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Argus Hydrogen and Future Fuels

Market news, analysis and prices

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Can Germany reinvigorate Danish green H2?

Berlin appears to be betting on Denmark's planned H2 pipeline between the two countries being able to deliver cheaper supply, writes Stefan Krumpelmann

Danish industry participants have repeatedly bemoaned the fact that public funding for the sector has dried up since initial allocations in 2023, but now Denmark's southern neighbour could propel some of the country's largest projects forward.

Germany's economy and energy ministry last week ran a consultation on plans to make up to €1.3bn ($1.5bn) available under the upcoming European Hydrogen Bank auctions-as-a-service scheme. But instead of supporting domestic projects, it wants to fund plants that can feed supply into the planned hydrogen pipeline from Denmark's Esbjerg to Ellund, for delivery into the future German core grid.

Berlin appears to be hoping that Danish projects can deliver supply to German industry at lower costs than domestic ventures and have a higher chance of being realised — even as they also require subsidies to materialise.

Higher utilisation rates in particular could be a big advantage for Danish projects. The German ministry says it wants to support projects with at least 7,000 full-load hours. In Denmark, this could possibly be achieved because the country's electricity mix is on track to be 90pc renewable before 2030. This would exempt plants linked to the grid from key requirements under the EU's renewable hydrogen definition, including hourly and temporal correlation and additionality.

Two large projects stand out as potential major beneficiaries of Germany's funding support — Switzerland-headquartered MorGen Energy's Njordkraft plant and Danish fund manager Copenhagen Infrastructure Partners' (CIP) Host PtX facility. Both are located near Esbjerg, are targeting 1GW of electrolyser capacity and are eyeing deliveries into the planned pipeline. MorGen's website states that Njordkraft could make 135,000 t/yr of renewable hydrogen, while CIP's most recent release on Host PtX referred to a production capacity of about 120,000 t/yr.

Danish industry body Hydrogen Denmark's project map shows only a few other plants in the vicinity of the pipeline, with none exceeding 20MW capacity.

Germany may have to tweak some auction terms compared with the EU rules if it wants to allocate €1.3bn, in particular a provision that caps support for individual projects at €250mn.

In the consultation text, the ministry said it would limit total allocations at €700mn if the marginal winning bid is above €1.50/kg. In this case, the funding could support at most 46,000 t/yr over the 10-year subsidy period. But if the marginal bid is at or below €1.50/kg, this would unlock the remaining €600mn based on the ministry's plans. It could then subsidise at least 87,000 t/yr. If all funding can go to a single project and Njordkraft or Host PtX secure the support for their declared output, the €1.3bn could provide €0.96/kg or €1.08/kg, respectively.

Germany has yet to decide the final rules and Berlin still requires the green light from the EU to provide the state aid.

If approved, the funding could increase the likelihood that the Esbjerg-Ellund link will get built. Denmark's government has given its okay for the link and committed public funding, but on the condition that shippers book at least 500MW of entry and exit capacity for 2031-40 at a sales process that will open in January.

The target output for Njordkraft and Host PtX would equate to 410MW and 460MW, respectively, based on hydrogen's lower heating value, indicating that each project alone could require close to or even all of the 500MW capacity. If both go through, they could far exceed the booking target.

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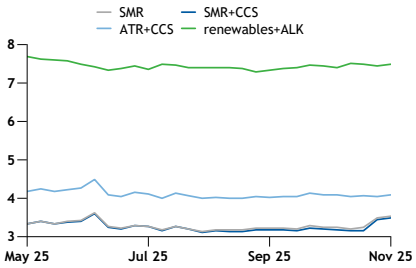
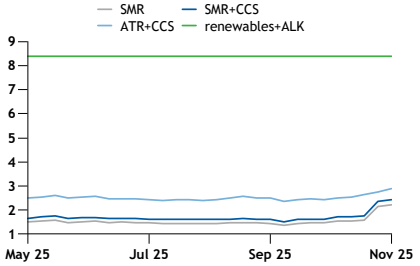
HYDROGEN COSTS

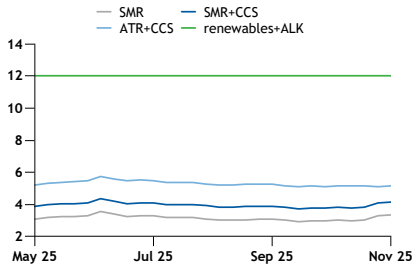
Northwest Europe average cost €/kg



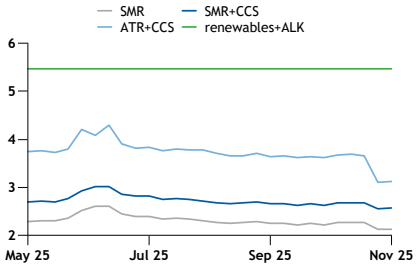
North America average cost $/kg



Northeast Asia average cost $/kg



Exporter average cost $/kg



Regional hydrogen cost markers						25 Nov
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 18 Nov	Cost	± 18 Nov
Baseline						
Northwest Europe	SMR	€/kg	3.53	+0.03	2.70	+0.02
Northwest Europe	SMR	$/kg	4.07	+0.01	3.11	nc
North America	SMR	$/kg	2.22	+0.08	1.19	+0.08
Northeast Asia	SMR	$/kg	3.34	+0.06	2.39	+0.06
BAT+						
Northwest Europe	SMR+CCS	€/kg	3.48	+0.04	2.54	+0.03
Northwest Europe	SMR+CCS	$/kg	4.01	+0.01	2.93	+0.01
North America	SMR+CCS	$/kg	2.42	+0.08	1.26	+0.08
Northeast Asia	SMR+CCS	$/kg	4.16	+0.06	3.09	+0.06
Low-C						
Northwest Europe	ATR+CCS	€/kg	4.08	+0.03	3.03	+0.03
Northwest Europe	ATR+CCS	$/kg	4.71	+0.01	3.50	+0.01
North America	ATR+CCS	$/kg	2.88	+0.12	1.57	+0.13
Northeast Asia	ATR+CCS	$/kg	5.15	+0.06	3.95	+0.07
No-C						
Northwest Europe	Island renewable+PEM	€/kg	7.49	+0.05	6.14	+0.04
Northwest Europe	Island renewable+PEM	$/kg	8.64	nc	7.08	nc
North America	Island renewable+PEM	$/kg	8.41	nc	6.66	nc
Northeast Asia	Island renewable+PEM	$/kg	12.02	nc	10.48	nc
Exporter						
Exporter baseline	SMR	$/kg	2.13	+0.01	1.42	+0.01
Exporter BAT+	SMR+CCS	$/kg	2.57	+0.01	1.77	+0.02
Exporter low-C	ATR+CCS	$/kg	3.12	+0.02	2.21	+0.03
Exporter no-C	Island renewable+PEM	$/kg	5.47	nc	3.48	nc

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

CO2e emissions on a gate-to-gate basis

Pump prices, 70MPa				4 Nov
	Unit	Price		± 2 Oct
Japan				
Iwatani	¥/kg	1,650.00		nc
		Low	High	
Eneos	¥/kg	2,200.00	2,750.00	nc
Germany				
H2Mobility (stations with “green” H2 supply)	€/kg	13.00		nc
		Low	High	
H2Mobility (stations with conventional H2 supply)	€/kg	15.05	19.25	nc

MARKET DEVELOPMENTS

Dutch Power2X withdraws from Spanish H2 bank aid

AccionaPlug will now receive €2.53/kg — the highest subsidy for any project across the two hydrogen bank rounds, writes Pamela Machado

Spain has selected two new renewable hydrogen projects for support under the European hydrogen bank scheme, after Dutch developer Power2X decided not to take up its €246mn ($284mn) award.

Power2X's ErasmoPower2X project was selected in July as one of three ventures for Spain's auctions-as-a-service (AAAS) allocation, but the developer has decided not to take up the support, Spain's ecological transition ministry Miteco says. The ministry did not disclose the reason for the withdrawal, and Power2X was not immediately available to comment. Power2X would have received €0.61/kg in funding for 40,200 t/yr over the first 10 years of ErasmoP2X's production.

ErasmoP2X has been replaced by Hy4Greenvillafranca's H2 Villafranca project and AccionaPlug's Valle H2V Navarra initiative. Both projects will have an electrolyser capacity of 25MW, but AccionaPlug — a joint venture between Spanish renewables company Acciona and US hydrogen firm Plug Power — is targeting much higher production and was successful with a higher bid, resulting in a total award of €93.6mn, compared with €20.5mn for the H2 Villafranca project.

AccionaPlug's winning bid of €2.53/kg is now the highest successful submission across both hydrogen bank rounds, surpassing the €1.88/kg with which Norway's GreenH secured a €21.9mn award in the second auction's EU-wide maritime pot. The bid was also the highest submitted by any of the 36 Spanish projects that took part in the second auction, EU data indicate. This suggests all Spanish projects that submitted eligible bids and that have not withdrawn applications have now been selected for subsidies either from the EU pot or the Spanish budget.

As the project list was exhausted with new selections, Madrid was unable to use up the €400mn earmarked for the AAAS scheme. The two new projects and the two that remain from the initial selection will share €240mn between them.

Industry participants have frequently noted that the hydrogen bank subsidies will in most cases not suffice to bridge the gap between the cost of renewable hydrogen production and prices that offtakers are willing to pay. But AccionaPlug stands a much better chance than its peers with its €2.53/kg support.

