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Argus *Hydrogen and Future Fuels*

Market news, analysis and prices

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Mena's big H2 plans run into market realities

Piecemeal carbon legislation, high energy costs and a lack of demand are holding back the region's green hydrogen potential, writes Aidan Lea

The Middle East and north Africa (Mena) region has made bold strides towards hydrogen leadership in recent years, with governments from Morocco to Oman promising land access and tax breaks to draw investors. UN climate summits in Egypt and Dubai gave the region a platform to promote its plans, and after Saudi Arabia's Neom in 2023 became the world's first hydrogen megaproject to reach a final investment decision (FID), many expected the floodgates to open.

But as 2025 begins, a new picture is emerging. Neom shows the region can execute big infrastructure projects. But as delegates heard at this month's Abu Dhabi Sustainability Week, consumers' reluctance to pay for clean energy and slow demand growth means a rethink of targets and timelines is needed.

Abu Dhabi renewables firm Masdar had a 1mn t/yr target for hydrogen production by 2030, the firm's chief green hydrogen officer, Abdelqader al-Ramahi, told the conference, based on winning 5pc market share. But that target has been recalculated, he said, with the market growing more slowly than expected, as Europe's laboured and ineffective implementation of legislation checks momentum.

Lax CO_2 rules are a problem everywhere, according to French utility EDF, which has projects in Oman, Morocco and Egypt. "Until Europe, Japan or any end users for hydrogen put a value on carbon, we don't believe that a market will be unlocked," EDF Middle East chief executive Luc Koechlin told attendees. This view was echoed by Norwegian developer Scatec, which quit a renewable ammonia project in Oman in 2023. On the sidelines in Abu Dhabi, the firm told *Argus* that it "didn't see the demand coming" to match up with the project's timelines.

Nor is there much demand within the Mena region. "There aren't many people," developer InterContinental's chief executive, Alexander Tancock, told the conference. "We need to figure out where does that cheap green hydrogen go." The dearth of Middle East demand is unlikely to change until its governments collaborate more on pricing CO_2, Tancock said. While the EU applies sustainable aviation fuel (SAF) mandates across the bloc's airlines and consumers, any Middle East airline moving unilaterally would take a hit versus its competitors, he noted.

UAE energy and infrastructure minister Suhail al-Mazrouei argued it "doesn't make sense to talk about a country when you're creating a market for hydrogen — you need to talk about the globe". For that reason, the UAE is exploring demand creation in shipping and aviation in talks with the International Maritime Organisation and the International Air Transport Association, al-Mazrouei said. "Creating the market is evolution, not revolution, and it is happening," he added.

With challenges in sharper focus, Mena's hopeful developers are targeting "pockets" of demand, Scatec's chief executive, Terje Pilskog, told *Argus*. The firm is prioritising renewable ammonia at a brownfield site in Egypt to leverage infrastructure and manage costs, and has an off-taker in Germany's state-backed H2Global auction initiative. Targeting such "pockets" is the way forward until a global CO_2 price arrives, he says. Masdar, meanwhile, has said its frontrunner hydrogen projects aiming for FIDs in 2025 will target markets in green steel and aviation, and has singled out e-SAF as the best investment in the hydrogen sector.

Despite challenges, Mena arguably remains ahead of other export-focused regions. "The Middle East will be a major player in this space, because it's a major player in energy," Tancock said. "There's just no way around it."

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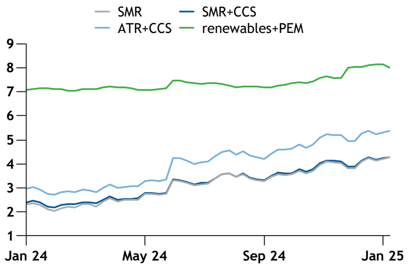
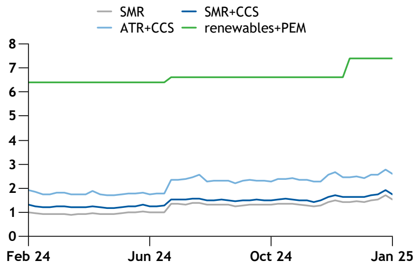
HYDROGEN COSTS

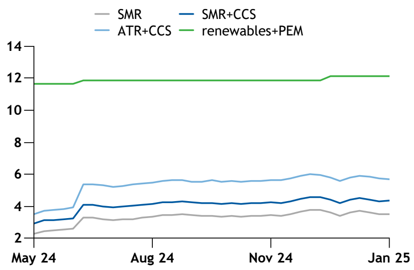
Northwest Europe average cost €/kg



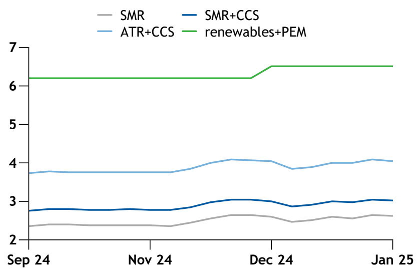
North America average cost $/kg



Northeast Asia average cost $/kg



Exporter average cost $/kg



Regional hydrogen cost markers						28 Jan
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 21 Jan	Cost	± 21 Jan
Baseline						
Northwest Europe	SMR	€/kg	4.28	+0.07	3.72	+0.07
Northwest Europe	SMR	$/kg	4.48	+0.14	3.90	+0.14
North America	SMR	$/kg	1.53	-0.18	0.96	-0.18
Northeast Asia	SMR	$/kg	3.52	+0.01	2.90	+0.01
Middle East	SMR	$/kg	3.29	+0.12	2.73	+0.12
BAT+						
Northwest Europe	SMR+CCS	€/kg	4.27	+0.05	3.61	+0.06
Northwest Europe	SMR+CCS	$/kg	4.47	+0.12	3.78	+0.12
North America	SMR+CCS	$/kg	1.73	-0.18	1.05	-0.18
Northeast Asia	SMR+CCS	$/kg	4.33	+0.01	3.59	+0.01
Middle East	SMR+CCS	$/kg	3.67	+0.12	3.00	+0.12
Low-C						
Northwest Europe	ATR+CCS	€/kg	5.36	+0.06	4.16	+0.08
Northwest Europe	ATR+CCS	$/kg	5.61	+0.15	4.36	+0.15
North America	ATR+CCS	$/kg	2.59	-0.18	1.37	-0.18
Northeast Asia	ATR+CCS	$/kg	5.69	-0.03	4.36	-0.02
Middle East	ATR+CCS	$/kg	4.70	+0.12	3.49	+0.12
No-C						
Northwest Europe	Island renewable+PEM	€/kg	8.00	-0.13	5.01	-0.08
Northwest Europe	Island renewable+PEM	$/kg	8.38	nc	5.25	nc
North America	Island renewable+PEM	$/kg	7.38	nc	4.55	nc
Northeast Asia	Island renewable+PEM	$/kg	12.12	nc	9.34	nc
Middle East	Island renewable+PEM	$/kg	6.02	nc	3.36	nc
Exporter						
Exporter baseline	SMR	$/kg	2.62	-0.03	2.06	-0.02
Exporter BAT+	SMR+CCS	$/kg	3.03	-0.02	2.36	-0.02
Exporter low-C	ATR+CCS	$/kg	4.05	-0.03	2.84	-0.02
Exporter no-C	Island renewable+PEM	$/kg	6.52	nc	3.64	nc

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

CO2e emissions on a gate-to-gate basis

Pump prices, 70MPa			9 Jan
	Unit	Price	± 3 Dec
Japan			
Eneos	¥/kg	2,200.00	nc
Iwatani	¥/kg	1,650.00	nc
Germany			
H2Mobility (stations with "green" H2 supply)	€/kg	13.00	+1.50
H2Mobility (stations with conventional H2 supply)	€/kg	17.75-19.25	+2.10

MARKET DEVELOPMENTS

US H2 hubs seek clarity after IRA spending freeze

Hub developers report a disturbing lack of communication from the White House on what Trump's funding freeze means on the ground, writes Jasmina Kelemen

Developers of the US' planned hydrogen hubs have been largely left on their own so far to figure out how President Donald Trump's executive order suspending funds from the Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA) affects billions of dollars awarded by the previous administration.

As part of former president Joe Biden's effort to spearhead a hydrogen economy, the two acts served as a vehicle to provide as much as $7bn to develop seven regional hubs as well as hydrogen production tax credits of up to $3/kg.

Those behind two of the seven designated hubs told *Argus* last week that they have not received any government guidance regarding Trump's executive order on 20 January to pause IRA-related disbursements. The other hubs did not respond to requests for comment.

"We have reached out to the DOE [Department of Energy] to gain further clarity on how the executive order will impact the funding process," according to the Gulf coast's HyVelocity Hub, which signed an agreement in November that secured up to $1.2bn in federal funding. "We are awaiting guidance from the DOE on next steps and near-term actions related to the implementation of this order."

The Appalachian Hydrogen Hub (Arch2), which formalised a deal in summer for up to $925mn, said it has not received any information regarding modifications to the contract it signed with the DOE's Office of Clean Energy Demonstrations. The hub will therefore "continue moving forward on this project as planned".

It was unclear whether the hubs had already received initial funding tranches awarded upon closing agreements with the DOE to initiate planning and development activities. For example, HyVelocity was eligible for $22mn in first-phase funding upon signing the agreement with the DOE, while Arch2 stood to receive $30mn. The last two of the seven hubs to conclude negotiations with the DOE finalised their contracts on 17 January, just before Trump was inaugurated.

