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Argus *Hydrogen and Future Fuels*

Market news, analysis and prices

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LatAm looks at domestic offtake to spur H2

Fostering a domestic market could be the most effective way to advance projects in the region, even if development is slow, writes Pamela Machado

Latin American countries hope to see the first final investment decisions (FIDs) for large renewable hydrogen projects this year, but much will hinge on their success in unlocking domestic offtake opportunities.

Similar to the rest of the world, Latin America's hydrogen sector can claim some modest progress in 2025, but not the long-awaited first FIDs, with lack of international demand one of the main causes.

Countries in the region still harbour big long-term export ambitions, but the realisation that demand in Europe and east Asia will not materialise at the scale once anticipated has prompted a pivot towards fostering domestic offtake first.

Chile launched a $2.8bn tax credit scheme for domestic consumption of renewable hydrogen and derivatives in August, targeting the maritime and mining sectors. Applications for the first tranche of the tax benefits, with a budget of $700mn, are expected to open early this year. Timely delivery of this support would be crucial to help projects along, after the first large initiatives received environmental approval in the second half of 2025.

Brazil has yet to finalise the rules of its own $3bn tax credit scheme, but the underlying law established that the benefit should prioritise projects with greater potential for decarbonisation. Brazil would do well to take a leaf out of Chile's book — Brazil's large agricultural sector relies heavily on fertiliser imports and could be a source of significant demand for locally produced green fertilisers.

Colombia recently unveiled a comprehensive action plan with initiatives to be implemented by 2030. The country's hydrogen strategy, launched back in 2021, needed to be revised to reflect current market realities, the government says. The new plan pays special attention to building up a domestic market through potential introduction of mandates for use of renewable hydrogen in production of green fertilisers and in the mobility sector.

Nurturing a domestic market, even a limited one, will be one of the most effective ways to expedite initial projects. One of the region's most advanced projects — Atome's green fertiliser plant in Paraguay — has secured several financing deals and offtakers for 100pc of output by targeting demand in the Mercosur countries, although it has yet to reach an FID, following several delays.

Countries still have to clear some major obstacles, such as long-winded permitting procedures and infrastructure bottlenecks. Brazil's energy ministry approved two tenders this year to expand the power grid — a move that could help address industry concerns about infrastructure.

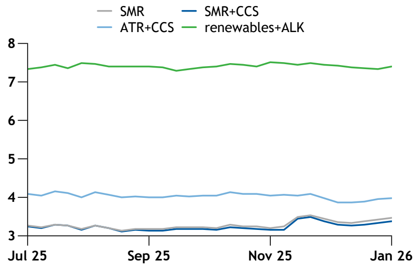
Although the market is developing slowly, industry participants still see highly favourable long-term prospects in the region. US electrolyser manufacturer Electric Hydrogen recently expanded into Brazil — marking its debut in Latin America. The region offers "one of the most compelling economic cases" for large-scale hydrogen and derivatives projects, the firm says.

Latin American countries could also benefit from their close relations with China. Several Chinese electrolyser manufacturers have plans to set up shop in the region and some are becoming directly involved in planned production projects. Among these is Envision Energy, which in China operates the largest renewable ammonia plant globally and could leverage its experience — and low-cost equipment — at its planned project in Brazil's Pecem complex.