Spanish projects in second European hydrogen bank auction*

Pot	Status	Project	Developer	Production *t/yr*	Bid *€/kg*	Electrolysis cap. *MW*	Total aid *€mn*
EU	Selected	SolWinHyCadiz	Viridi RE	6,300	0.40	80	25.2
EU	Selected	H2LZ	Ignis Hidrogeno	2,600	0.41	20	10.7
EU	Selected	H2CRI	Green Devco	3,000	0.44	30	13.1
EU	Selected	TordesillasH2	Elawan Energy	1,700	0.48	15	8.0
EU	Withdrawn	Villamartin H2	Galena Renovables	12,600	0.20	252	25.1
EU	Withdrawn	Puerto Serrano H2	Galena Renovables	4,900	0.25	98	12.3
EU	Withdrawn	AGS	Armonia Green Sevilla	23,800	0.41	198	97.7
EU	Withdrawn	AGG280	Armonia Green Galicia	23,800	0.42	198	100.0
EU	Selected from reserve	H2CEF	Green Devco	1,900	0.78	20	14.6
EU	Selected from reserve	Tharsis-Ely-1	Cepsa Sustainable Fuels	10,500	0.80	80	84.0
EU	Selected from reserve	Noon	Iberdrola	16,100	0.84	120	135.5
EU	Selected from reserve	GH2Move-VLC	Diverxia Infrastructure	200	0.85	5	1.8
EU	Selected from reserve	ArandaH2	Forest Power Aranda	6,400	0.98	45	63.0
EU	Selected from reserve	ArteixoH2V	AccionaPlug	1,200	1.10	9	13.3
EU	Selected from reserve	Atlas	Recisol	6,000	1.20	50	71.6
EU	Selected from reserve	H2Brisa	H2 Los Barrios	13,900	1.22	125	169.3
Spain AAAS	Selected	eM-Numancia	Elyse Energy	6,360	0.69	60	43.9
Spain AAAS	Selected	Orange.bat	Smartenergy	11,960	0.69	100	82.5
Spain AAAS	Withdrawn	ErasmoP2X	Power2X	40,200	0.61	325	245.6
Spain AAAS	Selected from reserve	H2Villafranca	Hy4Greenvillafranca	1,360	1.50	25	20.5
Spain AAAS	Selected from reserve	H2 Valley Navarra	AccionaPlug	3,700	2.53	25	93.6

** EU data imply that 15 Spanish projects did not meet eligibility criteria or withdrew from the process before entering grant agreement negotiations*

— EU, Miteco

MARKET DEVELOPMENTS

Australian H2 sector reassesses low-carbon fuel future

Smaller-scale initiatives could be the answer to Australia's H2 plans, as the energy transition focus shifts towards other fuels, writes Tom Major

Australia's energy transition will still include hydrogen and derivatives, but at a smaller initial scale with more targeted outcomes than previously expected, delegates heard at the Asia-Pacific Hydrogen Summit in Sydney last week.

The sector's swathe of projects that made it the world's top destination for renewable hydrogen developers has shrunk significantly, with access to capital and offtake proving harder to come by than initially anticipated.

Although some gigawatt-scale projects are still planned, timelines are pushing well into the 2030s as smaller, sub-100MW schemes predominate.

In a year when iron ore mining firm Fortescue delayed plans for a major renewable hydrogen business and widescale use of the fuel for mobility, mining and shipping, the focus has shifted to end uses to curb emissions at chemicals plants.

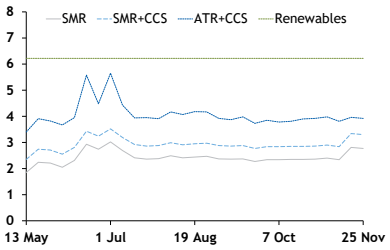
This includes ventures such as Australian explosives manufacturer Orica's planned 50MW Hunter Valley Hydrogen Hub (HVHH), which aims to partially replace natural gas feedstock for ammonia production. Orica is targeting a final investment decision for the renewable hydrogen facility in the first quarter of next year, on the back of a sizeable subsidy of nearly $6/kg and an as-yet unnamed new project partner. Domestic utility Origin Energy pulled out of HVHH last year but Orica remains confident about renewable ammonia's long-term prospects. But the world's energy majors lack the commitment to hydrogen, Orica says, meaning new players and new sources of capital will be required to grow the sector.

InterContinental Energy — which is developing hydrogen projects in Australia and in Oman — says that state backing at an early stage and equity stakes have been key to progressing the industry in the Middle Eastern country and is urging Canberra to provide similar support.

But as hydrogen developers look forward to government support in the form of a second A$2bn ($1.3bn) round of the Hydrogen Headstart subsidy scheme, the cost and complexity of widescale adoption of hydrogen as a transport fuel appear to be behind government policy measures that are shifting to support biofuels.

Australia's largest state economy of New South Wales (NSW) used the Sydney event to pledge A$170mn for renewable fuel and biomethane production, as it looks to meet its tough emissions reduction targets in the next decade. The money is focused on biomethane with further funds for commercial-scale production of renewable fuels from emerging technologies, which could include e-fuels.

Australian H2 costs $/kg



Cotton on

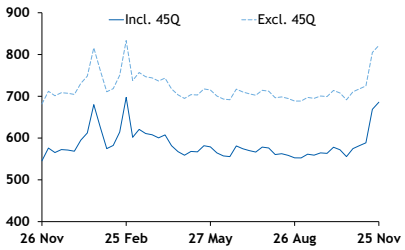
But hydrogen is finding success in niche places with business models that support low-emission goals. New Zealand-based developer Hiringa Energy's 15MW joint venture to produce 4,500 t/yr of ammonia for low-emission cotton fertilizers has begun construction near the NSW town of Moree, with further hubs planned.

Bunkering uses also figure in future hydrogen plans, with ammonia and methanol uptake predicted to boost hydrogen demand into the next decade as ship orders are fulfilled. A major exporter and source of much of Asia's bulk commodity imports, this provides a significant opportunity for Australia. Bunkering of hydrogen-based methanol and ammonia at Australia's massive iron ore ports could be useful for growing the nascent sector's reach, especially if the International Maritime Organisation's net zero framework is adopted next year.

Delegates agreed that the current gloom surrounding the sector can be turned around with positive development of smaller-scale schemes. With the global wavering commitment to the 2050 net zero target — reflected by growing domestic opposition to the target year — ensuring value for money and jobs from federal subsidies will be key to winning over a hydrogen-sceptical Australian public.

NEWS

Argus JKLAB $/t



ExxonMobil pauses Baytown low-carbon H2 plant

ExxonMobil has paused its plans to build what would have become the largest low-carbon hydrogen production facility in the world in Baytown, Texas.

"After an initial investment among all the partners of $500mn, we chose to pause spending as we wait for this market to develop," the company says. "We've said for years we'd pace spending on our Baytown Blue Hydrogen Project depending on the development of technology, supportive public policy and a market willing to pay a premium for low-carbon products."

Most potential offtakers remain reluctant to pay a premium for cleaner products despite initiatives in Europe and Asia designed to curb emissions by subsidising the adoption of low-carbon hydrogen. ExxonMobil announced the project in 2022 as the US government, led by then president Joe Biden, promised billions of dollars worth of tax incentives to kick-start domestic production of cleaner hydrogen. But much of this has evaporated with President Donald Trump's decision to reverse clean energy support.

The Baytown facility was to produce roughly 900,000 t/yr of hydrogen from natural gas with carbon capture and storage to mitigate emissions. Most of the hydrogen was intended to decarbonise ExxonMobil's refinery operations at Baytown, but some would have been turned into about 1mn t/yr of ammonia for exports. Abu Dhabi's state-owned Adnoc bought a 35pc stake in the project in 2024.

ExxonMobil had been in talks with global trading company Trammo to finalise a binding offtake agreement from the plant, which recently stalled. The two firms had previously signed a non-binding agreement for ExxonMobil to supply Trammo with up to 500,000 t/yr of low-carbon ammonia. ExxonMobil had also signed a preliminary supply deal for 250,000 t/yr with Japanese trading firm Marubeni, which also agreed to take an equity stake in the project.

Prospects for clean ammonia adoption have faced setbacks recently, especially the delayed International Maritime Organisation vote on a net zero framework and South Korea's signals of a shift away from previous plans for extensive ammonia co-firing with coal.

By Jasmina Kelemen and Lizzy Lancaster

InterContinental to control Australian AREH H2 project

Perth-headquartered InterContinental Energy will take operatorship and majority ownership of the planned 1.6mn t/yr Australian Renewable Energy Hub (AREH) renewable hydrogen plant, four months after BP exited the venture.

InterContinental is taking over BP's former 63.57pc stake in addition to its previous 26.39pc holding. Australian firm CWP Global still holds a 10.04pc share in AREH. But subject to approval by the Australian Foreign Investment Review Board, InterContinental plans to acquire 100pc of AREH by February. BP left the project in Western Australia's Pilbara region in July, as it refocused on oil and gas output, with AREH considered outside its core priorities.

Majority ownership for the firm comes as Pilbara positions itself at the centre of Australia's renewables transition, InterContinental's Australia head Isaac Hinton said at the Asia-Pacific Hydrogen Summit in Sydney on 20 November.

The A$30bn ($19.5bn) AREH plant is designed to eventually make 9mn t/yr of renewable ammonia for domestic use and exports, although this is not expected until well into the 2030s. The project's first phase could reach financial close in late 2027, InterContinental says, targeting potential offtake of renewable hydrogen for direct-reduced iron production.

By Tom Major

NEWS

EU publishes low-carbon H2 delegated act

The EU has finalised its definition of low-carbon hydrogen and derivatives with the publication of its delegated act in the bloc's official journal on 21 November.

The act confirms the methodology for calculating greenhouse gas (GHG) emissions for different low-carbon hydrogen production pathways that do not fall under the EU's definition of renewable fuels of non-biological origin (RFNBO). The EU had already in 2023 established a 3.38kg of CO_2 equivalent per kg threshold for low-carbon hydrogen and the European Commission presented the delegated act in July this year. This was confirmed in early November by the European Parliament — despite opposition from some members — and the member states.

