mark Hutchinson, says the facility is going ahead as planned. "Our belief is we can get the best economics out of our electrolyser facility," Hutchinson says. "Andy [Marsh] has a different view. That's fine, so bring it on." FFI will use its own technology for manufacturing proton exchange membrane and alkaline electrolysers, and still expects the first units to be produced this year. Hutchinson says the in-house technology has been in development for some time and that "we've learned a lot since the discussion with Plug".

Plug and FFI, a subsidiary of iron ore firm Fortescue Metals, had in 2021 formed a 50:50 joint venture to develop the manufacturing plant in Gladstone — a region that could become a key hub for green hydrogen production.

FFI executive director Andrew Forrest says Plug will continue to supply electrolysers to the Australian firm for some of its hydrogen projects, with Marsh confirming that the two firms will still "work together" on electrolysers.

By Stefan Krumpelmann

NEWS

Australian firm estimates 'gold' hydrogen reserves

A hydrogen subsidiary of Australian oil and gas firm Buru is targeting exploration in an area in South Australia that it says could hold 343,000t of "gold" hydrogen.

Buru subsidiary 2H Resources says it has been advised by South Australia's department for energy and mining that it was the "preferred applicant" to receive grants for six petroleum exploration licences and two gas storage exploration licences. The licences will be formally issued subject to an agreement with relevant native title parties that the company says it hopes to reach before the end of the year.

Natural hydrogen has been found in many petroleum exploration wells in South Australia and in Western Australia's Canning Basin, 2H says. The company engaged independent oil and gas adviser RISC to assess the prospective hydrogen resources in the targeted area, which it found could be in the range of 48,850-1.3mn t, with 343,000t the "best estimate". The areas for which 2H received the licences cover around 30,000km^2, roughly equivalent to the size of Belgium, the firm says.

Although it remains an unproven resource, naturally occurring hydrogen has attracted attention with its promise of requiring less capital expenditure than a typical hydrogen project, such as a new-build blue or green hydrogen facility. The downside of digging for hydrogen is that it rarely exists naturally in high-purity volumes that make extraction worthwhile.

2H says it is performing geophysical analyses of the potential hydrogen fields, and is planning project development activities to support initial light vehicle charging applications, as well as larger-scale production for industrial offtake.

By Emmeline Willey

India's Gujarat targets 8mn t/yr H2 output by 2035

The Indian state of Gujarat aims to become a "global hub of green hydrogen manufacturing capacity", with production of 8mn t/yr in the next 10-12 years, according to the state's cabinet minister of industries Balvantsinh Rajput.

Scaling up hydrogen, batteries and green manufacturing is integral to the state's plan to double down on manufacturing, and the government is offering support to local industries that switch to renewable energy, Rajput told the B20 business summit in Gandhinagar.

Gujarat already contributes 9pc of India's GDP and 18pc of its industrial output. The state wants to boost its own GDP to $500bn/yr by 2026-27 and to $1 trillion/yr by 2030-32, while increasing the share of manufacturing in GDP to more than 50pc over the next decade from 35pc today, Rajput said.

India's hydrogen strategy — detailed earlier this month and bankrolled with an initial outlay of 197.44bn rupees ($2.42bn) — combined with an assistance scheme for industry could enable Gujarat to hit its hydrogen targets and spur green manufacturing of fertilisers, steel and chemicals. The state has "ample availability of wasteland", which can be used for wind and solar power generation and, in turn, production of renewable hydrogen, Rajput says.

Gujarat is India's main export hub, handling 40pc of the country's cargo from its 49 ports, he said, adding that the state's 920km^2 Dholera Special Investment Region (SIR) will emerge as a global manufacturing hub in a few years. Authorities have been pushing the newly created city for over a decade and, although progress appears to have been slow, companies including Indian conglomerate Reliance are considering projects in the SIR.

By Aidan Lea

Indian plans for H2 funding	$bn
Electrolyser manufacturing	0.55
Pilot projects for green H2 use	0.18
Research and development	0.05
Other	0.05
Total	**2.42**

— Indian government

IN BRIEF

Offtake deals for Vertex 1GW plant	MW
Encirc	300+
Essar Oil UK	280+
Tata Chemicals Europe	200+
Pilkington UK	Undisclosed
Total	**780+**
	— *Vertex*

UK's Vertex Hydrogen agrees offtake with Tata Chemicals

UK-based Vertex Hydrogen has agreed to supply blue hydrogen to Tata Chemicals Europe (TCE) for use at its Northwich plant in northwest England. The deal means Vertex has now found offtakers for the majority of the first-stage capacity at a 1GW plant that it is developing next to Essar Oil UK's 195,000 b/d Stanlow refinery. Vertex is a joint venture between Essar Oil UK and low-carbon energy firm Progressive Energy. Vertex and TCE signed a heads of terms offtake agreement for over 200MW. TCE, a subsidiary of India's Tata, makes sodium carbonate, salt and sodium bicarbonate for use in the manufacture of food and animal feed, glass, detergents, chemicals and other products. This is the latest deal that Vertex has lined up with offtakers in the UK's HyNet cluster.