NovoHydrogen — which announced last month that it had signed an agreement securing it a portion of the initial $27.5mn awarded to the Pacific Northwest Hydrogen Hub (PNWH2) for its renewable hydrogen project in Oregon — referred all questions about funding to the hub, but said it was moving ahead with its plans. PNWH2 did not immediately respond to a request for comment.

DOE funds earmarked *$mn*

Hub	Initial tranche	Max funds
Arches	30	1,200
Arch2	30	925
HH2H	20	925
HyVelocity	22	1,200
Mach2	19	750
MachH2	22	1,000
PNWH2	28	1,000

— DOE

Playing into a new narrative

Programmes that are eligible for IRA and IIJA funding are now subject to 90-day reviews and will be evaluated to see whether they align with the new administration's policy objectives, which were laid out elsewhere in the executive order. Accordingly, the hydrogen industry is highlighting how the sector can fit into Trump's political agenda. "We expect that any investments related to hydrogen will be seen as a valuable component of ensuring American energy dominance," the Fuel Cell & Hydrogen Energy Association says.

Separate from the hub disbursements, which were intended to spur as much as $43bn in private investment, hydrogen production tax credits are considered by many industry watchers to be on more solid ground. Biden's DOE finalised those rules in the *Federal Register*, meaning they are now written into law and can only be changed by Congress.

With many of the planned hydrogen projects, including those affiliated with the hubs, spread across Republican districts and supported by oil and gas concerns, many players believe lawmakers will be loath to rescind the incentives. Texas' Republican governor Greg Abbott described the hubs at the time of their announcement in October 2023 as a "historic investment" that would "cement Texas' position as the national leader in energy and hydrogen production".

MARKET DEVELOPMENTS

Activist investor win might shift Air Products' H2 plans

Investors urge Air Products to focus on low-risk, high-margin projects, but the company is still likely to pursue clean hydrogen in some form, writes Aidan Lea

Activist investors looking to influence US industrial gas firm Air Products and its multi-billion-dollar clean hydrogen projects have won seats on the board and ousted chief executive Seifi Ghasemi from his board seat. The vote was not a clean sweep for New York-based firm Mantle Ridge, as it gained seats for three of its four candidates. Ghasemi will remain chief executive until the board elects his successor, which could be the candidate put forward by Mantle Ridge.

The activist investors argued that Air Products' five-year shareholder returns had underperformed against industrial gas peers, being approximately half of Air Liquide's and less than a third of Linde's. Mantle Ridge said it could boost margins and share prices at Air Products by cost cutting to tackle "corporate bloat", clarifying leadership succession plans and limiting its focus to "low-risk, high-margin" investments. It plans to promote ex-employees of US industrial gas firm Praxair, now merged with Linde, who Mantle Ridge says can steer Air Products back to being a "very predictable, no-surprises, low-risk business".

The shake-up will probably influence Air Products' strategy and might make other first movers reassess. That said, several of its projects look likely to continue, albeit with adjustments, so it might not be such a setback for clean hydrogen.

The shake-up will probably influence Air Products' strategy and might make other first movers reassess. That said, several of its projects look likely to continue

Air Products' $8.5bn renewable ammonia joint venture at Saudi Arabia's Neom has started construction and it could be difficult to back out, even though Mantle Ridge says the timing is out of step with industrial gas peers and overly aggressive compared with demand that it says is more likely to come after 2030. Air Products should not have sanctioned the project without firm customer contracts, Mantle Ridge has said, noting that Linde and Air Liquide have not sanctioned clean projects of this size. Air Products needs to reduce its liability for 30 years of offtake potentially worth $20bn-30bn, Mantle Ridge said.

The US firm has signed a deal to sell a third of Neom's output to TotalEnergies from 2030 and recently said it planned to find buyers in the next 6-12 months for the remainder. Ghasemi had initially resisted pressure to sign more long-term contracts, arguing that being the first supplier would allow Air Products to charge high prices. But he recently said the firm would avoid other large-scale projects until offtake for current projects is secured and Air Products in late 2024 quit a $4.5bn Texas renewable hydrogen project because of a lack of an anchor customer.

Mantle Ridge wants a refined approach to hydrogen production from gas with carbon capture and storage (CCS), which it calls "a sizeable and attractive growth opportunity for Air Products, if structured correctly". It has urged the company to focus on "core characteristics" — such as producing gases at its $7bn Louisiana project — rather than carbon sequestration or merchant ammonia trading. These activities should be delegated to more specialist firms, akin to the strategy of its peers, and as Air Products has done with its project in Alberta, Canada (*see table*).

Earlier in January, Air Products' leadership had asked shareholders to reject the "short-term opportunism" of the takeover in order to protect "long-term superior value creation".

Roles of industrial gas firms in CCS-H2 projects

Project	Louisiana	Beaumont, Texas	Baytown, Texas	Alberta, Canada
H2 production	Air Products	Linde	Air Liquide	Air Products
CO_2 sequestration	Air Products	ExxonMobil	ExxonMobil	Alberta government
H2 offtaker	Air Products	OCI	ExxonMobil	Imperial
Share of costs	$7bn	$1.8bn	$0.8bn	$0.9bn

— Mantle Ridge

NEWS

Trammo to buy US CCS-based ammonia from ExxonMobil

Trading firm Trammo is planning to buy up to 500,000 t/yr of ammonia produced from natural gas with carbon capture and storage (CCS) at ExxonMobil's planned Baytown facility in Texas.

The two firms have signed a "heads of agreement to advance discussions" for offtake of 300,000-500,000 t/yr. Trammo is planning to sell the ammonia to customers "in Europe and worldwide... for use as fertiliser feedstock and for other key industrial applications", the companies say.

Neither side has specified a start date for deliveries or contract duration. But they note that the preliminary deal envisages "long-term offtake" and "furthers Trammo's goal of making available in the market significant volumes of low-carbon ammonia by 2030". This suggests that deliveries could begin shortly after the Baytown facility starts operations in 2029.

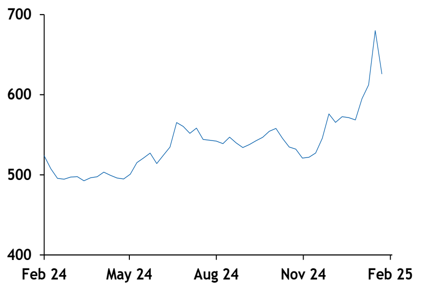
Offtake of 500,000 t/yr could cover half of the roughly 1mn t/yr of ammonia that ExxonMobil intends to produce at Baytown. The plant is due to produce nearly 900,000 t/yr of hydrogen — with a targeted carbon capture rate of 98pc — but most of this would be used to decarbonise refinery operations at Baytown.

Japanese power producer Jera previously said it is considering offtake of 500,000 t/yr of ammonia from the plant, as part of plans to take an equity stake in the project. Other firms that have been in offtake discussions are Japanese trading house Mitsubishi and South Korean conglomerate SK Materials. Abu Dhabi state-owned Adnoc last year secured a 35pc stake in the project.

ExxonMobil says it is planning a final investment decision on the plant this year, but notes that this would hinge on "supportive government policy, regulatory permitting and market conditions".

By Stefan Krumpelmann

Argus JKLAB inc 45Q subsidy $/t



Spain repeals windfall tax on large energy companies

Spain's parliament has repealed a government decree to revive a controversial tax on the revenue of large energy companies that some firms said threatened investment in renewable hydrogen projects.

The proposed reform and one-year extension of the original levy of 1.2pc on revenues of energy companies reporting annual sales of more than €1bn ($1.1bn) before the Covid-19 pandemic was rejected in the lower house — including by parties that helped the minority Socialist government into power in 2023.

Spain's largest oil and gas company, Repsol, announced last year that it was freezing investment in renewable hydrogen and contemplating shifting investment to Portugal after news that the Socialists were negotiating with their coalition partners to extend the levy. Spain's Cepsa, controlled by Abu Dhabi, also threatened to halt investment after the tax led the company to swing to a loss in 2023.

Repsol previously said an end to the windfall tax could allow it to take final investment decisions (FIDs) on three renewable hydrogen projects — at its Tarragona, Bilbao and Cartagena refineries — in 2025. At least one of these FIDs is likely to be examined and could be taken at Repsol's board meeting on 29 January.

Repsol has separately lodged an environmental impact assessment (EIA) for the 200MW Hydric electrolysis plant near to its Puertollano refinery, which it intends to develop with compatriot RIC Energy. Although Repsol and RIC have not yet decided on a supplier for the electrolyser system, they have chosen proton exchange membrane technology for the initial 30MW of capacity and alkaline technology for the remaining 170MW, according to the EIA.

By Jonathan Gleave

Planned renewable H2 projects, Spain

NEWS

More firms flock to Finland for e-fuels projects

More companies have announced e-fuels projects in Finland, which boasts favourable conditions for renewable hydrogen production and biogenic CO_2, as well as ambitious usage mandates.

Norwegian clean fuels start-up Freija announced on 22 January plans to build an e-methane production facility on a 15 hectare site near Tampere city, Finland, that could eventually provide up to 174,000 t/yr. The project will use hydrogen produced at an integrated electrolyser facility alongside biogenic CO_2 to help decarbonise commercial road transport across Europe.