Critics have bemoaned the lack of an explicit recognition of nuclear power purchase agreements (PPAs) in the methodology and of investor-protection measures such as grandfathering clauses. Some have also argued that rules on accounting for upstream methane emissions in gas-based hydrogen production with carbon capture and storage are too restrictive.

But energy commissioner Dan Jorgensen has "provided assurance" over protection for existing investments and has announced plans for a revised methodology by the end of 2026 to better integrate nuclear PPAs and other low-carbon electricity sources, according to industry body Hydrogen Europe.

By Pamela Machado

EU details ongoing hydrogen matchmaking process

European Commission officials have provided details on the recently opened first call of the bloc's hydrogen mechanism and say they have been "positively surprised" by the interest that suppliers have shown in the initial days.

The commission opened the call on 12 November and firms can submit supply offers until 2 January. Initial offers were received on the first day and "everything is working very well", said Maciej Ciszewski, head of the diversification and joint purchasing unit at the commission's energy directorate, during a virtual workshop on 19 November. Interested firms should register as soon as possible to ensure that there is enough time for them to go through the process, Ciszewski said.

Submissions can come from suppliers in any country, except countries under EU sanctions. Suppliers can submit offers for seven different products complying with either the EU's definition of renewable fuels of non-biological origin (RFNBO) or low-carbon hydrogen (*see table*). They must detail the project status, start date and expected supply for each year until 2050. Suppliers are not required to disclose preferred contract and pricing structures, but the commission recommends this to facilitate matching with offtakers, Ciszewski said.

Delivery points can either be broad regions based on the EU NUTS2 classification or specific locations such as airports or ports.

The commission is reviewing applications and may reject some, for example if it detects "unrealistic volumes" being offered, officials said. Submissions themselves are not binding and do not result in any legal or contractual commitments.

A call for offtakers in the EU will be launched on 19 January and close on 20 March. Participants will be able to see their "personalised" matchmaking results by 31 March. Suppliers and offtakers will then be able to engage in direct negotiations, without commission involvement. The same entity cannot act as supplier and offtaker in the same call, commission officials said.

Results will not be made public, but the commission may release some aggregate findings. It could host several matchmaking rounds each year, officials said.

By Stefan Krumpelmann

Eligible products*
Gaseous hydrogen with over 98pc purity
Gaseous hydrogen with over 97.7pc purity
Liquid hydrogen
Ammonia
Methanol
e-SAF
e-Methane
*can be RFNBO or low-carbon

— European Commission

NEWS

EU seeks end to first-come, first-served in grid plan

The European Commission will outline "no regret", quick-fix measures — namely, prioritising mature projects in the connection queue — that would allow member states to ease grid access congestion, in a draft proposal seen by *Argus*.

The policy proposal outlines that although substantial investment and more thorough grid planning are the best long-term solutions to accelerating grid access for new capacity, in the short term, ending a first-come, first-served approach and allowing regulators to prioritise a project in the grid queue according to its maturity would be of substantial benefit.

Specifically, the draft encourages states to place prioritisation criteria at the national level, in line with EU competition rules on transparency and non-discrimination, to make grid queue prioritisation a standard policy in member states. The ambition is not only to accelerate advanced developments, but also to root out ghost projects that clutter connection queues and slow project deployment.

Again, within realisable short-term measures, the commission also advocates that national regulators and network operators provide better information to participants about grid availability, particularly locational breakdowns of capacity, so developers can better integrate these figures into the planning process and choose access points more effectively.

Would-be hydrogen producers across Europe have repeatedly bemoaned difficulties with securing grid access and the lack of connections has derailed some projects, such as Spanish Repsol's planned facility in Puertollano. Although rule changes could make it easier for projects to secure access, they would arguably also result in some hydrogen plants losing their positions in the grid connection queues given that many have made little progress in recent years.

By Daniel Craig

UK's ITM gets 710MW electrolyser order from Germany

UK electrolyser manufacturer ITM Power will deliver systems with a combined capacity of 710MW to two projects led by German renewable energy developer Stablegrid, under a deal that is the UK firm's largest order so far.

Stablegrid's Netzbrucke 410 project in Rustringen, a 30MW renewable hydrogen plant, will use ITM's Neptune V proton exchange membrane electrolysers. Stablegrid expects to make a final investment decision (FID) in 2026. A second project involves 680MW of electrolyser capacity. Pre-front end engineering and design work is scheduled to begin in January, with an FID targeted for 2028.

Both projects will operate as "grid balancing" assets, using underground hydrogen caverns to stabilise the power system by absorbing discrepancies between electricity supply and hydrogen offtake, ITM says. The projects are designed to operate in so-called "grid-bridge" mode. This means they will aim to reduce redispatch interventions, which refers to managing grid congestion by lowering power generation before a bottleneck and increasing generation when past it. Germany's redispatch costs have risen with the expansion of weather-dependent renewable power, with "negative" redispatch estimated at €2bn-3bn/yr ($2.3bn-3.5bn/yr), ITM says.

ITM's electrolysers have been selected for several major European projects, including by Yara for its 24MW Porsgrunn project, RWE for its 200MW Lingen project and Shell for its 100MW Refhyne H2 project in western Germany. But the latest deal is ITM's "largest single customer selection" to date, ITM says, adding that it currently has just under 500MW either deployed or in project execution.

By Akansha Victor

ANALYSIS

China's green NH3 faces offtake hurdles during ramp-up

Renewable NH3 is being sold to the domestic market at conventional ammonia prices as producers struggle to generate premiums for now, writes Dinise Chng

China's renewable ammonia output is ramping up at an impressive pace, but producers are for now struggling to fetch a premium for domestic sales and recent developments have clouded the outlook for future exports.

Two large plants, with a combined capacity of 500,000 t/yr, have boosted China's renewable ammonia output this year. Envision Energy's 320,000 t/yr plant in Chifeng, Inner Mongolia, is the largest renewable ammonia project in operation globally. Utility SPIC Jilin Electric Power's facility in Da'an, Jilin, is smaller at 180,000 t/yr of capacity, but still comfortably eclipses any plant outside China.

At least 1.9mn t/yr of additional capacity is scheduled to come on line between now and the end of 2027, *Argus* data show, with much of this concentrated in Inner Mongolia that offers highly favourable wind and solar conditions.

Industry participants indicate Chinese renewable ammonia prices at about 4,800-6,200 yuan/t ($675-872/t) ex-works, depending on the region and plant, equivalent to $600-700/t fob for export cargoes.

With no overseas offtake for now, the new supply is being sold to the domestic market at conventional ammonia price levels, as Chinese buyers are not prepared to pay a premium at this stage, industry participants say. Product is primarily directed to conventional ammonia downstream markets, such as denitrification, compound fertiliser production and the petrochemicals sector.

The longer-term aim for producers is to target international markets in order to fetch a premium. China can arguably produce renewable ammonia at lower costs than any other country. But even at offer prices of $600-700/t fob for exports, there remains a large premium to conventional supply. Grey ammonia cargoes for December loading are selling at $460-480/t fob.

And demand prospects have taken a hit from recent political developments. The International Maritime Organisation's decision last month to postpone a vote on its net zero framework means more uncertainty for demand in the shipping sector, which is widely regarded as a potential key offtaker for renewable ammonia and e-methanol.

Chinese producers were also said to be vying for offtake on the back of South Korea's second clean hydrogen power generation bidding market. But Seoul cancelled the procedure on 17 October, the day bids were due, and has since indicated that it may scrap plans for ammonia co-firing with coal as it looks to phase out coal-fired power generation altogether by 2040. South Korea's previous plans for co-firing with coal could have translated into low-carbon ammonia demand of about 3mn t/yr by 2030, based on Argus Consulting estimates.

China's new green ammonia capacity

Company	Ammonia capacity '000 t/yr	Location	On line
China Energy Engineering	200	Songyuan, Jilin	2026
Shenzhen Energy	150	Etuokeqi, Inner Mongolia	2026
Mintal Group	600	Damaoqi, Inner Mongolia	2027
Tianying Energy	450	Tongliao, Inner Mongolia	2027
CHN Energy	50	Cangzhou, Inner Mongolia	2027
Jizhong New Energy	500	Ulanqab, Inner Mongolia	2027

— *Argus data*

Key renewable NH3 locations, China

Getting RED-y

Despite the setbacks and prevailing cost premium, first exports could materialise soon. Envision earlier this year struck a binding offtake agreement with Japanese trading house Marubeni for a portion of the Chifeng plant's output and first deliveries under the deal were expected for this quarter.

Envision and SPIC have also obtained certification to confirm their output's compliance with the EU's definition of renewable fuels of non-biological origin. Plans for exports to Europe could gain more traction when there is more clarity on national implementations of the revised renewable energy directive (RED III).

In any event, China is advancing infrastructure plans to facilitate future renewable ammonia exports. The three key ports currently used for loading grey ammonia exports are Lianyungang, Nanjing and Zhanjiang, but there are plans to build two additional ports with loading facilities at Yingkou and Dalian, specifically targeted at shipping renewable ammonia supply.

ANALYSIS

Power fee patchwork, grid hurdles hamper Indian H2

A harmonised approach to fees will be key to effective cross-state transmission but infrastructure issues pose a persistent problem, writes Akansha Victor

India's central government and federal states are eager to pave the way for production of renewable hydrogen and derivatives through a swathe of incentives. But project developers say further alignment between states is necessary to propel initiatives forward, especially on charges associated with renewable electricity supply.