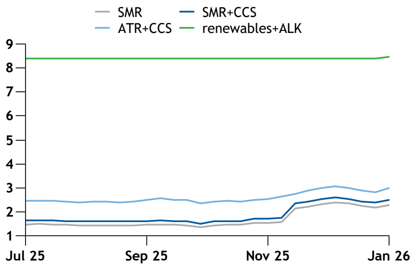
CONTENTS

HYDROGEN COSTS

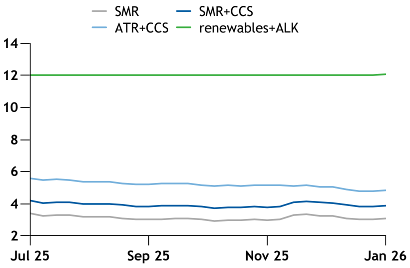
Northwest Europe average cost €/kg



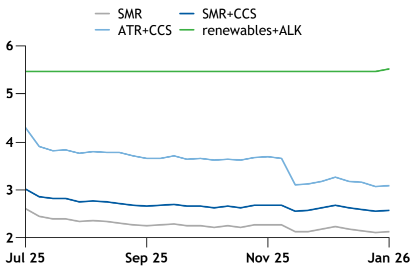
North America average cost $/kg



Northeast Asia average cost $/kg



Exporter average cost $/kg



Regional hydrogen cost markers						6 Jan
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 30 Dec	Cost	± 30 Dec
Baseline						
Northwest Europe	SMR	€/kg	3.47	+0.04	2.63	nc
Northwest Europe	SMR	$/kg	4.07	+0.03	3.09	nc
North America	SMR	$/kg	2.28	+0.09	1.22	+0.06
Northeast Asia	SMR	$/kg	3.06	+0.05	2.09	+0.03
BAT+						
Northwest Europe	SMR+CCS	€/kg	3.38	+0.04	2.44	+0.01
Northwest Europe	SMR+CCS	$/kg	3.97	+0.04	2.86	nc
North America	SMR+CCS	$/kg	2.48	+0.09	1.29	+0.07
Northeast Asia	SMR+CCS	$/kg	3.88	+0.05	2.79	+0.03
Low-C						
Northwest Europe	ATR+CCS	€/kg	3.97	+0.02	2.91	-0.01
Northwest Europe	ATR+CCS	$/kg	4.66	+0.01	3.42	-0.01
North America	ATR+CCS	$/kg	2.98	+0.18	1.64	+0.15
Northeast Asia	ATR+CCS	$/kg	4.82	+0.04	3.59	+0.02
No-C						
Northwest Europe	Island renewable+PEM	€/kg	7.40	+0.06	6.03	+0.01
Northwest Europe	Island renewable+PEM	$/kg	8.69	+0.05	7.08	nc
North America	Island renewable+PEM	$/kg	8.47	+0.06	6.68	+0.02
Northeast Asia	Island renewable+PEM	$/kg	12.07	+0.05	10.49	+0.01
Exporter						
Exporter baseline	SMR	$/kg	2.12	+0.01	1.36	-0.03
Exporter BAT+	SMR+CCS	$/kg	2.57	+0.02	1.71	-0.03
Exporter low-C	ATR+CCS	$/kg	3.08	+0.02	2.10	-0.02
Exporter no-C	Island renewable+PEM	$/kg	5.52	+0.05	3.49	+0.01

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

CO2e emissions on a gate-to-gate basis

Pump prices, 70MPa				6 Jan
	Unit	Price		± 2 Dec
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

Brazil plans grid expansion to support H2, data centres

Brazil's grid may need to grow by 5,000km by 2030 to meet rising power demand, including from hydrogen and data centre projects, writes Pamela Machado

Brazil's energy ministry expects to spend nearly 120bn reals ($21.6bn) over the next 10 years on expanding and strengthening the national electricity grid to support energy-intensive initiatives such as hydrogen and data centre projects.

A 10-year energy infrastructure plan from national energy research and planning agency EPE states that hydrogen projects could require close to 28GW of power capacity by 2038, and data centre projects 26.3GW. Each of these sectors alone could therefore require additions of well over 10pc of the 216GW of power capacity that Brazil had installed by late 2025.

But the projections are not definitive because "the effective implementation of these [hydrogen and data centre] projects within the next 10 years is subject to multiple constraints", according to EPE. Development of the hydrogen industry will depend on the competitiveness of Brazilian projects and the growth of domestic and international consumer markets, the agency says.

EPE says it is monitoring project development and that it will continue to assess hydrogen projects' medium and long-term energy needs.

Ceara and Piaui, Brazil

Most hydrogen projects are planned in Brazil's northeast, in states such as Ceara and Piaui. They entail large-scale electrolysis plants and many would also have associated facilities to produce ammonia or methanol derivatives, further lifting power demand. Data centre plans are mostly focused around Sao Paulo, but an increasing number of projects look to the northeast, EPE says.

Brazil's energy authorities are already working on enabling 3-4GW of additional power supply in the northeast to accommodate the first hydrogen projects in the coming years.