Freija has begun front-end engineering and design efforts for the first of a three-phase development concept and has submitted an environmental impact assessment (EIA) covering all three phases.

Each phase corresponds to an individual plant, each with a planned capacity of 58,000 t/yr, Freija says. The combined 174,000 t/yr of e-methane output could require close to 90,000 t/yr of hydrogen, based on *Argus* estimates, making the project one of the largest planned e-methane facilities globally.

Total investment across all three phases of development is estimated at more than €1bn ($1.04bn) and is to be financed by a combination of equity and debt, Freija says. The first of the three plants is on track for a final investment decision (FID) in 2026, with e-methane production to begin in 2029.

Also on 22 January, Swedish project developer Liquid Wind and Finnish power company TSE revealed their plans to develop an e-methanol plant in Naantali, southwest Finland, that will be able to produce 100,000 t/yr. The companies expect to take an FID next year, with a view to starting operations in 2029. Liquid Wind will be the main project developer and has already started work on an EIA and permitting.

The site could require roughly 20,000 t/yr of renewable hydrogen, *Argus* estimates. It will take around 160,000 t/yr of biogenic CO_2 from a nearby biomass-based power plant. Waste heat from the e-methanol production plant will be used for district heating in the Turku region.

Finland looks increasingly attractive for e-fuel project developers, partly because of strong policy support. The government last month finalised legislation that introduces mandates for use of renewable hydrogen and derivatives in transport from 2028. By 2030, fuel suppliers will have to meet a 4pc share, well above the average 1.2pc minimum required by the EU across 2030-31.

By Jethro Robathan and Pamela Machado

Tampere and Naantali, Finland

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

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

— EU

Boeing invests in Norwegian e-SAF producer

US aircraft manufacturer Boeing is investing in Norwegian firm Norsk e-Fuel to support its plans to produce hydrogen-based sustainable aviation fuel (e-SAF).

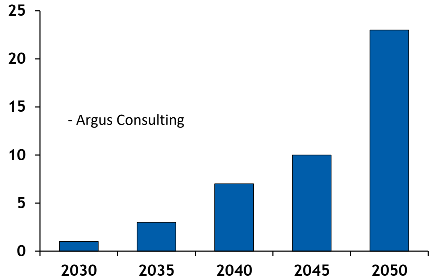
Norsk e-Fuel plans to open three e-SAF plants by 2032 with a combined production capacity of 200,000 t/yr. The e-SAF will be produced by combining renewable hydrogen with recycled CO_2.

Neither company would share investment figures, but they confirmed that the strategic partnership would entitle Boeing to e-SAF offtake rights. Boeing says its investment will help it secure the volumes required to meet commitments under EU law, as well as strengthen energy security in the Nordic region.

The EU has set specific mandates for e-SAF supply from 2030. Under the bloc's ReFuelEU regulation, synthetics must account for 1.2pc of all aviation fuels in 2030-31, 2pc in 2032, 5pc in 2035 and 35pc in 2050.

By Jethro Robathan

Mandated EU e-SAF use *mn t/yr*



NEWS

Winners of first electrolyser manufacturing tender

	Capacity subsidised *MW/yr*	Max. subsidy awarded *Rsbn ($mn)*
Bucket 1 — all stack technologies		
Reliance	300	4.4 (53.7)
Ohmium	137	2.0 (24.6)
John Cockerill Greenko	300	4.4 (53.7)
Advait Infratech	100	1.5 (17.9)
Jindal India	300	4.4 (53.7)
L&T	63	0.9 (11.3)
Bucket 2 — indigenously developed stack technology		
Homihydrogen	102	1.5 (18.2)
Adani New Industries	199	2.9 (35.6)

— SECI

Winners of second electrolyser manufacturing tender

	Capacity subsidised *MW/yr*	Max. subsidy awarded *Rsbn ($mn)*
Bucket 1 — all stack technologies		
Avaada Electrolyser	49.5	0.7 (8.5)
Newage Green Electro	71.5	1.1 (12.2)
Waaree Energies	300	4.4 (51.3)
Gensol, Matrix Gas and Renewables	237	3.5 (40.5)
Advait Infratech	200	3.0 (34.2)
Ohmium Operations	137	2.0 (23.4)
GH2 Solar	105	1.6 (17.9)
Total bids	**1,100**	
Bucket 2A — indigenously developed stack tech		
Newage Green Electro	228.5	3.4 (39.1)
Adani Enterprises	71.5	1.1 (12.2)
Total bids	**300**	
Bucket 2B — indigenously developed stack tech (smaller units)		
Adani Enterprises	30	0.4 (5.1)
Eastern Electrolyser	30	0.4 (5.1)
Newtrace	30	0.4 (5.1)
Suryaashish KA1 Solar Park	10	0.1 (0.7)
Total bids	**100**	

— SECI

India allocates full $513mn electrolyser subsidy budget

India has allocated all of its 44.4bn rupee ($513.7mn) budget to subsidise up to 3 GW/yr of electrolyser manufacturing capacity across two 1.5 GW/yr tender rounds and will hold no further rounds, government officials tell *Argus*.

The officials confirm that India's 2024 second round had allocated the Rs22.2bn that remained after the first round. The Rs44.4bn budget for electrolysers accounts for about a fifth of the Rs197.44bn that New Delhi has earmarked for its "national green hydrogen mission".

Both rounds offered support over five years, starting at Rs4,440/kW in the first year, and then falling annually. Successful bidders will receive up to Rs14.8mn per MW/yr for all categories in both rounds. But the final amount that companies will receive depends on their targets for "local value addition" (LVA) and electrolyser efficiency that Delhi called "specific energy consumption" (SEC). The government will check whether companies comply with the requirements and could reduce the incentives if they do not, according to one government official.

The government had asked for minimum 40pc domestic components in the first year of subsidies, rising to 50pc in the second year and 80pc by the fifth year in the case of alkaline electrolysers, with lower thresholds for other technologies.

Winning firms generally placed bids with more ambitious pledges to use Indian-made components in their electrolysers, according to SECI data.

Domestic firms Waree Energies, Matrix Gas and Renewables, Advait Infratech and Newage Green Electro have committed to 90pc LVA for alkaline electrolysers from the first year. US-based Ohmium, in its bid, stated that it can maintain 80pc LVA for its proton exchange membrane electrolysers consistently in all five years. Meanwhile, renewables firm GH2 Solar has proposed achieving 80pc LVA in the first year, increasing to more than 90pc from the second year.

Companies will also have to satisfy the government's SEC targets. The firms that prevailed in the tender were generally those promising more efficient technology. The government is keen to support the most efficient kit in a drive to produce lower-cost renewable hydrogen.

By Akansha Victor

US start-up Verdagy lines up 320MW electrolyser deal

US start-up Verdagy has struck a deal to supply 320MW of electrolyser equipment to compatriot Petron Scientech for biofuels and e-fuels production plants.

The "strategic partnership" appears preliminary rather than binding as neither company has given details on timelines or costs. Verdagy declined to disclose more information. The electrolysers would produce 45,000 t/yr of hydrogen, according to Verdagy, and the hydrogen would be used in the production of sustainable aviation fuel (SAF), biodiesel and e-methanol.

Petron Scientech is in talks with airlines and shipping companies about SAF and e-methanol offtake. The New Jersey-based firm and its affiliated company BioChem are developing production projects in India and Portugal.

Verdagy primarily offers 20MW alkaline electrolyser modules. It received a $40mn US government grant to help open its Silicon Valley electrolyser factory, which it says has 1 GW/yr of capacity and has started manufacturing equipment.

Verdagy has had its technology endorsed by Shell and has raised $73mn from investors including Singaporean company Temasek, Portugal's Galp and Yara Growth Ventures, among others. But apart from a supply agreement with Israeli company Doral, it has announced few other deals.

By Aidan Lea

ANALYSIS

Industry body H2 Peru has put together a framework with the British embassy that it hopes will help Peru catch up with its neighbours, writes Pamela Machado

Peru's H2 sector seeks progress on overdue regulations

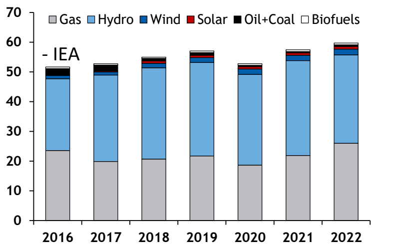
The Peruvian government is behind with its timeline for developing a regulatory framework for the hydrogen sector. Industry body H2 Peru is now looking to push the process forward, arguing that a framework is crucial for making headway.

Peru approved a hydrogen promotion law in March last year that entailed a broad definition of green hydrogen and vaguely promised "economic and tax benefits" for the sector. But it lacked details, such as specific greenhouse gas emissions thresholds or the shape and form of incentive mechanisms.

The government had 180 days from the approval in March to establish a more specific regulatory framework, so this is now months overdue. And while Lima has generally shown willingness to promote clean hydrogen, the government needs to pick up the pace and complete the framework to enable the industry to move forward, H2 Peru's general manager, Fernando Maceda, tells *Argus*.

H2 Peru has developed a framework proposal together with the British embassy in Lima and is setting up meetings with different ministries to discuss this. The 70-page document sets out rules for the entire hydrogen value chain, including production, transport, storage and use. It addresses myriad topics, including safety, certification and incentive mechanisms.