Developers have bemoaned a patchwork of rules and fees that is difficult to navigate and say a lack of certainty on levies is increasing project risks.

Costs associated with getting electricity from renewables assets to hydrogen production sites are a primary concern, developers said at the International Conference on Green Hydrogen in New Delhi earlier this month. Wheeling charges, which cover costs for electricity transmission, distribution and losses, vary widely between states. Some provide substantial reductions or full exemptions for renewables assets or hydrogen production sites, while others do not.

Rules around electricity banking, which allows developers to feed surplus energy into the grid and withdraw it at a later stage, also vary and are not clear in many cases, industry participants say. Some states, such as West Bengal and Rajasthan, have included specific provisions for electricity banking in their respective green hydrogen policies and allow for power to be "banked" for up to 30 days. But in many states, such provisions have not been made even though specific hydrogen policies have been drawn up, companies say.

Although reductions or exemptions to such fees and other initiatives intended to bring down power supply costs are ultimately a matter of state policy, project developers see a role for the central government in Delhi to contribute to a more uniform approach. The government should issue national guidelines and model templates that states can adopt to trim costs and help projects along, they say. Developers point to states such as Odisha, Maharashtra and Andhra Pradesh as offering rules that could serve as a blueprint for countrywide best practices.

A more harmonised approach to fees will be key, especially when electricity is moved from one state to another. But such cross-state transmission also still faces more fundamental challenges in many cases. India has built out its renewables capacity at a remarkable pace, but power transmission infrastructure has struggled to follow suit, including in some of the most favourable locations.

Installed RE capacity as of October	*GW*
State	
Rajasthan	41.2
Gujarat	40.9
Maharashtra	28.3
Tamil Nadu	26.7
Karnataka	25.7
Andhra Pradesh	14.4
Himachal Pradesh	12.7
Madhya Pradesh	11.7
Telangana	7.9
Uttar Pradesh	6.6

— *MNRE*

Locked grid

Rajasthan accounted for 7GW of the 24.3GW solar photovoltaic capacity added across India in April-October. The state's 35.3GW of installed solar capacity by the end of last month was more than a quarter of the country's total.

But getting power out of Rajasthan to other states is difficult because of a lack of transmission capacity, project developer Acme's executive vice-president and head of business development, Arnava Sinha, said at the Delhi event. Producing hydrogen and ammonia in landlocked Rajasthan is less attractive than making it in coastal regions because the location complicates exports.

Most hydrogen projects are expected to build their own captive renewable power assets. But developers note that most projects will not be able to consume all the electricity they generate and many could not capitalise on the excess power unless the government changes its rules. Many projects are planned in special economic zones (SEZs) or export-oriented units (EOUs), but renewable power generated in these areas cannot be sold to offtakers in India's domestic tariff area. Selling surplus electricity from an EOU to an SEZ is also not possible under existing rules. More flexibility on electricity sales could make many projects more viable, developers argue.

INTERVIEW

Many levers to trim H2 truck costs: Cellcentric

Cellcentric is a 50:50 joint venture company between automakers Daimler Truck and Volvo Group that develops and manufactures fuel cell systems, primarily for heavy-duty trucks. The firm focuses on improving proton exchange membrane fuel cells to make them more efficient and reliable. It operates a pilot-scale fuel cell stack manufacturing and assembly site in Germany and has a plant in Burnaby, Canada. Cellcentric is planning a new and larger production hub in Weilheim, Germany, conditional on market demand rising. Argus spoke to the firm's head of sales, marketing and communications, Joachim Ladra, about its roots, the technology and expansion plans. Edited highlights follow:

How was Cellcentric established and what is your business strategy?

Cellcentric was established in 2021 as an independent tier 1 automotive supplier, structured as a 50:50 joint venture between Daimler Truck and Volvo Group. It was formed by carving out all fuel cell-related activities from what back then was Daimler AG, which included an organisation working on automotive fuel cell technology since the late 1980s. All intellectual property, facilities and personnel from those three decades of engineering work were transitioned into Cellcentric. The motivation for both Daimler Truck and Volvo was identical — a strong drive for decarbonisation and the need to meet stringent CO_2 reduction targets in Europe. It was clear that further refinement of diesel technology would not be sufficient. This drove the need for a no-emission solution.

'It was clear that further refinement of diesel technology would not be sufficient. This drove the need for a no-emission solution'

Fuel cells require significant investment to reach high-volume production. Sharing this cost with a like-minded partner was a more attractive approach. The core strategy is to leverage economies of scale by pooling the volume from two of the world's largest commercial vehicle manufacturers, which is the key driver to achieving the cost-reduction effects necessary to compete with diesel vehicles on a total cost of ownership (TCO) basis.

What is your plan for scaling up production?

We currently have our pilot plant in operation in Esslingen, Germany. This facility is designed according to all the requirements of a high-volume, automotive-grade facility, and it will serve as our copy-paste template. We are using it to continuously refine and stabilise our production processes. This allows us to scale quickly by duplicating this footprint once market demand increases. We have developed these production processes, which are not available off the shelf, through long-standing partnerships with companies in the machinery and equipment sector.

'Our calculations show that once we get in the corridor of €6/kg of hydrogen, we see a viable case to make a fuel cell truck TCO-competitive with a diesel truck'

The next stepping stone will be our large-scale production at the Cleantech Innovation Park. We are effectively waiting for the ketchup bottle effect — first there is nothing and then everything comes out at once. Everyone in the heavy-duty space is looking at hydrogen, but technical feasibility is only one aspect. We also need the availability of hydrogen at a viable price point. Once those parameters fall into the right corridors, the market will jump-start, and our flexible, template-based approach is designed to be ready to feed that demand.

What hydrogen price point is required for fuel cell trucks to be competitive, and how do they compare with battery-electric vehicles?

Fleet operators focus on the TCO and not so much on the hydrogen price at the pump. The TCO includes capital costs, operating costs, vehicle costs, taxes and road tolls. Our calculations show that once we get in the corridor of €6/kg ($6.90/kg) of hydrogen, we see a viable case to make a fuel cell truck TCO-competitive with a diesel truck. The TCO perspective for electric trucks is as equally volatile

INTERVIEW

as for hydrogen. The comparison with battery-electric is less about TCO and more about the aspect of general viability. In the use case of battery-electric trucks, we see severe limitations in the availability of electric energy out of the grid. The most perfect vehicle and charging solution only get you as far as the grid provides you with the juice. This limitation is a significant infrastructure challenge, comparable to the infrastructure challenges hydrogen faces.

'The most perfect vehicle and charging solution only get you as far as the grid provides you with the juice. This limitation is a significant infrastructure challenge'

How is customer feedback from current prototypes influencing your next-generation fuel cell system?

Daimler Truck has a sizeable fleet of prototype vehicles using our systems in operation, including an initial customer fleet where mature prototypes are included in the daily operations of logistics companies. This generates a lot of market feedback that we use to improve the technology. This data are a key driver for our NextGen system, where we are targeting improvements for the vehicle operator and the original equipment manufacturer [OEM].

We have been looking at lowering fuel consumption, as the more you drive the truck, the bigger the portion of the fuel price is getting in the TCO calculation. We will achieve a 20pc improvement in fuel consumption compared with our current BZA150 system, by focusing on multiple aspects of the fuel cell system. There is not one single enabler but a comprehensive package of measures derived from our engineering at the cell, system design and operating strategy levels. Fuel cells today run at significantly lower temperatures than diesel engines, which makes the cooling system in the vehicle complex and costly. We are closing this gap by allowing our fuel cells to operate at higher temperatures without negative effects in terms of lifetime, durability or efficiency. By closing this gap, we significantly reduce the burden on the cooling system, which takes technical complexity, cost and potential failure points out of the vehicle equation for the OEMs.

Diesel engines have not reached the level of maturity overnight and that's a tremendous benchmark that we're working against in the fuel cell industry. But effectively, it's that level of technical and commercial performance that we need to reach because customers will keep buying diesel trucks if we don't.

'The challenge is to synchronise all these ramp-up activities so that we don't have one missing puzzle piece that destroys the entire picture for everyone'

Beyond heavy-duty trucks, which other vehicle segments are you targeting?

The fundamental baseline is the heavy-duty truck. This is where we see the biggest volume and therefore the biggest lever for economies of scale. We then take this mature, automotive-grade technology and apply it to other applications where we see a good fit, similar to how truck diesel engines are used in many non-truck applications. We are actively pursuing the bus and coach area, the off-highway segment, the rail industry and the stationary power generation market. We can offer partners in these markets access to a mature technology and the significant cost-reduction perspectives that come from our automotive scale.

What do you see as the primary challenge for the hydrogen ecosystem, particularly regarding infrastructure and regulation?

The single biggest challenge is synchronisation of the ramp-up. Technical solutions across the value chain — production, logistics, refuelling and vehicles — are already available at an advanced stage. The challenge is to synchronise all these ramp-up activities so that we don't have one missing puzzle piece that destroys the entire picture for everyone. To make this happen, the industry requires a stable political framework. Uncertainty, such as political will that keeps changing or slow transposition of regulation, creates "what if" questions. In the current economic headwinds, any investment is scrutinised, and this uncertainty creates a risk of holding back one of the players we need to scale up in sync.

IN BRIEF

Atome's Villeta project

Atome receives more financing for Paraguay green fertiliser plant

UK firm Atome has secured $200mn in debt financing from the Inter-American Development Bank (IDB) to develop its green fertiliser project in Villeta, Paraguay. The package will be delivered through IDB's private-sector arm IDB Invest. The deal comes shortly after Atome secured a $100mn financing agreement from the World Bank's International Finance Corporation. Atome says it will invest $630mn in the Villeta project. The company previously said it expects to take a final investment decision on the project by the end of the year, but it pushed back the project timeline several times in the past, citing engineering-phase setbacks. Atome will deploy a 120MW electrolysis system to make renewable ammonia, aiming to reach a final output of 260,000 t/yr of green fertilisers for Norwegian firm Yara.