Cepsa, Enagas to build 200MW electrolyser

Spanish integrated energy firm Cepsa is partnering with gas grid operator Enagas and solar photovoltaic (PV) developer Alter Enersun to build a hydrogen electrolyser and PV plant in Huelva, southern Spain, each with a capacity of 200MW. The electrolyser will come on line in 2026 and is to be located at Cepsa's 220,000 b/d refining and petrochemicals complex in Huelva. It will be used to supply green hydrogen for advanced biofuels production at the refinery, replacing Cepsa's existing fossil hydrogen demand. The plant represents the first tranche of 1GW of renewables-powered electrolyser capacity that Cepsa plans to have on line at Huelva by 2030 as part of its 2GW Andalusian Green Hydrogen Valley initiative.

Japan's IHI plans LNG-to-ammonia terminal conversions

Japanese engineering firm IHI plans to convert existing LNG receiving, storage and gasification terminals into ammonia terminals to support development of ammonia supply chains. The firm targets commercial use for ammonia by the latter half of the decade. IHI aims to make use of its experience and technology in corrosion and materials to carry out the conversion with minimal modifications, a shorter construction period and lower costs. It is still examining detailed timelines and at which LNG terminals it will begin exploring potential conversions.

Brasilia promises 'ambitious' hydrogen plan

Brazil's mines and energy minister, Alexandre Silveira, has promised to adopt ambitious energy policies for development of Brazil's hydrogen industry. The government will focus on improving the legal and regulatory framework for the industry to boost investment in capacity for the domestic and export market, Silveira says. He has indicated that his view of the sector is in line with that of the previous government, which promised to take a "rainbow" approach to hydrogen regulations, with renewables, oil and gas production capacity all contributing to the country's hydrogen potential.

US provides $47mn for H2 storage, transport technologies

The US Department of Energy has announced that it is to provide up to $47mn in funding to reduce costs and improve the performance of hydrogen storage and transport technologies. The department anticipates funding projects for 2-4 years — including hydrogen carrier development, onboard liquid hydrogen storage systems, liquid hydrogen fuelling and transfer components and systems, and membrane electrode assemblies for medium and heavy-duty applications. The research and development opportunities spurred by the funding will work in tandem with the US' clean hydrogen hubs programme and its electrolysis research efforts, according to the department.

COMPLETE HYDROGEN PRODUCTION COSTS

No-C Hydrogen									31 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/kg	± 24 Jan	Price	Price in $/kg	± 24 Jan
Netherlands	Wind + PEM	Green	€/kg	5.84	6.35	nc	4.10	4.46	nc
Netherlands	Grid + GOO + ALK	Green	€/kg	11.36	12.35	-1.37	10.31	11.21	-1.37
UK	Wind + PEM	Green	£/kg	4.89	6.05	nc	3.39	4.19	nc
UK	Grid + GOO + ALK	Green	£/kg	12.44	15.40	-1.78	11.53	14.27	-1.79
Germany	Wind + PEM	Green	€/kg	6.96	7.57	nc	5.20	5.65	nc
Germany	Grid + GOO + ALK	Green	€/kg	11.52	12.52	-1.45	10.45	11.36	-1.45
France	Wind + PEM	Green	€/kg	7.16	7.78	nc	5.39	5.86	nc
France	Grid + GOO + ALK	Green	€/kg	14.23	15.47	-2.08	13.17	14.31	-2.08
Spain	Diurnal + PEM	Green	€/kg	4.65	5.05	nc	2.90	3.15	nc
Spain	Grid + GOO + ALK	Green	€/kg	10.15	11.03	-0.62	9.05	9.84	-0.62
US west coast	Diurnal + PEM	Green	$/kg	5.12	5.12	nc	3.29	3.29	nc
Canada	Wind + PEM	Green	C$/kg	8.58	6.43	nc	6.02	4.51	nc
Oman	Diurnal + PEM	Green	$/kg	5.45	5.45	nc	3.53	3.53	nc
Saudi Arabia	Diurnal + PEM	Green	$/kg	5.53	5.53	nc	3.61	3.61	nc
UAE	Diurnal + PEM	Green	$/kg	5.61	5.61	nc	3.83	3.83	nc
Qatar	Diurnal + PEM	Green	$/kg	5.59	5.59	nc	3.77	3.77	nc
Namibia	Diurnal + PEM	Green	$/kg	5.94	5.94	nc	3.61	3.61	nc
South Africa	Diurnal + PEM	Green	$/kg	5.90	5.90	nc	3.72	3.72	nc
Japan	Wind + PEM	Green	¥/kg	1,795	13.80	nc	1,542	11.86	nc
China	Diurnal + PEM	Green	Yn/kg	32.06	4.73	nc	19.32	2.85	nc
India	Diurnal + PEM	Green	Rs/kg	402.65	4.94	nc	239.64	2.94	nc
South Korea	Wind + PEM	Green	W/kg	15,926	12.92	nc	13,547	10.99	nc
Vietnam	Wind + PEM	Green	$/kg	7.86	7.86	nc	5.75	5.75	nc
Australia	Diurnal + PEM	Green	A$/kg	7.10	5.03	nc	4.49	3.18	nc
Brazil	Diurnal + PEM	Green	$/kg	5.41	5.41	nc	3.23	3.23	nc
Chile	Diurnal + PEM	Green	$/kg	5.40	5.40	nc	3.48	3.48	nc