Peru electricity mix TWh



One of the draft's key points is to establish a more specific definition for both green and low-carbon hydrogen. H2 Peru proposes defining green hydrogen as being produced from water through processes that use renewable energy sources. Low-carbon hydrogen would be produced from "hydrocarbons or other substances" and emit no more than 3.38kg of CO_2 equivalent per kg of hydrogen — an emissions threshold in line with the EU's.

Renewables accounted for just over 55pc of power generation in Peru in 2022, a low share by South American standards. But there is significant potential for scaling up renewables generation — especially hydroelectric and solar power — H2 Peru says. Also, Peru could harness its proven gas reserves to produce low-carbon hydrogen with the use of carbon capture and storage, the association says.

Arequipa region, Peru

The group's proposal also includes a set of policy recommendations to accelerate developments, including enacting tax incentives, streamlining permitting and introducing carbon pricing mechanisms. These benefits should be available to both green and low-carbon hydrogen projects, the association argues.

The government should also develop a national strategy and policy for hydrogen, stating short and long-term goals and laying out a targeted action plan, H2 Peru says. Most South American peers have already gone down this route in recent years.

Darkest Peru?

Unlike Chile and Brazil, Peru has not seen a large number of project announcements, but developers have been showing increasing interest in the country. Last year, the government announced that it had allocated 4,000 hectares in Arequipa to South African developer Phelan for a $2.5bn renewable hydrogen project. And US-based MMex Resources is eyeing renewable ammonia production in Peru, while Japanese companies Marubeni and Osaka Gas are planning to produce synthetic methane there.

As elsewhere in South America, many projects will probably focus on export markets. But there is scope for the domestic application of clean hydrogen in mining, agriculture, cement and steel production, according to H2 Peru. Peruvian cement manufacturer Yura is planning to start a small-scale renewable hydrogen project in the coming months to support decarbonisation of its operations in the country, the company said last year.

INTERVIEW

Non-profit ITA upbeat on Brazil's H2 prospects

The Industrial Transition Accelerator (ITA) is a non-profit organisation launched in late 2023 at the UN climate summit Cop 28 in Dubai by the UAE, the UN Climate Change secretariat and Bloomberg Philanthropies. The scheme is backed by private-sector firms, governments and environmental groups. It was set up to help decarbonisation projects in heavy industry and the transportation sector reach final investment decisions (FIDs), although it does not offer direct financial assistance. The ITA has doubled down on Brazil, choosing four flagship projects in the country for renewable hydrogen and derivatives. Argus spoke with ITA's Brazil programme lead, Marc Moutinho, on the ambitions, project requirements and future plans. Edited highlights follow:

How does the ITA work?

Very fundamentally, it works to create better investment conditions for projects to reach final investment decisions in the sectors that we focus on, which are heavy industry and long-distance transport. We see that technology solutions to decarbonise these sectors are becoming more mature and well understood. The challenge is that for many of these technologies the investment case is still not strong enough — usually because they are more expensive to build or operate than the fossil fuel alternative. The ITA is focused on helping improve conditions for projects to attract the financing that they need.

'The ITA is trying to work on bringing the attention of financial institutions, particularly international ones, to Brazil to actually invest in those projects'

How can the ITA help to close the financing gap?

The financing gap can mean different things. One way to interpret it is the lack of financing available for projects. And, of course, that is a challenge. But I don't think it's as significant a challenge as people believe. There are projects happening in Brazil and there's a lot of capital, a lot of financial institutions, that are interested in finding good-quality projects in Brazil. But the important part is that these are good-quality projects. So another way to look at the financing gap is the strength of the investment case for those projects — how much is the green premium, or the difference in production costs between green and grey. I think that is a financing gap challenge and that's exactly what the ITA is trying to work on — trying to bring the attention of financial institutions, particularly international ones, to Brazil to actually invest in those projects. There's always a bit of nuance, but I think lack of capital when we think about things internationally is not as much of a challenge as strengthening the investment case.

Can you talk about the Brazil programme in more detail?

Taking the Brazil programme as an example, we have been mapping the projects being developed there and understanding the key challenges they are facing. Every project is unique and they always face a different constellation of challenges, but there are three areas that stand out very consistently. One is demand, so creating markets for green industrial products. The second is policy, which is usually strongly related to demand, but can cover other things. And then there is the financing — affordable financing under good conditions that projects need for higher capex investments.

If we take demand, for instance, one of the projects that we've selected for the ITA is Atlas Agro Green fertiliser. They explained to us that they believe they can produce green fertiliser quite competitively compared with the fertiliser that Brazil normally imports. They have buyers that are interested, but the difficulty is that the buyers aren't used to buying fertiliser under long-term contracts. And that's what Atlas Agro needs to show to the bank — that they will have stable

Brazil's projects supported through the Industrial Transition Accelerator *'000 t/yr*

Developer	State	Product	Output
Green Energy Park	Piaui	Ammonia	2,100
Fortescue	Ceara	Ammonia	900
European Energy	Pernambuco	E-methanol	100
Atlas Agro	Minas Gerais	Fertilisers	530

— ITA

INTERVIEW

revenues and ultimately get the financing that they need. What the ITA is doing is trying to understand what instruments could be used to make long-term offtake of fertilisers smoother. There are potentially policies that could be introduced and there are financial instruments that could help to make this possible.

There are always policies that could be strengthened to give projects in every sector a better investment case. And because the ITA programme is being done in partnership with the ministry of development and industry, which is developing Brazil's industrial policy and in particular a national decarbonisation strategy, we can make recommendations on how they can improve the policy framework. Then on finance, specifically, one way that we're helping is through a partnership with investment platform BIP, which was launched by the government, development bank Bndes and a few other institutions to bring international and domestic finance to decarbonisation projects in Brazil. In fact, two of the projects selected by the ITA are already on the BIP platform — Atlas Agro and Fortescue's green ammonia project. Hopefully, we can then continue to present projects to the platform, and it will then find the financiers for them.

'There's already a lot of recognition both from domestic and international companies that Brazil will be a good place to develop green industrial projects'

Why did the ITA choose Brazil for its first programme?

Very simply, there were three main reasons that we chose Brazil — government ambition, economic fundamentals and the project pipeline. In terms of government ambition, from the moment the ITA was launched at Cop 28, we had already begun to engage with the Brazilian government, which was already doing work on how to improve policy to encourage more green industry. That was a very promising start and meant that we could start conversations and begin developing the programme quickly. There's the topic of economic fundamentals and for all of the sectors we're looking at, Brazil is very well positioned to have green industrial projects that will eventually be competitive. Brazil already has a very clean electricity grid, and it has a lot of access to renewables. The project pipeline is basically the same as private-sector ambition. There's already a lot of recognition both from domestic and international companies that Brazil will be a good place to develop green industrial projects.

It's quite telling that the four projects we first selected for the Brazil programme are all from the chemicals sector — ammonia for fertilisers and methanol. There are many more projects in this sector than in most of the other sectors at which we are looking. I think part of this is companies recognising Brazil's competitive advantages for producing green chemicals like fertilisers — for all the reasons I just described. But the programme in Brazil is also looking at steel, cement, aluminium and aviation. The goal for us over the course of this year is to select additional projects from those sectors and also promote those.

'What's really important is to focus on emerging economies so we can make sure it happens in a green way from the beginning'

What are the next countries or geographies the ITA is focused on?

We're already developing a regional programme in the Middle East. We're considering a few options, but what's really important for us is to focus on emerging economies — economies where the industrial growth of the future is going to happen — so we can make sure it happens in a green way from the beginning.

Does the ITA disengage the moment a project reaches FID?

Country programmes are intended to run for about two years, during which time we try to make as much progress as possible, but hopefully even when the ITA steps away, the relationships we've built with stakeholders and the momentum we've already created mean organisations can continue the work. Even if the ITA cannot directly support projects past the end of its programme, the idea is that we'll create the foundations for the work that we've been doing to carry on.

IN BRIEF

Plug Power sells $30mn ITC from Georgia H2 plant

Hydrogen producer and equipment manufacturer Plug Power says it has boosted its liquidity through the transfer of a federal investment tax credit (ITC) to an unspecified investor. This is the first time that Plug Power has taken advantage of transferability rules laid out under the Inflation Reduction Act of 2022, and it is among the first such deals for hydrogen storage and liquefaction assets, Plug says. In an ITC transfer, a renewable energy developer can sell a tax credit and receive a one-time up-front payment. Plug qualified for the ITC through its investment in liquefaction and storage technologies at its hydrogen plant in Woodbine, Georgia, which began production early last year. The 15 t/d plant can also claim 45V production tax credits, Plug says.

Johnson Matthey cuts green H2 spending by 83pc to £5mn/yr

UK chemicals and technology firm Johnson Matthey will cut back spending in its renewable hydrogen technology business by 83pc "to reflect [a] market slowdown". The firm will trim yearly investment "to maintenance levels of no more than £5mn" ($6.2mn) at the start of the 2025-26 financial year, down from the average £30mn/yr it planned to spend following reductions in 2024. Last year's cuts had already reduced renewable hydrogen spending by a third, trimming the budget to 10pc of Johnson Matthey's capital allocation from 30pc before.