Maine offers special power rate for clean H2 proposals

The US state of Maine is offering discounted electricity to clean hydrogen projects through a pilot programme led by the Maine Public Utilities Commission (PUC). If a proposal is selected, the PUC will direct the utility where the project is located to negotiate a special rate contract with the qualifying facility if it is needed to make the project "viable and cost effective", according to a draft order. The state defines "clean hydrogen" as having lifecycle emissions of not more than 0.45kg of CO_2 equivalent per kg. Power capacity would be capped at 20MW. Developers must present bids by 10 December as a prerequisite to submitting a request for proposal, which Maine will issue by 31 December.

Elyse Energy projects

Project	Location	Production	Targeted start
eM-Rhone	Isere	150,000 t/yr e-methanol	2029
BioTJet	Pyrenees-Atlantiques	82,000 t/yr e-SAF	2030

— Elyse Energy

French Elyse secures financing for e-fuels projects

French developer Elyse Energy has secured €70mn ($81mn) in financing for two synthetic fuels projects from four French financial institutions. It includes a state-supported "strategic projects guarantee", which is granted to projects of "strategic interest", Elyse says. The financing will enable Elyse to advance the eM-Rhone e-methanol project and the BioTJet synthetic aviation fuels project. It "complements the €120mn fundraising" round completed at the end of 2024, Elyse says. In total, Elyse raised €328mn in funding for its French projects, the firm says.

Spanish Repsol, Solaria sign 10-year PPAs for renewable H2

Spanish renewables company Solaria will provide 330MW of renewable power to energy firm Repsol for hydrogen production in Spain. The firms signed two 10-year power purchase agreements (PPAs) — one covering 180MW of wind power and another for 150MW of solar. The firms did not disclose when the supply will start nor which electrolysis plants will be served. Repsol took a final investment decision in September on a 100MW electrolysis project at its Cartagena refinery in southeast Spain. It also has plans for 140MW of electrolysis at its Tarragona complex, which is set to receive more than €100mn ($115.5mn) in Spanish government aid.

Shell secures power for German renewable H2 project

Shell has signed two renewable power purchase agreements for its planned Refhyne 2 100MW electrolysis plant in Germany. The firm is planning to take about a third of the output from Nordsee One's 332MW wind farm under a five-year deal. Under a separate 10-year agreement, Shell will take about 75pc of the power generated by Solarkraftwerk Halenbeck-Rohlsdorf's 230MW solar project. An unspecified proportion of the power from both projects will feed the Refhyne 2 plant that is under construction at Shell Energy and Chemicals Park Rheinland and due to start up in 2027. The project will produce about 15,000 t/yr of hydrogen that will primarily support Shell's efforts to cut emissions at its adjacent refinery.

IN BRIEF

German GHG quota cabinet vote now planned for 3 December

Germany's federal environment ministry (BMUKN) says it now plans to submit a draft bill adjusting the country's greenhouse gas (GHG) quota for a federal cabinet vote on 3 December, but the date is still tentative because other ministries are also involved in the legislative process. Cabinet discussions on the bill have been postponed almost weekly since 8 October. A cabinet decision on 3 December would make implementation by 1 January unlikely given the ensuing parliamentary reviews. But some industry participants believe the law could still apply retroactively from 1 January if passed. The bill will include sub-quotas for use of renewable hydrogen and derivatives in the transport sector.

Upper house passes carbon storage law in Germany

Germany's upper house of parliament, the Bundesrat, has approved the government's proposed draft carbon storage and transport law, paving the way for its entry into force. The text had already been passed by the lower house of parliament, the Bundestag, earlier this month. The law will enable commercial carbon capture, use and storage applications and the building of CO_2 pipelines in Germany. The economy and energy ministry says it expects the basic infrastructure of a CO_2 pipeline network connected to carbon emitters and storage sites to be finalised in about 7-10 years. The government will, on the basis of the law, draw up a carbon management strategy and its long-term negative emissions strategy.

Oulu, Finland

Germany's Hy2gen plans 200MW e-methanol project in Finland

German hydrogen company Hy2gen is planning to build a 200MW e-methanol plant in the Vihreasaari industrial zone at Oulu port in northern Finland. The company was selected by a local committee following the conclusion of an open call for a green transition project in the Vihreasaari area that drew four proposals. As a next step, Hy2gen could receive a planning reservation until the end of 2026 to allow it to negotiate a co-operation agreement with the Oulu city government and to advance project planning. Several other companies are also planning e-fuels projects in Oulu, including German companies Energiequelle and Abo Energy.

Germany's Mohring signs green H2, NH3 deal in Mauritania

German project developer Mohring Energie has signed a deal with the government of Mauritania for development of a renewable hydrogen and ammonia plant in the country. Mohring says it is the first German company to sign a deal with Mauritania since the government last year enacted its green hydrogen code last year, which provides a range of financial incentives to project developers. Mohring plans to install 1GW of electrolyser capacity that will be able to produce up to 140,000 t/yr of renewable hydrogen and 400,000 t/yr of ammonia.

GreenGo, Set partner on Mauritania green NH3

Danish renewable developer GreenGo Energy has partnered with German energy trader Set Select Energy to co-develop GreenGo's Megaton Moon renewable ammonia project in Mauritania. Set will serve as offtake partner and co-developer and will work towards developing export facilities and exploring financing options, GreenGo says. GreenGo plans to develop the plant in several stages. It aims to take a final investment decision on the first 355,000 t/yr renewable ammonia phase in 2028, with a view to increasing production to 1.7mn t/yr in a second stage.

COMPLETE HYDROGEN PRODUCTION COSTS

No-C Hydrogen									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov
Netherlands Terneuzen	Wind + ALK	Green	€/kg	7.13	8.22	nc	5.85	6.75	nc
Netherlands	Grid + PPA + ALK	Green	€/kg	7.65	8.82	+0.03	5.68	6.55	+0.03
UK Harwich	Wind + ALK	Green	£/kg	5.23	6.85	nc	4.08	5.34	nc
UK	Grid + PPA + ALK	Green	£/kg	6.86	8.99	-0.08	5.06	6.63	-0.08
Germany Bremen	Wind + ALK	Green	€/kg	7.47	8.62	nc	6.14	7.08	nc
Germany	Grid + PPA + ALK	Green	€/kg	6.32	7.29	+0.01	4.36	5.02	+0.01
France Sete	Wind + ALK	Green	€/kg	7.88	9.09	nc	6.41	7.40	nc
France	Grid + PPA + ALK	Green	€/kg	6.82	7.86	-0.08	4.59	5.29	-0.07
Spain Teruel	Diurnal + ALK	Green	€/kg	4.94	5.69	nc	3.11	3.59	nc
Spain	Grid + PPA + ALK	Green	€/kg	5.02	5.78	-0.04	3.25	3.75	-0.03
Italy	Grid + PPA + ALK	Green	€/kg	8.11	9.36	-0.03	5.69	6.56	-0.03
Portugal	Grid + PPA + ALK	Green	€/kg	5.25	6.06	-0.09	3.53	4.07	-0.10
US Wilbarger	Diurnal + ALK	Green	$/kg	6.80	6.80	nc	4.85	4.85	nc
Canada Newfoundland	Wind + ALK	Green	C$/kg	14.10	10.02	nc	11.94	8.48	nc
Oman Duqm	Diurnal + ALK	Green	$/kg	3.87	3.87	nc	2.55	2.55	nc
Saudi Arabia Tabuk	Diurnal + ALK	Green	$/kg	3.67	3.67	nc	2.33	2.33	nc
UAE Abu Dhabi	Diurnal + ALK	Green	$/kg	5.05	5.05	nc	3.44	3.44	nc
Qatar Mesaleed	Diurnal + ALK	Green	$/kg	5.80	5.80	nc	4.25	4.25	nc
Namibia Walvis Bay	Diurnal + ALK	Green	$/kg	7.78	7.78	nc	4.00	4.00	nc
South Africa Coega	Diurnal + ALK	Green	$/kg	7.21	7.21	nc	4.88	4.88	nc
Japan Fukushima	Wind + ALK	Green	¥/kg	2,007	12.82	nc	1,694	10.81	nc
China Jilin	Diurnal + ALK	Green	Yn/kg	22.85	3.21	nc	17.48	2.46	nc
India Kutch	Diurnal + ALK	Green	Rs/kg	323.46	3.63	nc	252.99	2.84	nc
South Korea Ulsan	Wind + ALK	Green	W/kg	29,448	20.04	nc	26,696	18.17	nc
Vietnam Phu Yen	Wind + ALK	Green	$/kg	9.30	9.30	nc	7.86	7.86	nc
Australia Burrup	Diurnal + ALK	Green	A$/kg	9.62	6.22	nc	6.58	4.25	nc
Brazil Piaui	Diurnal + ALK	Green	$/kg	4.88	4.88	nc	2.87	2.87	nc
Chile Mejillones	Diurnal + ALK	Green	$/kg	4.45	4.45	nc	2.92	2.92	nc