Low-C hydrogen									31 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/kg	± 24 Jan	Price	Price in $/kg	± 24 Jan
Netherlands	ATR + CCS	Blue	€/kg	4.66	5.06	-0.42	4.01	4.36	-0.43
UK	ATR + CCS	Blue	£/kg	5.06	5.06	-0.43	4.38	4.38	-0.43
Germany	ATR + CCS	Blue	€/kg	4.70	5.11	-0.42	4.05	4.40	-0.42
Spain	ATR + CCS	Blue	€/kg	4.42	4.80	-0.36	3.72	4.04	-0.37
France	ATR + CCS	Blue	€/kg	4.55	4.95	-0.45	3.91	4.25	-0.45
US Gulf coast	ATR + CCS	Blue	$/kg	1.97	1.97	-0.05	1.27	1.27	-0.05
Canada	ATR + CCS	Blue	C$/kg	2.87	2.15	+0.01	1.92	1.44	+0.01
Japan	ATR + CCS	Blue	¥/kg	675	5.19	-0.13	581	4.47	-0.14
South Korea	ATR + CCS	Blue	W/kg	5,929	4.81	-0.11	5,041	4.09	-0.11
Australia	ATR + CCS	Blue	A$/kg	4.66	3.30	+0.22	3.64	2.58	+0.21
Trinidad	ATR + CCS	Blue	$/kg	4.47	4.47	-0.33	3.41	3.41	-0.33
Qatar	ATR + CCS	Blue	$/kg	4.36	4.36	-0.14	3.64	3.64	-0.14
UAE	ATR + CCS	Blue	$/kg	4.50	4.50	-0.15	3.79	3.79	-0.15
Russia west	ATR + CCS	Blue	$/kg	1.88	1.88	+0.01	1.06	1.06	nc
Russia east	ATR + CCS	Blue	$/kg	1.75	1.75	nc	0.93	0.93	nc

COMPLETE HYDROGEN PRODUCTION COSTS

BAT+ hydrogen									31 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/kg	± 24 Jan	Price	Price in $/kg	± 24 Jan
Netherlands	SMR + CCS	Blue	€/kg	3.97	4.32	-0.38	3.51	3.81	-0.38
UK	SMR + CCS	Blue	£/kg	4.20	4.20	-0.37	3.70	3.70	-0.36
Germany	SMR + CCS	Blue	€/kg	4.02	4.37	-0.37	3.54	3.85	-0.37
Spain	SMR + CCS	Blue	€/kg	3.77	4.10	-0.34	3.27	3.55	-0.34
France	SMR + CCS	Blue	€/kg	3.76	4.09	-0.38	3.28	3.57	-0.38
US Gulf coast	SMR + CCS	Blue	$/kg	1.45	1.45	-0.04	0.94	0.94	-0.04
Canada	SMR + CCS	Blue	C$/kg	1.92	1.44	-0.06	1.23	0.92	-0.06
Japan	SMR + CCS	Blue	¥/kg	557	4.28	-0.11	488	3.75	-0.11
South Korea	SMR + CCS	Blue	W/kg	5,226	4.24	-0.11	4,573	3.71	-0.11
Australia	SMR + CCS	Blue	A$/kg	3.87	2.74	+0.17	3.12	2.21	+0.16
Trinidad	SMR + CCS	Blue	$/kg	3.93	3.93	-0.34	3.15	3.15	-0.34
Qatar	SMR + CCS	Blue	$/kg	3.88	3.88	-0.15	3.35	3.35	-0.15
UAE	SMR + CCS	Blue	$/kg	3.88	3.88	-0.15	3.35	3.35	-0.15
Russia west	SMR + CCS	Blue	$/kg	1.33	1.33	nc	0.73	0.73	nc
Russia east	SMR + CCS	Blue	$/kg	1.22	1.22	nc	0.62	0.62	nc