Norwegian hydrogen refuelling firm cuts jobs, pauses development

Cavendish Hydrogen — a spin-off from Norwegian electrolyser maker Nel that develops hydrogen refuelling stations — says it has started restructuring its business activities "to adjust capacity to market demand". The move entails a reduction of around 45pc of its global workforce this quarter, Cavendish says. The firm has also decided to pause development of "the next generation" of its equipment offering. Cavendish saw "lower-than-expected" order intake in 2024, as the market for light-duty vehicle facilities weakened "faster than anticipated in 2024". Nel completed the spin-off of its mobility business in June, citing "limited synergies" between the electrolyser and refuelling businesses.

Norwegian Hydrogen acquires Aker Horizons' Rjukan plant

Norwegian Hydrogen has acquired the Rjukan renewable hydrogen project in southern Norway from compatriot Aker Horizons. Norwegian Hydrogen plans to develop 25MW of electrolysis capacity at the site, with potential for expansion "in the somewhat longer term". Aker Horizons said in 2023 that it planned to develop 20-40MW at Rjukan. Aker tells *Argus* that the decision to sell the asset comes after "discussions with an industrial gas partner regarding the Rjukan project were terminated" last year, and that it has retained an option to reinvest in the Rjukan project "upon reaching a final investment decision".

Snam, Acwa consider Saudi green NH3 supply to Italy

Italian gas transport system operator Snam has signed a preliminary deal with Saudi Arabia's Acwa Power to explore co-operation on renewable hydrogen and ammonia, which could involve development of an ammonia import terminal in Italy. The partnership envisages potential joint investments in infrastructure, according to the companies. They will study development of an ammonia import terminal to facilitate delivery of renewable hydrogen from Saudi Arabia to Italy, Austria and Germany using the planned SouthH2 pipeline corridor. This suggests renewable ammonia would be shipped to the Italian terminal and cracked back into hydrogen for delivery into the SouthH2 Corridor.

COMPLETE HYDROGEN PRODUCTION COSTS

No-C Hydrogen									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands	Wind + PEM	Green	€/kg	7.86	8.23	nc	4.95	5.18	nc
Netherlands	Grid + GOO + ALK	Green	€/kg	12.84	13.44	+0.59	10.46	10.95	+0.59
UK	Wind + PEM	Green	£/kg	6.51	8.09	nc	3.95	4.91	nc
UK	Grid + GOO + ALK	Green	£/kg	11.14	13.84	+0.61	9.09	11.29	+0.62
Germany	Wind + PEM	Green	€/kg	7.90	8.27	nc	4.93	5.16	nc
Germany	Grid + GOO + ALK	Green	€/kg	11.89	12.45	+0.59	9.47	9.92	+0.59
France	Wind + PEM	Green	€/kg	8.24	8.63	nc	5.16	5.40	nc
France	Grid + GOO + ALK	Green	€/kg	11.24	11.77	+0.51	8.75	9.16	+0.50
Spain	Diurnal + PEM	Green	€/kg	6.18	6.47	nc	3.41	3.57	nc
Spain	Grid + GOO + ALK	Green	€/kg	10.68	11.18	+0.27	7.96	8.34	+0.26
US west coast	Diurnal + PEM	Green	$/kg	6.62	6.62	nc	4.03	4.03	nc
Canada	Wind + PEM	Green	C$/kg	11.67	8.13	nc	7.27	5.06	nc
Oman	Diurnal + PEM	Green	$/kg	6.30	6.30	nc	3.33	3.33	nc
Saudi Arabia	Diurnal + PEM	Green	$/kg	6.05	6.05	nc	3.38	3.38	nc
UAE	Diurnal + PEM	Green	$/kg	5.65	5.65	nc	3.22	3.22	nc
Qatar	Diurnal + PEM	Green	$/kg	6.07	6.07	nc	3.52	3.52	nc
Namibia	Diurnal + PEM	Green	$/kg	7.35	7.35	nc	3.70	3.70	nc
South Africa	Diurnal + PEM	Green	$/kg	7.04	7.04	nc	3.79	3.79	nc
Japan	Wind + PEM	Green	¥/kg	2,550	16.39	nc	2,028	13.03	nc
China	Diurnal + PEM	Green	Yn/kg	32.67	4.50	nc	19.74	2.72	nc
India	Diurnal + PEM	Green	Rs/kg	570.60	6.61	nc	303.86	3.52	nc
South Korea	Wind + PEM	Green	W/kg	22,178	15.48	nc	17,565	12.26	nc
Vietnam	Wind + PEM	Green	$/kg	9.72	9.72	nc	5.68	5.68	nc
Australia	Diurnal + PEM	Green	A$/kg	10.01	6.30	nc	5.85	3.68	nc
Brazil	Diurnal + PEM	Green	$/kg	6.85	6.85	nc	3.53	3.53	nc
Chile	Diurnal + PEM	Green	$/kg	6.48	6.48	nc	3.71	3.71	nc

Low-C hydrogen									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands	ATR + CCS	Blue	€/kg	5.37	5.62	+0.13	4.21	4.41	+0.13
UK	ATR + CCS	Blue	£/kg	4.64	5.76	+0.15	3.59	4.46	+0.15
Germany	ATR + CCS	Blue	€/kg	5.37	5.62	+0.17	4.19	4.39	+0.17
Spain	ATR + CCS	Blue	€/kg	5.45	5.71	+0.14	4.00	4.19	+0.14
France	ATR + CCS	Blue	€/kg	5.33	5.58	+0.13	4.08	4.27	+0.13
US Gulf coast	ATR + CCS	Blue	$/kg	2.96	2.96	-0.31	1.74	1.74	-0.31
Canada	ATR + CCS	Blue	C$/kg	3.17	2.21	-0.06	1.42	0.99	-0.06
Japan	ATR + CCS	Blue	¥/kg	898	5.77	-0.07	685	4.40	-0.07
South Korea	ATR + CCS	Blue	W/kg	8,037	5.61	+0.02	6,175	4.31	+0.02
Australia	ATR + CCS	Blue	A$/kg	6.13	3.86	-0.03	4.18	2.63	-0.03
Trinidad	ATR + CCS	Blue	$/kg	5.38	5.38	+0.13	3.53	3.53	+0.13
Qatar	ATR + CCS	Blue	$/kg	4.61	4.61	+0.12	3.36	3.36	+0.12
UAE	ATR + CCS	Blue	$/kg	4.78	4.78	+0.12	3.61	3.61	+0.12
Russia west	ATR + CCS	Blue	$/kg	3.10	3.10	+0.01	1.03	1.03	+0.02
Russia east	ATR + CCS	Blue	$/kg	3.04	3.04	+0.01	0.96	0.96	+0.01

COMPLETE HYDROGEN PRODUCTION COSTS

BAT+ hydrogen									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands	SMR + CCS	Blue	€/kg	4.26	4.46	+0.11	3.62	3.79	+0.11
UK	SMR + CCS	Blue	£/kg	3.56	4.42	+0.12	2.99	3.71	+0.12
Germany	SMR + CCS	Blue	€/kg	4.30	4.50	+0.15	3.65	3.82	+0.15
Spain	SMR + CCS	Blue	€/kg	4.34	4.54	+0.14	3.53	3.70	+0.14
France	SMR + CCS	Blue	€/kg	4.26	4.46	+0.11	3.57	3.74	+0.11
US Gulf coast	SMR + CCS	Blue	$/kg	1.93	1.93	-0.33	1.26	1.26	-0.32
Canada	SMR + CCS	Blue	C$/kg	2.18	1.52	-0.03	1.21	0.84	-0.04
Japan	SMR + CCS	Blue	¥/kg	678	4.36	nc	560	3.60	nc
South Korea	SMR + CCS	Blue	W/kg	6,146	4.29	+0.01	5,115	3.57	+0.01
Australia	SMR + CCS	Blue	A$/kg	4.54	2.86	nc	3.46	2.18	nc
Trinidad	SMR + CCS	Blue	$/kg	4.14	4.14	+0.12	3.12	3.12	+0.13
Qatar	SMR + CCS	Blue	$/kg	3.66	3.66	+0.12	2.97	2.97	+0.12
UAE	SMR + CCS	Blue	$/kg	3.67	3.67	+0.12	3.02	3.02	+0.12
Russia west	SMR + CCS	Blue	$/kg	1.86	1.86	+0.01	0.71	0.71	+0.01
Russia east	SMR + CCS	Blue	$/kg	1.82	1.82	+0.01	0.67	0.67	+0.01

BAT+ hydrogen						28 Jan
				Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan
Netherlands	SMR + CCS retrofit	Blue	€/kg	3.96	4.15	+0.11
UK	SMR + CCS retrofit	Blue	£/kg	3.20	3.97	+0.12
Germany	SMR + CCS retrofit	Blue	€/kg	3.97	4.16	+0.15
Spain	SMR + CCS retrofit	Blue	€/kg	3.85	4.03	+0.14
France	SMR + CCS retrofit	Blue	€/kg	3.91	4.09	+0.12
US Gulf coast	SMR + CCS retrofit	Blue	$/kg	1.52	1.52	-0.32
Canada	SMR + CCS retrofit	Blue	C$/kg	1.71	1.19	-0.03
Japan	SMR + CCS retrofit	Blue	¥/kg	577	3.71	nc
South Korea	SMR + CCS retrofit	Blue	W/kg	5,315	3.71	+0.01
Australia	SMR + CCS retrofit	Blue	A$/kg	3.85	2.42	nc
Trinidad	SMR + CCS retrofit	Blue	$/kg	3.29	3.29	+0.13
Qatar	SMR + CCS retrofit	Blue	$/kg	3.17	3.17	+0.11
UAE	SMR + CCS retrofit	Blue	$/kg	3.22	3.22	+0.12
Russia west	SMR + CCS retrofit	Blue	$/kg	0.91	0.91	+0.01
Russia east	SMR + CCS retrofit	Blue	$/kg	0.86	0.86	nc