Low-C hydrogen									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov
Netherlands	ATR + CCS	Blue	€/kg	4.17	4.81	+0.01	3.11	3.59	+0.02
UK	ATR + CCS	Blue	£/kg	3.60	4.71	+0.21	2.68	3.52	+0.21
Germany	ATR + CCS	Blue	€/kg	4.05	4.67	+0.01	3.13	3.61	nc
Spain	ATR + CCS	Blue	€/kg	4.00	4.61	-0.05	2.87	3.31	-0.05
France	ATR + CCS	Blue	€/kg	4.03	4.65	nc	2.85	3.29	nc
US Gulf coast	ATR + CCS	Blue	$/kg	3.08	3.08	+0.09	1.76	1.76	+0.09
Canada	ATR + CCS	Blue	C$/kg	3.78	2.68	+0.16	1.95	1.38	+0.16
Japan	ATR + CCS	Blue	¥/kg	815	5.20	+0.06	626	4.00	+0.06
South Korea	ATR + CCS	Blue	W/kg	7,495	5.10	+0.07	5,721	3.89	+0.06
Australia	ATR + CCS	Blue	A$/kg	6.07	3.92	-0.04	4.12	2.67	-0.03
Trinidad	ATR + CCS	Blue	$/kg	4.46	4.46	-0.02	2.71	2.71	-0.02
Russia west	ATR + CCS	Blue	$/kg	2.60	2.60	nc	1.25	1.25	+0.01
Russia east	ATR + CCS	Blue	$/kg	2.52	2.52	+0.01	1.16	1.16	nc
Saudi-Arabia	ATR + CCS	Blue	$/kg	2.36	2.36	nc	1.26	1.26	nc

COMPLETE HYDROGEN PRODUCTION COSTS

BAT+ hydrogen									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov
Netherlands	SMR + CCS	Blue	€/kg	3.51	4.04	+0.01	2.57	2.96	+0.02
UK	SMR + CCS	Blue	£/kg	2.98	3.91	+0.19	2.18	2.85	+0.19
Germany	SMR + CCS	Blue	€/kg	3.41	3.93	nc	2.60	3.00	+0.01
Spain	SMR + CCS	Blue	€/kg	3.46	4.00	-0.03	2.46	2.84	-0.04
France	SMR + CCS	Blue	€/kg	3.50	4.04	+0.01	2.46	2.83	+0.01
US Gulf coast	SMR + CCS	Blue	$/kg	2.52	2.52	+0.07	1.35	1.35	+0.07
Canada	SMR + CCS	Blue	C$/kg	3.27	2.32	+0.09	1.65	1.17	+0.09
Japan	SMR + CCS	Blue	¥/kg	654	4.17	+0.06	486	3.11	+0.07
South Korea	SMR + CCS	Blue	W/kg	6,098	4.15	+0.06	4,524	3.08	+0.06
Australia	SMR + CCS	Blue	A$/kg	5.11	3.30	-0.04	3.38	2.18	-0.05
Trinidad	SMR + CCS	Blue	$/kg	3.80	3.80	-0.02	2.25	2.25	-0.02
Russia west	SMR + CCS	Blue	$/kg	2.13	2.13	nc	0.93	0.93	+0.01
Russia east	SMR + CCS	Blue	$/kg	2.07	2.07	nc	0.87	0.87	nc
Saudi-Arabia	SMR + CCS	Blue	$/kg	1.90	1.90	nc	204	204	nc

BAT+ hydrogen							25 Nov
				Excl. capex			
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	
Netherlands	SMR + CCS retrofit	Blue	€/kg	2.61	3.01	+0.01	
UK	SMR + CCS retrofit	Blue	£/kg	2.18	2.86	+0.19	
Germany	SMR + CCS retrofit	Blue	€/kg	2.64	3.05	nc	
Spain	SMR + CCS retrofit	Blue	€/kg	2.51	2.89	-0.04	
France	SMR + CCS retrofit	Blue	€/kg	2.50	2.88	nc	
US Gulf coast	SMR + CCS retrofit	Blue	$/kg	1.28	1.28	+0.07	
Canada	SMR + CCS retrofit	Blue	C$/kg	1.71	1.22	+0.10	
Japan	SMR + CCS retrofit	Blue	¥/kg	459	2.93	+0.06	
South Korea	SMR + CCS retrofit	Blue	W/kg	4,289	2.92	+0.06	
Australia	SMR + CCS retrofit	Blue	A$/kg	3.23	2.09	-0.04	
Trinidad	SMR + CCS retrofit	Blue	$/kg	2.16	2.16	-0.02	
Russia west	SMR + CCS retrofit	Blue	$/kg	0.86	0.86	nc	
Russia east	SMR + CCS retrofit	Blue	$/kg	0.81	0.81	+0.01	

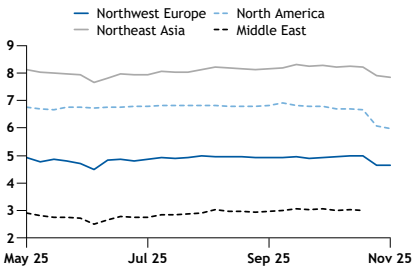
BAT+ hydrogen											25 Nov
					Incl. capex			Excl. capex			
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov	
Australia	Coal gasification + CCS	5,500	Blue	A$/kg	6.31	4.08	+0.03	3.92	2.54	+0.03	
Australia	Coal gasification + CCS	6,000	Blue	A$/kg	6.55	4.24	+0.01	4.16	2.69	+0.01	
China	Coal gasification + CCS	3,800	Blue	Yn/kg	26.26	3.69	+0.01	18.21	2.56	+0.01	
China	Coal gasification + CCS	5,500	Blue	Yn/kg	25.89	3.64	+0.02	17.84	2.51	+0.02	
Indonesia	Coal gasification + CCS	5,500	Blue	$/kg	3.56	3.56	+0.01	2.36	2.36	+0.01	
Indonesia	Coal gasification + CCS	3,800	Blue	$/kg	3.44	3.44	+0.01	2.24	2.24	+0.01	
South Africa	Coal gasification + CCS	4,800	Blue	$/kg	4.69	4.69	+0.01	2.44	2.44	+0.01	
South Africa	Coal gasification + CCS	6,000	Blue	$/kg	4.81	4.81	nc	2.56	2.56	nc	
Russia west	Coal gasification + CCS	6,000	Blue	$/kg	3.40	3.40	-0.02	1.74	1.74	-0.01	
US east coast	Coal gasification + CCS	6,000	Blue	$/kg	4.02	4.02	nc	2.39	2.39	-0.01	

COMPLETE HYDROGEN PRODUCTION COSTS

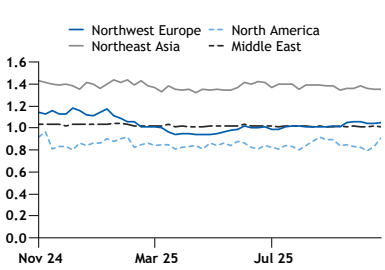
Baseline hydrogen									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov
Netherlands	SMR	Grey	€/kg	3.56	4.10	+0.01	2.72	3.14	+0.01
UK	SMR	Grey	£/kg	2.90	3.81	+0.19	2.19	2.86	+0.19
Germany	SMR	Grey	€/kg	3.48	4.01	-0.01	2.76	3.18	nc
Spain	SMR	Grey	€/kg	3.51	4.05	-0.04	2.62	3.02	-0.04
France	SMR	Grey	€/kg	3.54	4.09	+0.01	2.61	3.01	nc
US Gulf coast	SMR	Grey	$/kg	2.11	2.11	+0.07	1.07	1.07	+0.08
Canada	SMR	Grey	C$/kg	3.29	2.34	+0.10	1.85	1.32	+0.10
Japan	SMR	Grey	¥/kg	522	3.33	+0.06	373	2.38	+0.06
South Korea	SMR	Grey	W/kg	4,929	3.35	+0.06	3,531	2.40	+0.06
Australia	SMR	Grey	A$/kg	4.28	2.77	-0.04	2.75	1.78	-0.04
Trinidad	SMR	Grey	$/kg	3.23	3.23	-0.01	1.85	1.85	-0.02
Russia west	SMR	Grey	$/kg	1.72	1.72	nc	0.65	0.65	nc
Russia east	SMR	Grey	$/kg	1.67	1.67	+0.01	0.60	0.60	+0.01
Saudi-Arabia	SMR	Grey	$/kg	1.51	1.51	nc	0.65	0.65	nc

Hydrogen decarbonisation spreads					25 Nov
	Incl. capex		Excl. capex		
	$/kg	± 18 Nov	$/kg	± 18 Nov	
Northwest Europe					
No-C to BAT+	4.63	-0.01	4.15	-0.01	
Low-C to BAT+	0.70	nc	0.57	nc	
BAT+ to baseline	-0.06	nc	-0.18	+0.01	
North America					
No-C to BAT+	5.99	-0.08	5.40	-0.08	
Low-C to BAT+	0.46	+0.04	0.31	+0.05	
BAT+ to baseline	0.20	nc	0.07	nc	
Northeast Asia					
No-C to BAT+	7.86	-0.06	7.39	-0.06	
Low-C to BAT+	0.99	nc	0.86	+0.01	
BAT+ to baseline	0.82	nc	0.70	nc	
Net exporter					
No-C to BAT+	2.90	-0.01	1.71	-0.02	
Low-C to BAT+	0.55	+0.01	0.44	+0.01	
BAT+ to baseline	0.44	nc	0.35	+0.01	

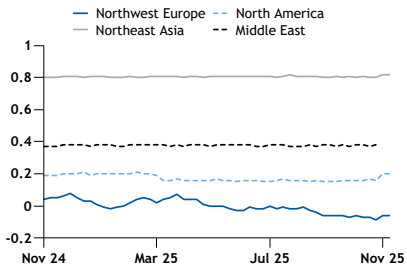
Decarb spread No-C to BAT+ *$/kg*



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



Decarb spread BAT+ to baseline *$/kg*



COMPLETE HYDROGEN PRODUCTION COSTS

Decarbonisation spreads relevant for subsidy mechanisms					25 Nov		
		Incl. capex			Excl. capex		
	Unit	Spread	Spread in $/kg	± 18 Nov	Spread	Spread in $/kg	± 18 Nov
France							
No-C to Baseline[1]	€/kg	4.34	5.00	-0.01	3.80	4.39	nc
Germany							
No-C to BAT+[2]	€/kg	4.06	4.68	-0.01	3.54	4.08	nc
Netherlands							
No-C to baseline[3]	€/kg	3.57	4.12	-0.01	3.13	3.61	-0.01