BAT+ hydrogen						31 Jan
					Excl. capex	
	Process	Legacy colour	Unit	Price	Price in $/kg	± 24 Jan
Netherlands	SMR + CCS retrofit	Blue	€/kg	3.64	3.96	-0.37
UK	SMR + CCS retrofit	Blue	£/kg	3.09	3.82	-0.35
Germany	SMR + CCS retrofit	Blue	€/kg	3.68	4.00	-0.36
Spain	SMR + CCS retrofit	Blue	€/kg	3.40	3.70	-0.33
France	SMR + CCS retrofit	Blue	€/kg	3.42	3.72	-0.37
US Gulf coast	SMR + CCS retrofit	Blue	$/kg	0.91	0.91	-0.05
Canada	SMR + CCS retrofit	Blue	C$/kg	1.32	0.99	-0.06
Japan	SMR + CCS retrofit	Blue	¥/kg	485	3.73	-0.11
South Korea	SMR + CCS retrofit	Blue	W/kg	4,573	3.71	-0.11
Australia	SMR + CCS retrofit	Blue	A$/kg	3.09	2.19	+0.16
Trinidad	SMR + CCS retrofit	Blue	$/kg	3.13	3.13	-0.34
Qatar	SMR + CCS retrofit	Blue	$/kg	3.33	3.33	-0.15
UAE	SMR + CCS retrofit	Blue	$/kg	3.33	3.33	-0.15
Russia west	SMR + CCS retrofit	Blue	$/kg	0.71	0.71	nc
Russia east	SMR + CCS retrofit	Blue	$/kg	0.59	0.59	-0.01

BAT+ hydrogen											31 Jan
						Incl. capex			Excl. capex		
	Process	kcal/kg	Legacy colour	Unit	Price	Price in $/kg	± 24 Jan	Price	Price in $/kg	± 24 Jan	
Australia	Coal gasification + CCS	5,500	Blue	A$/kg	4.60	3.26	+0.01	3.56	2.52	+0.02	
Australia	Coal gasification + CCS	6,000	Blue	A$/kg	7.53	5.34	-0.33	6.48	4.59	-0.33	
China	Coal gasification + CCS	3,800	Blue	Yn/kg	24.67	3.64	-0.03	19.52	2.88	-0.02	
China	Coal gasification + CCS	5,500	Blue	Yn/kg	24.47	3.61	-0.01	19.25	2.84	-0.01	
Indonesia	Coal gasification + CCS	5,500	Blue	$/kg	3.42	3.42	-0.03	2.59	2.59	-0.03	
Indonesia	Coal gasification + CCS	3,800	Blue	$/kg	3.17	3.17	-0.03	2.33	2.33	-0.04	
South Africa	Coal gasification + CCS	4,800	Blue	$/kg	3.35	3.35	+0.05	2.35	2.35	+0.05	
South Africa	Coal gasification + CCS	6,000	Blue	$/kg	3.51	3.51	-0.22	2.51	2.51	-0.22	
Russia west	Coal gasification + CCS	6,000	Blue	$/kg	2.71	2.71	nc	1.86	1.86	+0.01	
US east coast	Coal gasification + CCS	6,000	Blue	$/kg	3.46	3.46	-0.09	2.73	2.73	-0.09	