BAT+ hydrogen										28 Jan
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Australia	Coal gasification + CCS	5,500	Blue	A$/kg	6.07	3.82	-0.03	4.10	2.58	-0.03
Australia	Coal gasification + CCS	6,000	Blue	A$/kg	6.50	4.09	-0.05	4.53	2.85	-0.05
China	Coal gasification + CCS	3,800	Blue	Yn/kg	30.71	4.23	nc	21.05	2.90	-0.01
China	Coal gasification + CCS	5,500	Blue	Yn/kg	30.27	4.17	-0.01	20.69	2.85	-0.01
Indonesia	Coal gasification + CCS	5,500	Blue	$/kg	4.14	4.14	nc	2.65	2.65	nc
Indonesia	Coal gasification + CCS	3,800	Blue	$/kg	3.95	3.95	-0.01	2.46	2.46	-0.01
South Africa	Coal gasification + CCS	4,800	Blue	$/kg	4.22	4.22	nc	2.51	2.51	+0.01
South Africa	Coal gasification + CCS	6,000	Blue	$/kg	4.44	4.44	+0.02	2.72	2.72	+0.02
Russia west	Coal gasification + CCS	6,000	Blue	$/kg	4.04	4.04	nc	2.15	2.15	-0.01
US east coast	Coal gasification + CCS	6,000	Blue	$/kg	3.71	3.71	+0.01	2.48	2.48	+0.01

COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands	SMR	Grey	€/kg	4.27	4.47	+0.13	3.73	3.91	+0.13
UK	SMR	Grey	£/kg	3.32	4.13	+0.13	2.84	3.53	+0.13
Germany	SMR	Grey	€/kg	4.31	4.51	+0.16	3.76	3.94	+0.17
Spain	SMR	Grey	€/kg	4.32	4.52	+0.15	3.64	3.81	+0.15
France	SMR	Grey	€/kg	4.27	4.47	+0.13	3.69	3.86	+0.13
US Gulf coast	SMR	Grey	$/kg	1.56	1.56	-0.32	0.99	0.99	-0.32
Canada	SMR	Grey	C$/kg	2.14	1.49	-0.04	1.34	0.93	-0.03
Japan	SMR	Grey	¥/kg	549	3.53	nc	450	2.89	nc
South Korea	SMR	Grey	W/kg	5,029	3.51	+0.02	4,155	2.90	+0.01
Australia	SMR	Grey	A$/kg	3.75	2.36	nc	2.84	1.79	nc
Trinidad	SMR	Grey	$/kg	3.58	3.58	+0.12	2.72	2.72	+0.13
Qatar	SMR	Grey	$/kg	3.28	3.28	+0.12	2.70	2.70	+0.12
UAE	SMR	Grey	$/kg	3.29	3.29	+0.11	2.75	2.75	+0.12
Russia west	SMR	Grey	$/kg	1.41	1.41	+0.01	0.44	0.44	+0.01
Russia east	SMR	Grey	$/kg	1.37	1.37	+0.01	0.40	0.40	+0.01

Baseline hydrogen									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands	Grid + ALK	Yellow	€/kg	12.79	13.39	+0.59	10.41	10.90	+0.59
Netherlands	Grid + PEM	Yellow	€/kg	12.42	13.00	+0.55	9.85	10.31	+0.54
UK	Grid + ALK	Yellow	£/kg	10.97	13.63	+0.64	8.91	11.07	+0.64
UK	Grid + PEM	Yellow	£/kg	10.64	13.22	+0.60	8.42	10.46	+0.60
Germany	Grid + ALK	Yellow	€/kg	11.85	12.41	+0.60	9.43	9.87	+0.59
Germany	Grid + PEM	Yellow	€/kg	11.53	12.07	+0.55	8.92	9.34	+0.55
France	Grid + ALK	Yellow	€/kg	11.19	11.72	+0.51	8.70	9.11	+0.51
France	Grid + PEM	Yellow	€/kg	10.94	11.46	+0.48	8.25	8.64	+0.47
Spain	Grid + ALK	Yellow	€/kg	10.63	11.13	+0.27	7.93	8.30	+0.27
Spain	Grid + PEM	Yellow	€/kg	10.44	10.93	+0.25	7.52	7.87	+0.25
US west coast	Grid + ALK	Yellow	$/kg	9.49	9.49	+0.08	6.99	6.99	+0.08
US west coast	Grid + PEM	Yellow	$/kg	9.37	9.37	+0.08	6.67	6.67	+0.08
US Midwest	Grid + ALK	Yellow	$/kg	7.41	7.41	-0.26	4.90	4.90	-0.26
US Midwest	Grid + PEM	Yellow	$/kg	7.43	7.43	-0.24	4.72	4.72	-0.25
US east coast	Grid + ALK	Yellow	$/kg	8.35	8.35	-0.18	5.84	5.84	-0.18
US east coast	Grid + PEM	Yellow	$/kg	8.30	8.30	-0.17	5.60	5.60	-0.16
Japan	Grid + ALK	Yellow	¥/kg	1,564	10.05	-1.34	1,145	7.36	-1.34
Japan	Grid + PEM	Yellow	¥/kg	1,541	9.90	-1.24	1,088	6.99	-1.24

COMPLETE HYDROGEN PRODUCTION COSTS

Hydrogen decarbonisation spreads				28 Jan
	Incl. capex		Excl. capex	
	$/kg	± 21 Jan	$/kg	± 21 Jan
Northwest Europe				
No-C to BAT+	3.91	-0.12	1.47	-0.12
Low-C to BAT+	1.14	+0.03	0.58	+0.03
BAT+ to baseline	-0.01	-0.02	-0.12	-0.02
North America				
No-C to BAT+	5.65	+0.18	3.50	+0.18
Low-C to BAT+	0.86	nc	0.32	nc
BAT+ to baseline	0.20	nc	0.09	nc
Northeast Asia				
No-C to BAT+	7.79	-0.01	5.75	-0.01
Low-C to BAT+	1.36	-0.04	0.77	-0.03
BAT+ to baseline	0.81	nc	0.69	nc
Middle East				
No-C to BAT+	2.35	-0.12	0.36	-0.12
Low-C to BAT+	1.03	nc	0.49	nc
BAT+ to baseline	0.38	nc	0.27	nc
Net exporter				
No-C to BAT+	3.49	+0.02	1.28	+0.02
Low-C to BAT+	1.02	-0.01	0.48	nc
BAT+ to baseline	0.41	+0.01	0.30	nc

Decarbonisation spreads relevant for subsidy mechanisms							28 Jan
		Incl. capex			Excl. capex		
	Unit	Spread	Spread in $/kg	± 21 Jan	Spread	Spread in $/kg	± 21 Jan
France							
No-C to Baseline[1]	€/kg	3.97	4.16	-0.13	1.47	1.54	-0.13
Germany							
No-C to BAT+[2]	€/kg	3.60	3.77	-0.15	1.28	1.34	-0.15
Netherlands							
No-C to baseline[3]	€/kg	3.59	3.76	-0.13	1.21	1.27	-0.13

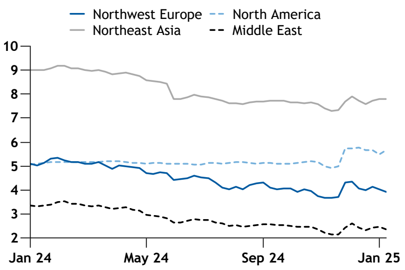
Differentials between the costs of renewable and natural gas-based hydrogen are used in subsidy mechanisms to establish the cost of switching to supply with a lower emissions intensity. The spreads above are relevant for the following:

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

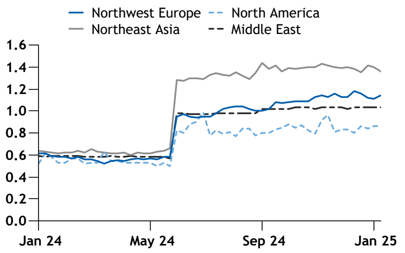
2 Future supply to Thyssenkrupp's direct reduced iron plant in Duisburg