EPE's plan also aims to increase regional interconnections. The goal is to allow for 60GW of wind and solar generation capacity in Brazil's northeast by 2033. This could be used locally, but also transmitted to demand centres in Sao Paulo and the southeast, the agency says.

The national grid will need to expand by more than 5,000km to support growing power demand by 2030, grid operator ONS states in a report to complement EPE's 10-year plan. ONS envisages a 17pc rise in maximum power demand from the national grid in 2030, compared with 2025 levels.

Data centre and hydrogen projects could "help absorb surplus renewable generation during the day" because they tend to operate continuously, ONS says. But they do not "contribute to alleviating critical peak periods".

Weather the storm

EPE's plan considers the effects of extreme weather events and climate change on power generation and grid integrity.

"Recent extreme events such as heat waves, historic droughts, floods and intense winds demonstrate the need for a specific look at vulnerabilities in the electrical system," the agency says.

Expanding grid capacity has become a key issue for hydrogen project developers and for energy industry participants in general. Brazil's power mix relies heavily on hydropower, which represented 56pc of generation in 2024, data from Paris-based watchdog the IEA show. Droughts leave Brazil's large hydropower plants operating below capacity and stronger connections between regions will be key to ensuring a stable power supply, EPE says.

Other countries in southern America that rely heavily on hydropower, such as Colombia, have started to consider ways in which they can accommodate large-scale hydrogen projects in the grid, in light of the potential for more widespread and extreme droughts.

MARKET DEVELOPMENTS

India's Gujarat targets 3mn t/yr green H2 by 2035

Gujarat's new policy envisages a Rs5 trillion investment injection into renewable hydrogen and power generation projects, writes Akansha Victor

India's western state of Gujarat plans to produce 3mn t/yr of renewable hydrogen by 2035, according to a new policy that sets out various incentives for potential project developers.

Gujarat's government had previously aimed for 1mn t/yr by 2030, but the new policy no longer includes a target for the end of the decade.

The state now aims to have 30GW of electrolyser capacity installed by 2030, supported by 75GW of dedicated renewable energy capacity. The 75GW for hydrogen alone would require a massive buildout of renewable capacity. Gujarat had 41.7GW installed as of November and accounted for about 15.9pc of India's total, according to the country's ministry of new and renewable energy.

With the new policy, Gujarat aims to attract about 5 trillion rupees ($55.6bn) of investment into renewable hydrogen and power generation projects and to cut natural gas consumption by at least 2mn t/yr.

Gujarat, India

The policy offers incentives across the renewable hydrogen value chain, including production, storage, transport and end-use applications. But developers that have taken advantage of benefits under the Gujarat wasteland allocation policy for green hydrogen will not be eligible for incentives under the new policy.

The state will grant incentives to projects with 1–10MW of electrolyser capacity, including a 20pc capital expenditure (capex) subsidy capped at Rs10mn/MW. It will also partially reimburse transmission and wheeling charges for renewable power used in hydrogen production for five years from commissioning.

Gujarat will also support biomass-based hydrogen projects, hydrogen hubs, refuelling stations and demand-side adoption. Up to five biomass-based projects with maximum output capacity of 5,000 t/yr hydrogen each will receive a 20pc capex subsidy of up to Rs80mn per 1,000 t/yr, or Rs400mn per project.

Hydrogen hubs will be eligible for a 20pc capex subsidy for up to Rs350mn per project for up to two hubs, each with a minimum production capacity of 3,000 t/yr. A hub must include at least 10 industrial units, including at least one hydrogen producer, and cover production, storage, transport and distribution.

The state aims to facilitate development of renewable hydrogen hubs near ports as part of its ambition to become a global exporter of renewable hydrogen and its derivatives. Deendayal Port at Kandla has said it plans to invite expressions of interest from developers shortly, with the objective of accommodating up to 150,000 t/yr of e-methanol production capacity.

Under the policy, the state will also offer a 30pc capex subsidy of up to Rs40mn per unit for the first 20 renewable hydrogen refuelling stations, with a single developer eligible for subsidies for up to three stations.

Driving demand

To stimulate demand, Gujarat will provide a 30pc capex subsidy of up to Rs5mn per vehicle for the first 500 hydrogen-fuelled passenger buses purchased by public transport companies and extend the support to heavy-duty hydrogen vehicles. Micro, small and medium-sized enterprises (MSMEs) will receive usage-linked support of Rs50/kg of renewable hydrogen for industrial consumption for five years, capped at Rs2.5bn in total and Rs250mn per MSME.