COMPLETE HYDROGEN PRODUCTION COSTS

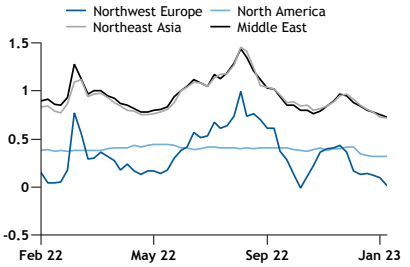
Baseline hydrogen									31 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/kg	± 24 Jan	Price	Price in $/kg	± 24 Jan
Netherlands	SMR	Grey	€/kg	3.96	4.30	-0.30	3.69	4.01	-0.31
UK	SMR	Grey	£/kg	3.26	4.04	-0.30	3.04	3.76	-0.30
Germany	SMR	Grey	€/kg	3.98	4.33	-0.30	3.72	4.04	-0.30
Spain	SMR	Grey	€/kg	3.74	4.07	-0.28	3.47	3.77	-0.27
France	SMR	Grey	€/kg	3.75	4.08	-0.30	3.49	3.79	-0.30
US Gulf coast	SMR	Grey	$/kg	0.94	0.94	-0.04	0.65	0.65	-0.04
Canada	SMR	Grey	C$/kg	1.76	1.32	-0.05	1.37	1.03	-0.05
Japan	SMR	Grey	¥/kg	456	3.51	-0.10	417	3.21	-0.10
South Korea	SMR	Grey	W/kg	4,401	3.57	-0.09	4,031	3.27	-0.10
Australia	SMR	Grey	A$/kg	2.96	2.10	+0.15	2.55	1.81	+0.15
Trinidad	SMR	Grey	$/kg	3.10	3.10	-0.31	2.67	2.67	-0.30
Qatar	SMR	Grey	$/kg	3.15	3.15	-0.13	2.85	2.85	-0.13
UAE	SMR	Grey	$/kg	3.14	3.14	-0.14	2.85	2.85	-0.13
Russia west	SMR	Grey	$/kg	0.80	0.80	nc	0.46	0.46	nc
Russia east	SMR	Grey	$/kg	0.69	0.69	nc	0.36	0.36	nc

Baseline hydrogen									31 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/kg	± 24 Jan	Price	Price in $/kg	± 24 Jan
Netherlands	Grid + ALK	Yellow	€/kg	10.91	11.86	-1.34	9.86	10.72	-1.34
Netherlands	Grid + PEM	Yellow	€/kg	11.27	12.25	-1.25	9.60	10.43	-1.24
UK	Grid + ALK	Yellow	£/kg	12.05	14.91	-1.78	11.14	13.79	-1.78
UK	Grid + PEM	Yellow	£/kg	12.18	15.08	-1.65	10.74	13.29	-1.65
Germany	Grid + ALK	Yellow	€/kg	11.07	12.03	-1.42	10.00	10.87	-1.42
Germany	Grid + PEM	Yellow	€/kg	11.43	12.42	-1.32	9.72	10.57	-1.32
France	Grid + ALK	Yellow	€/kg	13.78	14.98	-2.05	12.71	13.82	-2.05
France	Grid + PEM	Yellow	€/kg	13.95	15.16	-1.91	12.25	13.31	-1.92
Spain	Grid + ALK	Yellow	€/kg	9.70	10.54	-0.60	8.60	9.35	-0.59
Spain	Grid + PEM	Yellow	€/kg	10.17	11.05	-0.56	8.42	9.15	-0.56
US west coast	Grid + ALK	Yellow	$/kg	12.25	12.25	-4.82	11.10	11.10	-4.82
US west coast	Grid + PEM	Yellow	$/kg	12.61	12.61	-4.50	10.78	10.78	-4.49
US Midwest	Grid + ALK	Yellow	$/kg	5.91	5.91	-1.03	4.76	4.76	-1.03
US Midwest	Grid + PEM	Yellow	$/kg	6.71	6.71	-0.96	4.88	4.88	-0.96
US east coast	Grid + ALK	Yellow	$/kg	6.46	6.46	-1.60	5.31	5.31	-1.60
US east coast	Grid + PEM	Yellow	$/kg	7.22	7.22	-1.49	5.39	5.39	-1.49
Japan	Grid + ALK	Yellow	¥/kg	1,986	15.27	-0.75	1,834	14.10	-0.75
Japan	Grid + PEM	Yellow	¥/kg	2,008	15.44	-0.70	1,765	13.57	-0.70

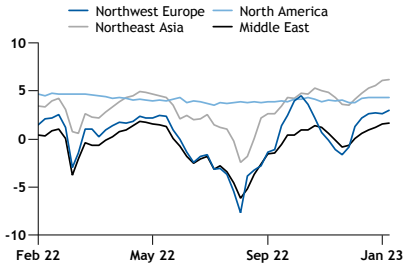
COMPLETE HYDROGEN PRODUCTION COSTS

Decarbonisation spreads	Incl. capex		Excl. capex	31 Jan
	$/kg	± 24 Jan	$/kg	± 24 Jan
Northwest Europe				
No-C to BAT+	2.97	+0.38	1.58	+0.38
BAT+ to baseline	0.02	-0.08	-0.21	-0.08
North America				
No-C to BAT+	4.33	+0.05	2.97	+0.05
BAT+ to baseline	0.32	nc	0.09	nc
Northeast Asia				
No-C to BAT+	6.22	+0.11	4.84	+0.11
BAT+ to baseline	0.72	-0.01	0.49	-0.01
Middle East				
No-C to BAT+	1.67	+0.15	0.34	+0.15
BAT+ to baseline	0.73	-0.02	0.50	-0.02
Net exporter				
No-C to BAT+	2.42	+0.04	0.99	+0.05
BAT+ to baseline	0.66	nc	0.42	-0.01