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

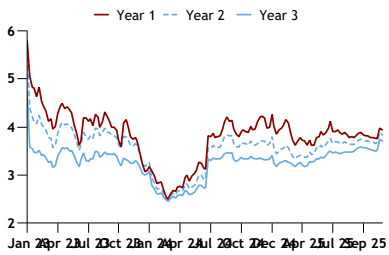
Low-C hydrogen forward										25 Nov
				Incl. capex			Excl. capex			
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov	
Netherlands										
2026	ATR + CCS	Blue	€/kg	4.05	4.68	-0.04	3.00	3.45	-0.05	
2027	ATR + CCS	Blue	€/kg	3.92	4.52	-0.05	2.86	3.30	-0.05	
2028	ATR + CCS	Blue	€/kg	3.75	4.33	-0.04	2.69	3.10	-0.04	
UK										
2026	ATR + CCS	Blue	£/kg	3.48	4.55	-0.06	2.56	3.36	-0.06	
2027	ATR + CCS	Blue	£/kg	3.38	4.43	-0.06	2.47	3.23	-0.07	
Germany										
2026	ATR + CCS	Blue	€/kg	3.93	4.53	-0.05	2.53	3.48	-0.04	
2027	ATR + CCS	Blue	€/kg	3.81	4.39	-0.05	3.01	3.34	-0.05	
2028	ATR + CCS	Blue	€/kg	3.64	4.20	-0.04	2.89	3.14	-0.05	
France										
2026	ATR + CCS	Blue	€/kg	3.93	4.53	-0.05	2.74	3.17	-0.05	
Spain										
2026	ATR + CCS	Blue	€/kg	3.91	4.51	-0.05	2.78	3.21	-0.05	

BAT+ hydrogen forward										25 Nov
				Incl. capex			Excl. capex			
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov	
Netherlands										
2026	SMR + CCS	Blue	€/kg	3.43	3.96	-0.04	2.49	2.87	-0.05	
2027	SMR + CCS	Blue	€/kg	3.32	3.83	-0.05	2.38	2.75	-0.05	
2028	SMR + CCS	Blue	€/kg	3.20	3.69	-0.04	2.26	2.61	-0.03	
UK										
2026	SMR + CCS	Blue	£/kg	2.92	3.82	-0.05	2.11	2.76	-0.05	
2027	SMR + CCS	Blue	£/kg	2.85	3.74	-0.05	2.04	2.68	-0.05	
Germany										
2026	SMR + CCS	Blue	€/kg	3.34	3.85	-0.04	2.53	2.91	-0.05	
2027	SMR + CCS	Blue	€/kg	3.24	3.74	-0.05	2.43	2.80	-0.05	
2028	SMR + CCS	Blue	€/kg	3.12	3.59	-0.04	2.30	2.66	-0.04	
France										
2026	SMR + CCS	Blue	€/kg	3.45	3.98	-0.04	2.40	2.77	-0.04	
Spain										
2026	SMR + CCS	Blue	€/kg	3.40	3.93	-0.04	2.40	2.77	-0.04	

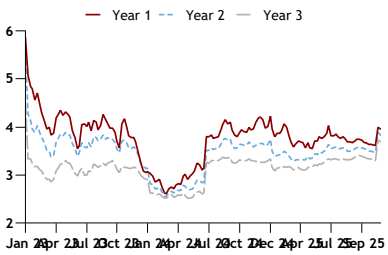
COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen forward									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 18 Nov	Cost	Cost in $/kg	± 18 Nov
Netherlands									
2026	SMR	Grey	€/kg	3.48	4.02	-0.05	2.65	3.05	-0.05
2027	SMR	Grey	€/kg	3.39	3.91	-0.06	2.55	2.95	-0.05
2028	SMR	Grey	€/kg	3.28	3.78	-0.05	2.45	2.82	-0.04
UK									
2026	SMR	Grey	£/kg	2.88	3.77	-0.05	2.16	2.83	-0.05
2027	SMR	Grey	£/kg	2.83	3.71	-0.05	2.11	2.77	-0.05
Germany									
2026	SMR	Grey	€/kg	3.41	3.93	-0.05	2.69	3.10	-0.05
2027	SMR	Grey	€/kg	3.33	3.84	-0.05	2.60	3.00	-0.06
2028	SMR	Grey	€/kg	3.22	3.71	-0.04	2.49	2.88	-0.04
France									
2026	SMR	Grey	€/kg	3.49	4.02	-0.05	2.56	2.95	-0.05
Spain									
2026	SMR	Grey	€/kg	3.45	3.98	-0.05	2.56	2.95	-0.05

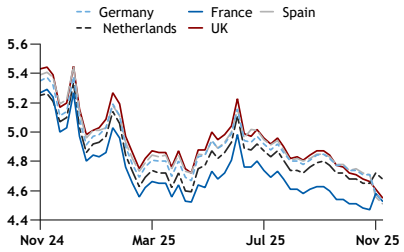
German SMR costs $/kg



Dutch SMR+CCS costs $/kg



European year 1 ATR+CCS costs $/kg



Direct reduction iron costs (21 Nov)		$/t
Specification	**Cost**	**±**
Natural gas DRI, ex-works NW Europe	375.35	-3.40
DRI spread No-C hydrogen (renewables+ALK) vs natural gas NW Europe	437.52	+17.22
DRI spread BAT+ hydrogen (SMR+CCS) vs natural gas NW Europe	168.40	+22.44

Renewable hydrogen certificate revenue (RH2CR)				25 Nov
	€/kg	± 18 Nov	$/kg	± 18 Nov
Germany RH2CR from GHG reduction obligations	4.52	+0.06	5.21	+0.03
Netherlands RH2CR from renewable fuel units	5.39	-0.01	6.22	-0.05

In Germany and the Netherlands, companies can generate tradeable certificates by delivering renewable hydrogen to the road fuel markets. They can then sell these certificates to parties that are obliged to meet certain greenhouse gas emission reduction targets (in Germany) or a certain share of renewable energy supply (in the Netherlands). The RH2CRs represent the revenue suppliers can generate from selling the certificates for each kg of hydrogen they produce. Calculations are based on hydrogen's lower heating value of 120 MJ/kg. For Germany, they assume a 70pc reduction in GHG emissions compared with the fossil fuel comparator of 94.1t of CO_2 equivalent/MJ.

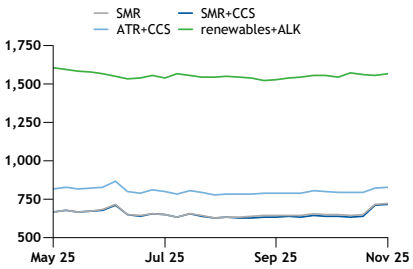
COMPLETE AMMONIA PRODUCTION COSTS

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

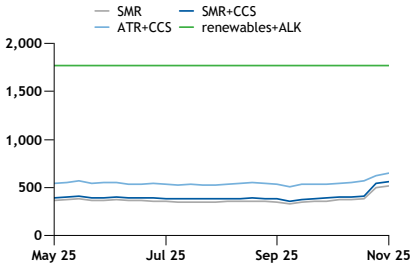
CO2e emissions on a gate-to-gate basis; purity >99.5pc; temperature -33°C

Regional ammonia cost markers						25 Nov
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 18 Nov	Cost	± 18 Nov
Baseline						
Northwest Europe	SMR	€/t	720	+5	512	+5
Northwest Europe	SMR	$/t	831	nc	590	+1
North America	SMR	$/t	515	+14	254	+14
Northeast Asia	SMR	$/t	699	+10	459	+10
BAT+						
Northwest Europe	SMR+CCS	€/t	717	+7	486	+6
Northwest Europe	SMR+CCS	$/t	827	+2	560	+2
North America	SMR+CCS	$/t	557	+15	268	+14
Northeast Asia	SMR+CCS	$/t	850	+11	585	+11
Low-C						
Northwest Europe	ATR+CCS	€/t	828	+7	570	+5
Northwest Europe	ATR+CCS	$/t	955	+1	657	+1
North America	ATR+CCS	$/t	645	+22	323	+22
Northeast Asia	ATR+CCS	$/t	1,030	+11	734	+11
No-C						
Northwest Europe	Island renewable+PEM	€/t	1,564	+11	1,248	+9
Northwest Europe	Island renewable+PEM	$/t	1,804	nc	1,439	nc
North America	Island renewable+PEM	$/t	1,767	nc	1,363	nc
Northeast Asia	Island renewable+PEM	$/t	2,412	nc	2,068	nc
Exporter						
Exporter baseline	SMR	$/t	492	+2	248	+1
Exporter BAT+	SMR+CCS	$/t	576	+1	307	+2
Exporter low-C	ATR+CCS	$/t	681	+4	380	+4
Exporter no-C	Island renewable+PEM	$/t	1,157	nc	710	nc