Gujarat has also allocated Rs1bn for research and development. To work towards its ambition of becoming a renewable hydrogen hub, the state aims to prioritise land allocation, support water infrastructure — including desalination plants — and develop dedicated green transmission corridors.

State-owned Gujarat Power Corporation will be tasked with implementing the policy and disbursing the support.

NEWS

Hungary sets 1pc green H2 transport quota for 2030

Hungary has set a 1pc quota for use of renewable hydrogen and derivatives in transport by 2030, in line with the EU minimum.

A government decree published on 31 December sets the quota for renewable fuels of non-biological origin (RFNBOs) along with mandates for biofuels, biogas and renewable electricity, transposing the EU's revised renewable energy directive (RED III) into national law.

Hungary's law applies a twofold multiplier to RFNBO energy content and an additional multiplier if supplied to the maritime or aviation sectors. This means the real RFNBO share in transport, measured in energy terms, can be below 1pc.

Several other member states are also applying such multipliers, which is creating a gap between nominal and real targets, according to Brussels-based industry group Hydrogen Europe.

Hungarian fuel suppliers will face a penalty of 32 forint for each MJ they fall short of their quota. This equals Ft3,840/kg (€9.96/kg) based on hydrogen's lower heating value of 120 MJ/kg. The penalty is higher than in most countries that have implemented the rules, but lower than Germany's latest draft.

Suppliers can meet quotas through use of renewable hydrogen at refineries to produce conventional transport fuels. Unlike some countries, such as Finland, Hungary does not cap the use of the 'refinery route' or apply a correction factor to its contribution relative to direct RFNBO use in transport applications.

Hungary's law does not set specific RFNBO quotas for the years leading up to 2030 or for subsequent years. While RED III does not require this, some countries have opted to phase in quotas from as early as this year and to set quotas beyond 2030 to increase long-term certainty.

By Stefan Krumpelmann

EU misses 2025 target for hydrogen bank grants

Only a third of projects awarded subsidies in the second round of the European Hydrogen Bank appear to have signed final grant agreements by late 2025, missing the EU's target to conclude all deals.

Of the 18 projects invited for grant negotiations as of September, six have signed agreements with the European Commission, according to its Innovation Fund dashboard. Three of these are in Spain, two in Norway and one in Finland. Between them, they would provide just over 380MW of electrolysis capacity. The commission was not immediately available to comment on the status of the other projects.

The commission invited 15 projects for grant negotiations in May. It said at the time that final agreements would be signed by November at the latest. But by September, seven initiatives had withdrawn from the scheme, prompting the commission to invite 10 new projects from its reserve list. When it announced the reshuffle, the commission said it would present the final list of awards before the end of 2025.

The delays mean some projects may now be commissioned as late as 2031. Developers receiving hydrogen bank subsidies have five years after signing the agreement to complete their projects.

Firms that forfeited subsidies said the lack of flexibility on delivery conditions made it challenging to accept the grant under current requirements. Developers must pay an 8pc completion guarantee when signing the grant agreement.

In December, the commission launched the third auction round of the hydrogen bank programme. Producers have until 19 February to submit their bids.

By Pamela Machado

EU H2 bank signed grant agreements*

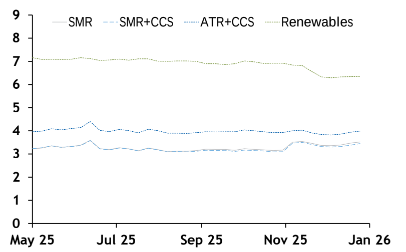
Project	Developer	Location
GH2Move-VLC	Diverxia	Spain
Noon	Iberdrola	Spain
H2CRI	Green DevCo	Spain
HammerfestH2	GreenH	Norway
RjukanH2	Norwegian Hydrogen	Norway
Kristinestad PtX	Koppo Energia	Finland

**as of 5 January*

— European Commission

NEWS

French H2 costs €/kg



France finalises rules for first H2 subsidy tender

France has finalised rules for its first tender to subsidise renewable and low-carbon electrolytic hydrogen production and pre-selected participants now have until 27 February to submit final bids.