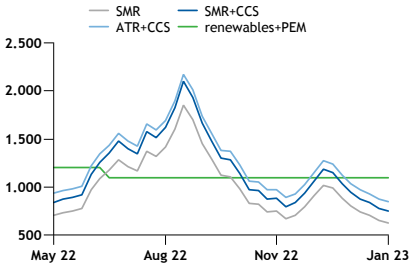
Decarb spread BAT+ to baseline $/kg



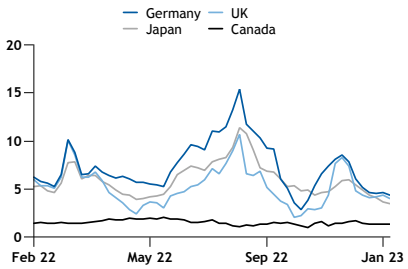
Decarb spread No-C to BAT+ $/kg



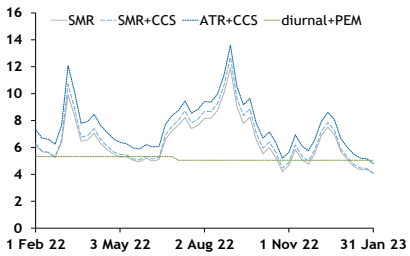
Middle East average cost $/kg



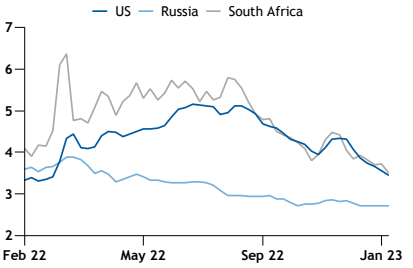
SMR H2 costs incl. capex $/kg



Spanish H2 costs incl. capex $/kg



Coal H2 costs NAR 6,000 $/kg



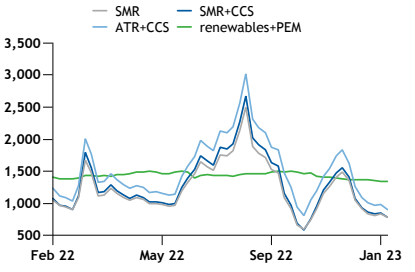
COMPLETE AMMONIA PRODUCTION COSTS

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

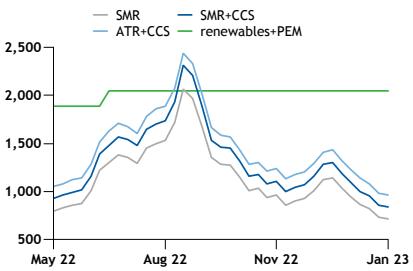
CO2e emissions on a gate-to-gate basis; purity >99.5pc; temperature -33°C

Regional ammonia cost markers					31 Jan
		Incl. capex		Excl. capex	
	Process	$/t	± 24 Jan	$/t	± 24 Jan
Baseline					
Northwest Europe	SMR	846	-51	730	-52
North America	SMR	316	-8	200	-7
Northeast Asia	SMR	714	-16	594	-17
Middle East	SMR	627	-23	514	-22
BAT+					
Northwest Europe	SMR+CCS	850	-64	695	-65
North America	SMR+CCS	370	-8	215	-8
Northeast Asia	SMR+CCS	837	-19	678	-19
Middle East	SMR+CCS	752	-26	599	-26
Low-C					
Northwest Europe	ATR+CCS	983	-74	796	-74
North America	ATR+CCS	475	-3	288	-3
Northeast Asia	ATR+CCS	964	-20	772	-22
Middle East	ATR+CCS	846	-25	662	-24
No-C					
Northwest Europe	Island renewable+PEM	1,458	nc	1,056	nc
North America	Island renewable+PEM	1,173	nc	782	nc
Northeast Asia	Island renewable+PEM	2,050	nc	1,648	nc
Middle East	Island renewable+PEM	1,095	nc	705	nc
Exporter					
Exporter baseline	SMR	507	-6	392	-6
Exporter BAT+	SMR+CCS	618	-8	464	-8
Exporter low-C	ATR+CCS	712	-4	525	-6
Exporter no-C	Island renewable+PEM	1,081	nc	671	nc