3 Operational support granted to selected projects in Dutch subsidy scheme

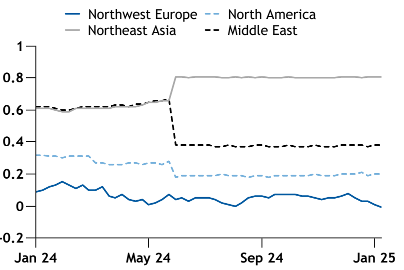
Decarb spread No-C to BAT+ *$/kg*



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



Decarb spread BAT+ to baseline *$/kg*

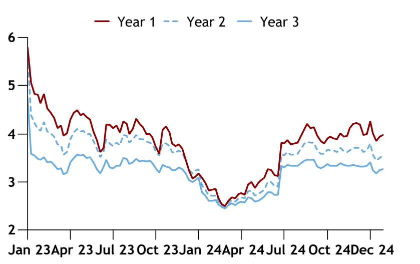


COMPLETE HYDROGEN PRODUCTION COSTS

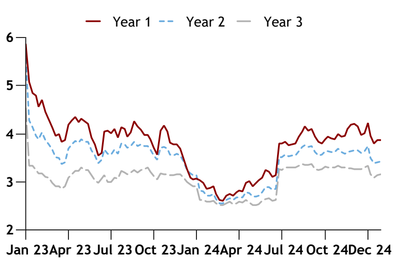
Low-C hydrogen forward									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands									
2026	ATR + CCS	Blue	€/kg	4.71	4.93	+0.01	3.55	3.72	+0.01
2027	ATR + CCS	Blue	€/kg	4.21	4.41	+0.01	3.06	3.20	+0.01
2028	ATR + CCS	Blue	€/kg	3.91	4.09	+0.01	2.75	2.88	+0.01
UK									
2026	ATR + CCS	Blue	£/kg	4.05	5.03	+0.02	3.01	3.74	+0.02
2027	ATR + CCS	Blue	£/kg	3.67	4.56	+0.01	2.63	3.27	+0.02
Germany									
2026	ATR + CCS	Blue	€/kg	4.76	4.98	+0.01	3.11	3.75	+0.01
2027	ATR + CCS	Blue	€/kg	4.27	4.47	+0.01	3.58	3.24	+0.01
2028	ATR + CCS	Blue	€/kg	3.96	4.15	+0.01	3.09	2.92	+0.01
France									
2026	ATR + CCS	Blue	€/kg	4.61	4.83	-0.01	3.36	3.52	-0.01
Spain									
2026	ATR + CCS	Blue	€/kg	4.78	5.01	nc	3.33	3.49	nc

BAT+ hydrogen forward									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands									
2026	SMR + CCS	Blue	€/kg	3.70	3.87	+0.01	3.07	3.21	+0.02
2027	SMR + CCS	Blue	€/kg	3.28	3.43	+0.02	2.64	2.76	+0.02
2028	SMR + CCS	Blue	€/kg	3.01	3.15	+0.02	2.37	2.48	+0.02
UK									
2026	SMR + CCS	Blue	£/kg	3.09	3.84	+0.01	2.52	3.13	+0.02
2027	SMR + CCS	Blue	£/kg	2.77	3.44	+0.02	2.19	2.72	+0.01
Germany									
2026	SMR + CCS	Blue	€/kg	3.76	3.94	+0.02	3.11	3.26	+0.02
2027	SMR + CCS	Blue	€/kg	3.33	3.49	+0.02	2.68	2.81	+0.02
2028	SMR + CCS	Blue	€/kg	3.07	3.21	+0.02	2.42	2.53	+0.02
France									
2026	SMR + CCS	Blue	€/kg	3.69	3.86	+0.01	3.00	3.14	+0.01
Spain									
2026	SMR + CCS	Blue	€/kg	3.76	3.94	nc	2.96	3.10	nc

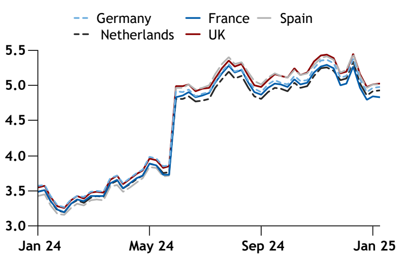
German SMR costs *$/kg*



Dutch SMR+CCS costs *$/kg*



European year 1 ATR+CCS costs *$/kg*



COMPLETE HYDROGEN PRODUCTION COSTS

Baseline hydrogen forward									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 21 Jan	Cost	Cost in $/kg	± 21 Jan
Netherlands									
2026	SMR	Grey	€/kg	3.72	3.90	+0.03	3.19	3.34	+0.03
2027	SMR	Grey	€/kg	3.31	3.47	+0.04	2.78	2.91	+0.04
2028	SMR	Grey	€/kg	3.07	3.21	+0.04	2.53	2.65	+0.04
UK									
2026	SMR	Grey	£/kg	2.90	3.60	+0.03	2.42	3.00	+0.03
2027	SMR	Grey	£/kg	2.58	3.21	+0.03	2.09	2.60	+0.02
Germany									
2026	SMR	Grey	€/kg	3.79	3.97	+0.04	3.24	3.39	+0.03
2027	SMR	Grey	€/kg	3.38	3.54	+0.05	2.83	2.96	+0.04
2028	SMR	Grey	€/kg	3.12	3.27	+0.03	2.58	2.70	+0.04
France									
2026	SMR	Grey	€/kg	3.71	3.88	+0.03	3.12	3.27	+0.03
Spain									
2026	SMR	Grey	€/kg	3.76	3.94	+0.02	3.08	3.23	+0.02

Direct reduction iron costs (24 Jan)		$/t
Specification	Cost	±
Natural gas DRI, ex-works NW Europe	439.33	+16.04
DRI spread No-C hydrogen (renewables+PEM) vs natural gas NW Europe	381.28	-4.88
DRI spread BAT+ hydrogen (SMR+CCS) vs natural gas NW Europe	147.54	+0.34

Argus Hydrogen and Future Fuels Data & Downloads

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

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- H2Global tenders for hydrogen and derivatives
- Global e-Methanol production facilities
- Global electrolyser orders
- Global electrolyser manufacturing capacity
- Global planned ammonia cracking facilities
- Global hydrogen production and electrolyser capacity targets
- Global renewable hydrogen-based SAF production sites
- Global hydrogen production and consumption targets by company
- Global hydrogen subsidy auctions tracker
- Global planned hydrogen DRI steelmaking plants
- Global planned and operational synthetic natural gas plants
- Global LOHC and liquid hydrogen seaborne transport plans

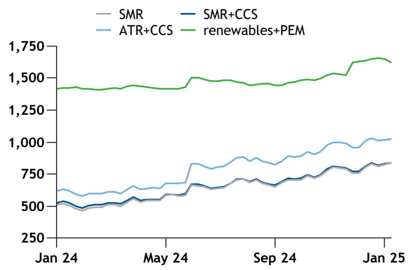
COMPLETE AMMONIA PRODUCTION COSTS

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

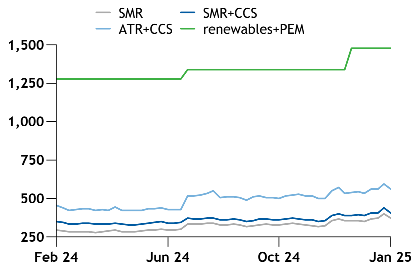
CO2e emissions on a gate-to-gate basis; purity >99.5pc; temperature -33°C

Regional ammonia cost markers						28 Jan
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 21 Jan	Cost	± 21 Jan
Baseline						
Northwest Europe	SMR	€/t	837	+11	666	+13
Northwest Europe	SMR	$/t	876	+24	697	+24
North America	SMR	$/t	371	-31	197	-32
Northeast Asia	SMR	$/t	710	+1	518	+1
Middle East	SMR	$/t	646	+19	486	+20
BAT+						
Northwest Europe	SMR+CCS	€/t	835	+8	647	+11
Northwest Europe	SMR+CCS	$/t	874	+21	677	+21
North America	SMR+CCS	$/t	406	-32	214	-32
Northeast Asia	SMR+CCS	$/t	854	+1	642	+1
Middle East	SMR+CCS	$/t	712	+20	534	+19
Low-C						
Northwest Europe	ATR+CCS	€/t	1,026	+8	735	+13
Northwest Europe	ATR+CCS	$/t	1,074	+25	770	+26
North America	ATR+CCS	$/t	560	-33	265	-32
Northeast Asia	ATR+CCS	$/t	1,094	-5	767	-4
Middle East	ATR+CCS	$/t	889	+20	616	+20
No-C						
Northwest Europe	Island renewable+PEM	€/t	1,624	-26	999	-16
Northwest Europe	Island renewable+PEM	$/t	1,701	nc	1,046	nc
North America	Island renewable+PEM	$/t	1,480	nc	902	nc
Northeast Asia	Island renewable+PEM	$/t	2,390	nc	1,799	nc
Middle East	Island renewable+PEM	$/t	1,179	nc	641	nc
Exporter						
Exporter baseline	SMR	$/t	542	-4	375	-3
Exporter BAT+	SMR+CCS	$/t	614	-4	428	-5
Exporter low-C	ATR+CCS	$/t	793	-5	507	-5
Exporter no-C	Island renewable+PEM	$/t	1,287	nc	701	nc