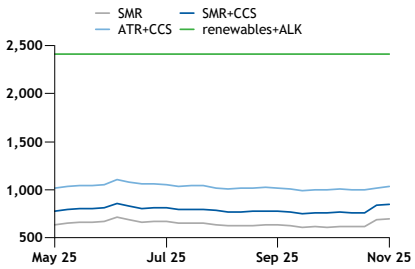
NW Europe ammonia average €/t



North America ammonia average $/t



Northeast Asia ammonia average $/t



COMPLETE AMMONIA PRODUCTION COSTS

No-C ammonia									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 18 Nov	Cost	Cost in $/t	± 18 Nov
Netherlands Terneuzen	Wind + ALK	Green	€/t	1,502	1,732	nc	1,200	1,384	nc
UK Harwich	Wind + ALK	Green	£/t	1,093	1,433	nc	824	1,079	nc
Germany Bremen	Wind + ALK	Green	€/t	1,547	1,784	nc	1,245	1,436	nc
France Sete	Wind + ALK	Green	€/t	1,645	1,897	nc	1,296	1,495	nc
Spain Teruel	Diurnal + ALK	Green	€/t	1,052	1,213	nc	645	744	nc
US Wilbarger	Diurnal + ALK	Green	$/t	1,463	1,463	nc	1,020	1,020	nc
Canada Newfoundland	Wind + ALK	Green	C$/t	2,916	2,071	nc	2,402	1,706	nc
Oman Duqm	Diurnal + ALK	Green	$/t	794	794	nc	517	517	nc
Saudi Arabia Tabuk	Diurnal + ALK	Green	$/t	753	753	nc	467	467	nc
UAE Abu Dhabi	Diurnal + ALK	Green	$/t	1,020	1,020	nc	686	686	nc
Qatar Mesaleed	Diurnal + ALK	Green	$/t	1,161	1,161	nc	843	843	nc
Namibia Walvis Bay	Diurnal + ALK	Green	$/t	1,721	1,721	nc	809	809	nc
South Africa Coega	Diurnal + ALK	Green	$/t	1,566	1,566	nc	978	978	nc
Japan Fukushima	Wind + ALK	Green	¥/t	403,466	2,576	nc	334,283	2,134	nc
China Jilin	Diurnal + ALK	Green	Yn/t	4,748	668	nc	3,515	495	nc
India Kutch	Diurnal + ALK	Green	Rs/t	65,966	740	nc	50,327	565	nc
South Korea Ulsan	Wind + ALK	Green	W/t	5,866,305	3,993	nc	5,250,603	3,574	nc
Vietnam Phu Yen	Wind + ALK	Green	$/t	1,906	1,906	nc	1,552	1,552	nc
Australia Burrup	Diurnal + ALK	Green	A$/t	1,924	1,244	nc	1,309	846	nc
Brazil Piaui	Diurnal + ALK	Green	$/t	1,080	1,080	nc	587	587	nc
Chile Mejillones	Diurnal + ALK	Green	$/t	964	964	nc	599	599	nc

Low-C ammonia									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 18 Nov	Cost	Cost in $/t	± 18 Nov
Netherlands	ATR + CCS	Blue	€/t	845	975	+3	585	675	+3
UK	ATR + CCS	Blue	£/t	724	949	+37	500	656	+37
Germany	ATR + CCS	Blue	€/t	809	933	+1	584	673	+1
Spain	ATR + CCS	Blue	€/t	817	942	-10	540	623	-9
France	ATR + CCS	Blue	€/t	830	957	nc	540	623	nc
US Gulf coast	ATR + CCS	Blue	$/t	683	683	+15	358	358	+16
Canada	ATR + CCS	Blue	C$/t	855	607	+28	406	289	+29
Japan	ATR + CCS	Blue	¥/t	162,510	1,038	+11	116,153	742	+11
South Korea	ATR + CCS	Blue	W/t	1,502,672	1,023	+12	1,067,105	726	+12
Australia	ATR + CCS	Blue	A$/t	1,278	826	-6	800	517	-6
Trinidad	ATR + CCS	Blue	$/t	946	946	-3	517	517	-3
Russia west	ATR + CCS	Blue	$/t	586	586	+1	252	252	nc
Russia east	ATR + CCS	Blue	$/t	572	572	+1	238	238	+1
Saudia-Arabia	ATR + CCS	Blue	$/t	533	533	nc	264	264	nc

Low-Carbon Ammonia benchmarks			25 Nov
	Unit	Cost	± 18 Nov
JKLAB CFR Ulsan, South Korea, incl. US 45Q tax credit	$/t	685.78	+16.88
JKLAB CFR Ulsan, South Korea, excl. US 45Q tax credit	$/t	821.78	+16.88
JKLAB CFR Niihama, Japan, differential	$/t	-0.04	-0.03
EULAB CFR ARA, incl. 45Q US tax credit	$/t	613.02	+16.37
EULAB CFR ARA, excl. 45Q US tax credit	$/t	749.02	+16.37

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

COMPLETE AMMONIA PRODUCTION COSTS

BAT+ ammonia										25 Nov
				Incl. capex			Excl. capex			
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 18 Nov	Cost	Cost in $/t	± 18 Nov	
Netherlands	SMR + CCS	Blue	€/t	725	836	+3	492	567	+2	
UK	SMR + CCS	Blue	£/t	614	804	+33	413	542	+34	
Germany	SMR + CCS	Blue	€/t	694	801	+1	493	569	+1	
Spain	SMR + CCS	Blue	€/t	718	828	-6	470	542	-7	
France	SMR + CCS	Blue	€/t	731	843	+1	471	544	+2	
US Gulf coast	SMR + CCS	Blue	$/t	576	576	+12	285	285	+12	
Canada	SMR + CCS	Blue	C$/t	756	537	+17	354	252	+17	
Japan	SMR + CCS	Blue	¥/t	133,251	851	+11	91,765	586	+11	
South Korea	SMR + CCS	Blue	W/t	1,246,788	849	+11	856,992	583	+11	
Australia	SMR + CCS	Blue	A$/t	1,094	707	-8	666	430	-8	
Trinidad	SMR + CCS	Blue	$/t	818	818	-3	434	434	-3	
Russia west	SMR + CCS	Blue	$/t	494	494	nc	196	196	+1	
Russia east	SMR + CCS	Blue	$/t	484	484	+1	185	185	nc	
Saudia-Arabia	SMR + CCS	Blue	$/t	445	445	nc	204	204	nc	

BAT+ ammonia											25 Nov
					Incl. capex			Excl. capex			
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/t	± 18 Nov	Cost	Cost in $/t	± 18 Nov	
Australia	Coal gasification + CCS	5,500	Blue	A$/t	1,380	892	+5	763	493	+5	
Australia	Coal gasification + CCS	6,000	Blue	A$/t	1,423	920	+2	805	521	+2	
China	Coal gasification + CCS	3,800	Blue	Yn/t	5,472	770	+2	3,392	477	+2	
China	Coal gasification + CCS	5,500	Blue	Yn/t	5,408	761	+5	3,328	468	+4	
Indonesia	Coal gasification + CCS	5,500	Blue	$/t	750	750	+2	440	440	+2	
Indonesia	Coal gasification + CCS	3,800	Blue	$/t	730	730	+3	419	419	+2	
South Africa	Coal gasification + CCS	4,800	Blue	$/t	1,044	1,044	+1	463	463	+1	
South Africa	Coal gasification + CCS	6,000	Blue	$/t	1,066	1,066	+1	485	485	+1	
Russia west	Coal gasification + CCS	6,000	Blue	$/t	765	765	-3	334	334	-3	
US east coast	Coal gasification + CCS	6,000	Blue	$/t	892	892	-1	472	472	nc	

Baseline ammonia									25 Nov
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 18 Nov	Cost	Cost in $/t	± 18 Nov
Netherlands	SMR	Grey	€/t	729	840	+1	518	597	+2
UK	SMR	Grey	£/t	595	780	+34	414	542	+33
Germany	SMR	Grey	€/t	702	809	-1	520	600	nc
Spain	SMR	Grey	€/t	720	831	-7	496	572	-7
France	SMR	Grey	€/t	732	844	nc	497	573	+1
US Gulf coast	SMR	Grey	$/t	497	497	+12	233	233	+12
Canada	SMR	Grey	C$/t	751	533	+16	387	275	+17
Japan	SMR	Grey	¥/t	109,082	696	+10	71,532	457	+11
South Korea	SMR	Grey	W/t	1,031,642	702	+11	678,833	462	+11
Australia	SMR	Grey	A$/t	939	607	-7	551	356	-8
Trinidad	SMR	Grey	$/t	708	708	-3	361	361	-3
Russia west	SMR	Grey	$/t	416	416	nc	146	146	nc
Russia east	SMR	Grey	$/t	406	406	+1	136	136	+1
Saudi-Arabia	SMR	Grey	$/t	372	372	nc	155	155	nc

COMPLETE AMMONIA PRODUCTION COSTS

Ammonia decarbonisation spreads	Incl. capex		Excl. capex		25 Nov
	$/t	± 18 Nov	$/t	± 18 Nov	
Northwest Europe					
No-C to BAT+	977	-2	879	-2	
Low-C to BAT+	128	-1	97	-1	
BAT+ to baseline	-4	+2	-30	+1	
North America					
No-C to BAT+	1,210	-15	1,095	-14	
Low-C to BAT+	88	+7	55	+8	
BAT+ to baseline	42	+1	14	nc	
Northeast Asia					
No-C to BAT+	1,562	-11	1,483	-11	
Low-C to BAT+	180	nc	149	nc	
BAT+ to baseline	151	+1	126	+1	
Net exporter					
No-C to BAT+	581	-1	403	-2	
Low-C to BAT+	105	+3	73	+2	
BAT+ to baseline	84	-1	59	+1	

E-SAF PRODUCTION COSTS

No-C e-SAF			Incl. capex			Excl. capex		25 Nov
	Process	Unit	Cost	Cost in $/t	±	Cost	Cost in $/t	±
Netherlands	PPA+ALK FT	€/t	9,329.93	10,761.16	+19.73	6,365.96	7,342.52	+19.73

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