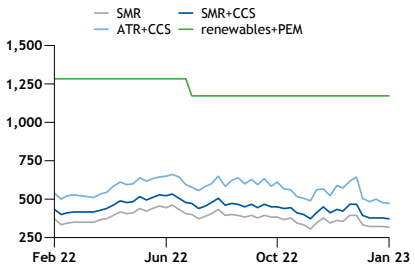
NW Europe ammonia incl. capex $/t



NE Asia ammonia incl. capex $/t



N America ammonia incl. capex $/t



COMPLETE AMMONIA PRODUCTION COSTS

No-C ammonia									31 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/t	± 24 Jan	Price	Price in $/t	± 24 Jan
Netherlands	Wind + PEM	Green	€/t	1,193	1,297	nc	828	900	nc
UK	Wind + PEM	Green	£/t	986	1,220	nc	669	828	nc
Germany	Wind + PEM	Green	€/t	1,392	1,513	nc	1,021	1,110	nc
France	Wind + PEM	Green	€/t	1,438	1,563	nc	1,066	1,159	nc
Spain	Diurnal + PEM	Green	€/t	936	1,017	nc	573	623	nc
US west coast	Diurnal + PEM	Green	$/t	1,040	1,040	nc	663	663	nc
Canada	Wind + PEM	Green	C$/t	1,741	1,305	nc	1,202	901	nc
Oman	Diurnal + PEM	Green	$/t	1,077	1,077	nc	674	674	nc
Saudi Arabia	Diurnal + PEM	Green	$/t	1,090	1,090	nc	688	688	nc
UAE	Diurnal + PEM	Green	$/t	1,108	1,108	nc	734	734	nc
Qatar	Diurnal + PEM	Green	$/t	1,104	1,104	nc	725	725	nc
Namibia	Diurnal + PEM	Green	$/t	1,189	1,189	nc	687	687	nc
South Africa	Diurnal + PEM	Green	$/t	1,171	1,171	nc	706	706	nc
Japan	Wind + PEM	Green	¥/t	349,149	2,685	nc	296,094	2,277	nc
China	Diurnal + PEM	Green	Yn/t	6,331	934	nc	3,694	545	nc
India	Diurnal + PEM	Green	Rs/t	79,390	974	nc	45,319	556	nc
South Korea	Wind + PEM	Green	W/t	3,119,797	2,531	nc	2,616,882	2,123	nc
Vietnam	Wind + PEM	Green	$/t	1,547	1,547	nc	1,093	1,093	nc
Australia	Diurnal + PEM	Green	A$/t	1,451	1,028	nc	913	647	nc
Brazil	Diurnal + PEM	Green	$/t	1,076	1,076	nc	614	614	nc
Chile	Diurnal + PEM	Green	$/t	1,063	1,063	nc	664	664	nc

Low-C ammonia									31 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/t	± 24 Jan	Price	Price in $/t	± 24 Jan
Netherlands	ATR + CCS	Blue	€/t	913	992	-72	742	807	-73
UK	ATR + CCS	Blue	£/t	972	972	-74	794	794	-73
Germany	ATR + CCS	Blue	€/t	910	989	-72	736	800	-72
Spain	ATR + CCS	Blue	€/t	859	934	-62	675	734	-63
France	ATR + CCS	Blue	€/t	891	969	-76	719	782	-77
US Gulf coast	ATR + CCS	Blue	$/t	460	460	-8	274	274	-9
Canada	ATR + CCS	Blue	C$/t	652	489	+2	402	301	+2
Japan	ATR + CCS	Blue	¥/t	128,997	992	-22	104,030	800	-24
South Korea	ATR + CCS	Blue	W/t	1,152,513	935	-19	917,080	744	-19
Australia	ATR + CCS	Blue	A$/t	979	694	+38	710	503	+36
Trinidad	ATR + CCS	Blue	$/t	894	894	-56	609	609	-56
Qatar	ATR + CCS	Blue	$/t	836	836	-24	650	650	-23
UAE	ATR + CCS	Blue	$/t	856	856	-25	673	673	-26
Russia west	ATR + CCS	Blue	$/t	420	420	+2	204	204	nc
Russia east	ATR + CCS	Blue	$/t	398	398	nc	182	182	nc