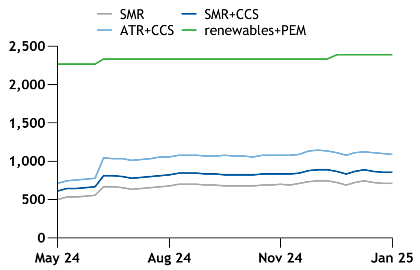
NW Europe ammonia average €/t



North America ammonia average $/t



Northeast Asia ammonia average $/t



COMPLETE AMMONIA PRODUCTION COSTS

No-C ammonia									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 21 Jan	Cost	Cost in $/t	± 21 Jan
Netherlands	Wind + PEM	Green	€/t	1,603	1,679	nc	995	1,042	nc
UK	Wind + PEM	Green	£/t	1,320	1,640	nc	780	969	nc
Germany	Wind + PEM	Green	€/t	1,595	1,670	nc	975	1,021	nc
France	Wind + PEM	Green	€/t	1,676	1,755	nc	1,028	1,076	nc
Spain	Diurnal + PEM	Green	€/t	1,227	1,285	nc	664	695	nc
US west coast	Diurnal + PEM	Green	$/t	1,309	1,309	nc	793	793	nc
Canada	Wind + PEM	Green	C$/t	2,371	1,651	nc	1,450	1,010	nc
Oman	Diurnal + PEM	Green	$/t	1,246	1,246	nc	633	633	nc
Saudi Arabia	Diurnal + PEM	Green	$/t	1,179	1,179	nc	642	642	nc
UAE	Diurnal + PEM	Green	$/t	1,103	1,103	nc	615	615	nc
Qatar	Diurnal + PEM	Green	$/t	1,186	1,186	nc	673	673	nc
Namibia	Diurnal + PEM	Green	$/t	1,474	1,474	nc	702	702	nc
South Africa	Diurnal + PEM	Green	$/t	1,392	1,392	nc	717	717	nc
Japan	Wind + PEM	Green	¥/t	499,810	3,212	nc	389,640	2,504	nc
China	Diurnal + PEM	Green	Yn/t	6,620	912	nc	3,796	523	nc
India	Diurnal + PEM	Green	Rs/t	112,135	1,299	nc	57,405	665	nc
South Korea	Wind + PEM	Green	W/t	4,363,971	3,046	nc	3,394,040	2,369	nc
Vietnam	Wind + PEM	Green	$/t	1,957	1,957	nc	1,083	1,083	nc
Australia	Diurnal + PEM	Green	A$/t	1,988	1,251	nc	1,160	730	nc
Brazil	Diurnal + PEM	Green	$/t	1,358	1,358	nc	669	669	nc
Chile	Diurnal + PEM	Green	$/t	1,263	1,263	nc	705	705	nc

Low-C ammonia									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 21 Jan	Cost	Cost in $/t	± 21 Jan
Netherlands	ATR + CCS	Blue	€/t	1,024	1,072	+23	744	779	+23
UK	ATR + CCS	Blue	£/t	881	1,094	+26	633	786	+26
Germany	ATR + CCS	Blue	€/t	1,029	1,077	+30	740	775	+30
Spain	ATR + CCS	Blue	€/t	1,063	1,113	+25	707	740	+25
France	ATR + CCS	Blue	€/t	1,026	1,074	+23	721	755	+23
US Gulf coast	ATR + CCS	Blue	$/t	618	618	-53	322	322	-53
Canada	ATR + CCS	Blue	C$/t	721	502	-13	297	207	-12
Japan	ATR + CCS	Blue	¥/t	173,191	1,113	-12	120,440	774	-12
South Korea	ATR + CCS	Blue	W/t	1,540,141	1,075	+3	1,087,411	759	+3
Australia	ATR + CCS	Blue	A$/t	1,233	776	-6	753	474	-6
Trinidad	ATR + CCS	Blue	$/t	1,093	1,093	+22	623	623	+22
Qatar	ATR + CCS	Blue	$/t	882	882	+20	595	595	+20
UAE	ATR + CCS	Blue	$/t	896	896	+20	636	636	+20
Russia west	ATR + CCS	Blue	$/t	720	720	+2	191	191	+2
Russia east	ATR + CCS	Blue	$/t	717	717	+2	188	188	+2

Japan and Korea low-carbon ammonia benchmark (JK LAB)			28 Jan
	Unit	Cost	± 21 Jan
CFR Ulsan, South Korea, incl. US 45Q tax credit	$/t	626.09	-53.89
CFR Ulsan, South Korea, excl. US 45Q tax credit	$/t	762.09	-53.89
CFR Niihama, Japan, differential	$/t	+0.13	-0.07

The JKLAB includes the US Gulf coast Low-C ATR+CCS ammonia production cost (with and without the US' 45Q tax credit for carbon sequestration) and freight costs for delivery to Ulsan, South Korea. The Niihama differential reflects the cost difference for delivery to Niihama in Japan, rather than to Ulsan.

COMPLETE AMMONIA PRODUCTION COSTS

BAT+ ammonia									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 21 Jan	Cost	Cost in $/t	± 21 Jan
Netherlands	SMR + CCS	Blue	€/t	829	868	+18	648	679	+19
UK	SMR + CCS	Blue	£/t	693	861	+20	532	661	+20
Germany	SMR + CCS	Blue	€/t	838	878	+25	651	682	+25
Spain	SMR + CCS	Blue	€/t	861	902	+23	630	660	+23
France	SMR + CCS	Blue	€/t	837	876	+19	639	669	+19
US Gulf coast	SMR + CCS	Blue	$/t	434	434	-56	242	242	-56
Canada	SMR + CCS	Blue	C$/t	541	377	-8	266	185	-8
Japan	SMR + CCS	Blue	¥/t	134,289	863	nc	100,055	643	nc
South Korea	SMR + CCS	Blue	W/t	1,210,622	845	+3	916,921	640	+2
Australia	SMR + CCS	Blue	A$/t	950	598	nc	639	402	nc
Trinidad	SMR + CCS	Blue	$/t	861	861	+22	556	556	+21
Qatar	SMR + CCS	Blue	$/t	716	716	+19	530	530	+19
UAE	SMR + CCS	Blue	$/t	707	707	+20	538	538	+19
Russia west	SMR + CCS	Blue	$/t	486	486	+2	143	143	+2
Russia east	SMR + CCS	Blue	$/t	480	480	+1	137	137	+2

BAT+ ammonia										28 Jan
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/t	± 21 Jan	Cost	Cost in $/t	± 21 Jan
Australia	Coal gasification + CCS	5,500	Blue	A$/t	1,201	756	-5	747	470	-5
Australia	Coal gasification + CCS	6,000	Blue	A$/t	1,274	802	-8	820	516	-9
China	Coal gasification + CCS	3,800	Blue	Yn/t	5,923	816	nc	3,709	511	-1
China	Coal gasification + CCS	5,500	Blue	Yn/t	5,851	806	-2	3,644	502	-2
Indonesia	Coal gasification + CCS	5,500	Blue	$/t	810	810	nc	466	466	nc
Indonesia	Coal gasification + CCS	3,800	Blue	$/t	777	777	-2	433	433	-2
South Africa	Coal gasification + CCS	4,800	Blue	$/t	841	841	nc	442	442	+2
South Africa	Coal gasification + CCS	6,000	Blue	$/t	878	878	+3	478	478	+3
Russia west	Coal gasification + CCS	6,000	Blue	$/t	824	824	nc	382	382	-2
US east coast	Coal gasification + CCS	6,000	Blue	$/t	734	734	+2	451	451	+1

Baseline ammonia									28 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 21 Jan	Cost	Cost in $/t	± 21 Jan
Netherlands	SMR	Grey	€/t	832	871	+22	668	699	+21
UK	SMR	Grey	£/t	651	809	+22	506	629	+23
Germany	SMR	Grey	€/t	839	879	+28	670	702	+28
Spain	SMR	Grey	€/t	860	900	+26	650	681	+26
France	SMR	Grey	€/t	838	877	+22	659	690	+23
US Gulf coast	SMR	Grey	$/t	368	368	-55	194	194	-56
Canada	SMR	Grey	C$/t	536	373	-7	287	200	-7
Japan	SMR	Grey	¥/t	111,103	714	-1	80,138	515	-1
South Korea	SMR	Grey	W/t	1,010,046	705	+2	744,998	520	+3
Australia	SMR	Grey	A$/t	809	509	+1	528	332	+1
Trinidad	SMR	Grey	$/t	761	761	+21	485	485	+21
Qatar	SMR	Grey	$/t	650	650	+19	482	482	+20
UAE	SMR	Grey	$/t	642	642	+19	490	490	+20
Russia west	SMR	Grey	$/t	405	405	+2	94	94	+1
Russia east	SMR	Grey	$/t	399	399	+1	89	89	+2

COMPLETE AMMONIA PRODUCTION COSTS

Ammonia decarbonisation spreads				28 Jan
	Incl. capex		Excl. capex	
	$/t	± 21 Jan	$/t	± 21 Jan
Northwest Europe				
No-C to BAT+	827	-21	369	-21
Low-C to BAT+	200	+4	93	+5
BAT+ to baseline	-2	-3	-20	-3
North America				
No-C to BAT+	1,074	+32	688	+32
Low-C to BAT+	154	-1	51	nc
BAT+ to baseline	35	-1	17	nc
Northeast Asia				
No-C to BAT+	1,536	-1	1,157	-1
Low-C to BAT+	240	-6	125	-5
BAT+ to baseline	144	nc	124	nc
Middle East				
No-C to BAT+	467	-20	107	-19
Low-C to BAT+	177	nc	82	+1
BAT+ to baseline	66	+1	48	-1
Net exporter				
No-C to BAT+	673	+4	273	+5
Low-C to BAT+	179	-1	79	nc
BAT+ to baseline	72	nc	53	-2

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