COMPLETE AMMONIA PRODUCTION COSTS

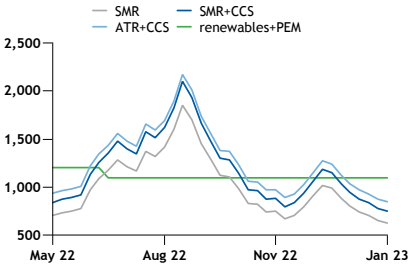
BAT+ ammonia							31 Jan		
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/t	± 24 Jan	Price	Price in $/t	± 24 Jan
Netherlands	SMR + CCS	Blue	€/t	796	865	-65	656	713	-65
UK	SMR + CCS	Blue	£/t	825	825	-63	677	677	-62
Germany	SMR + CCS	Blue	€/t	794	863	-63	650	706	-64
Spain	SMR + CCS	Blue	€/t	750	815	-58	598	650	-58
France	SMR + CCS	Blue	€/t	756	822	-64	613	666	-65
US Gulf coast	SMR + CCS	Blue	$/t	371	371	-7	218	218	-6
Canada	SMR + CCS	Blue	C$/t	491	368	-10	283	212	-10
Japan	SMR + CCS	Blue	¥/t	108,711	836	-19	88,035	677	-18
South Korea	SMR + CCS	Blue	W/t	1,032,947	838	-18	836,958	679	-19
Australia	SMR + CCS	Blue	A$/t	844	598	+29	619	439	+27
Trinidad	SMR + CCS	Blue	$/t	801	801	-58	565	565	-58
Qatar	SMR + CCS	Blue	$/t	754	754	-26	600	600	-26
UAE	SMR + CCS	Blue	$/t	750	750	-25	598	598	-26
Russia west	SMR + CCS	Blue	$/t	326	326	nc	147	147	nc
Russia east	SMR + CCS	Blue	$/t	307	307	nc	129	129	nc

BAT+ ammonia								31 Jan		
					Incl. capex			Excl. capex		
	Process	kcal/kg	Legacy colour	Unit	Price	Price in $/t	± 24 Jan	Price	Price in $/t	± 24 Jan
Australia	Coal gasification + CCS	5,500	Blue	A$/t	883	626	+2	646	458	+4
Australia	Coal gasification + CCS	6,000	Blue	A$/t	1,384	981	-57	1,146	812	-56
China	Coal gasification + CCS	3,800	Blue	Yn/t	4,582	676	-6	3,423	505	-3
China	Coal gasification + CCS	5,500	Blue	Yn/t	4,548	671	-2	3,375	498	-2
Indonesia	Coal gasification + CCS	5,500	Blue	$/t	640	640	-5	453	453	-6
Indonesia	Coal gasification + CCS	3,800	Blue	$/t	597	597	-5	409	409	-7
South Africa	Coal gasification + CCS	4,800	Blue	$/t	639	639	+8	413	413	+9
South Africa	Coal gasification + CCS	6,000	Blue	$/t	666	666	-38	440	440	-38
Russia west	Coal gasification + CCS	6,000	Blue	$/t	522	522	nc	331	331	+2
US east coast	Coal gasification + CCS	6,000	Blue	$/t	657	657	-15	492	492	-15

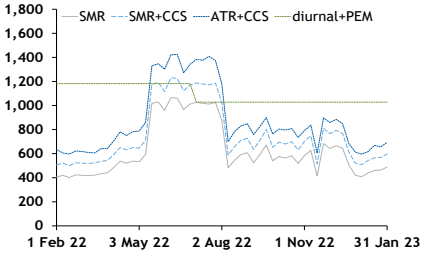
Baseline ammonia							31 Jan		
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Price	Price in $/t	± 24 Jan	Price	Price in $/t	± 24 Jan
Netherlands	SMR	Grey	€/t	793	862	-51	687	747	-53
UK	SMR	Grey	£/t	645	798	-51	556	688	-51
Germany	SMR	Grey	€/t	788	856	-51	680	739	-51
Spain	SMR	Grey	€/t	744	809	-48	633	688	-46
France	SMR	Grey	€/t	754	820	-51	648	704	-51
US Gulf coast	SMR	Grey	$/t	284	284	-7	168	168	-7
Canada	SMR	Grey	C$/t	463	347	-9	308	231	-8
Japan	SMR	Grey	¥/t	91,676	705	-17	75,942	584	-17
South Korea	SMR	Grey	W/t	891,194	723	-15	744,511	604	-17
Australia	SMR	Grey	A$/t	690	489	+26	523	371	+26
Trinidad	SMR	Grey	$/t	659	659	-53	482	482	-52
Qatar	SMR	Grey	$/t	630	630	-22	514	514	-23
UAE	SMR	Grey	$/t	623	623	-24	513	513	-22
Russia west	SMR	Grey	$/t	235	235	nc	101	101	nc
Russia east	SMR	Grey	$/t	217	217	nc	84	84	nc

COMPLETE AMMONIA PRODUCTION COSTS

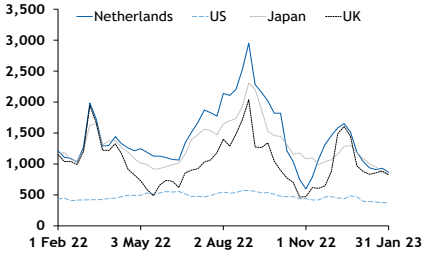
Middle East ammonia incl. capex $/t



Australia ammonia incl. capex $/t



SMR+CCS ammonia incl. capex $/t



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