The French government in July shortlisted 10 planned electrolytic hydrogen production projects for subsidies and subsequently held a "competitive dialogue" with them to determine final selection criteria on the back of draft rules published when the round was opened in December 2024.

The final rules amend some of the initial terms and specify aspects that the original text had left open. Successful projects will now only receive operating subsidies, while the original plans had envisaged the possibility of securing a combination of investment and operating aid. Participants must submit bids based on the requested operating support. This will be capped at €4/kg for up to 15 years, in line with the original plans. Requested subsidies will account for 80pc of a bid's assessment, with a project's lifecycle emissions factored in for the remaining 20pc. The draft terms had envisaged a 70pc weighting towards the submitted bid and 30pc for technological and environmental considerations.

Subsidies will be adjusted annually for factors such as labour costs, but the new text no longer references electricity, gas and CO_2 prices being taken into account for the review. The terms provide for a clawback mechanism to avoid "overcompensation" if a project's internal rate of return exceeds 10pc pre-tax.

Projects must have an electrolysis capacity of 5-100MW, and at least 60pc of a project's output must be designated for industrial use. A final investment decision must be taken within 30 months of the final awards — which are expected by mid-2026 — while commissioning must be within 60 months.

The final text preserves a clause that bars projects from using more than 25pc of electrolyser components from "a country outside the EU whose ramp-up of production capacity would lead to a significant risk of increased and irreversible dependence... on imports". Unlike the European Hydrogen Bank, the French rules do not specifically refer to China for this.

France aims to subsidise 200MW through this first round. A second, 250MW, round is to be launched later this year, followed by a 550MW round in 2027.

By Stefan Krumpelmann

Hydrogen vehicle deployment targets

Vehicle type	2026	2025
Busses	1,800	2,000
Passenger cars	6,000	11,000
Freight vehicles	–	10
Cargo vehicles	20	–
Cleaning vehicles	20	10
Total	7,820	13,020

— ministry of climate, energy and environment

Subsidies for hydrogen vehicles

Component	Subsidy *Wmn*
Passenger cars	22.5
Bus	210-260
Cargo vehicle	250
Cleaning vehicle	720
Fuel cell stack replacement	35

— ministry of climate, energy and environment

S Korea lowers H2 vehicle subsidy budget for 2026

South Korea is planning to allocate 576.2bn won ($398mn) in 2026 to support the deployment of 7,820 hydrogen-fuelled vehicles, alongside W189.7bn to expand hydrogen refuelling infrastructure. The budget for hydrogen-fuelled vehicle deployment is roughly 20pc lower than in 2025, when the ministry of climate, energy and environment planned to allocate W721.8bn, while the funding pot for refuelling stations is down from last year's W196.3bn.

The subsidies available for individual vehicles are unchanged from last year.

In 2025, deployment of hydrogen vehicles reached 6,903 units — barely half of the target of more than 13,000, although this was still up by 182pc from 2024, largely thanks to the launch of new passenger cars for the first time in seven years, the ministry says.

The buildout of hydrogen refuelling stations surpassed the government's target last year. The country added 75 new stations, lifting its total to 461 — against Seoul's goalramc of 450. The government aims to have more than 660 refuelling stations operational by 2030.

By Akansha Victor

ANALYSIS

Critical year ahead for India's H2 ambitions

New Delhi cites external factors for delays, but regulatory and infrastructural bottlenecks at home pose their own problems, writes Akansha Victor

India's renewable hydrogen sector enters the year with growing momentum, but also growing pressure to convert its ambitions into bankable projects. It will be a decisive year, as New Delhi must close regulatory gaps, clarify subsidy rules and speed up infrastructure upgrades to avoid pushing back production targets again.

New Delhi has concluded several subsidy tenders, underlining its ambition to position India as a global hub for renewable hydrogen and derivatives. But progress on the ground remains slow. Officials now concede that the original target of producing 5mn t/yr of renewable hydrogen by 2030, set in 2022, is unrealistic.

The government has lowered expectations to 3mn t/yr by 2030, and pushed back the 5mn t/yr milestone to 2032. It blames the delay on factors out of its control, such as shifting EU policy signals and the International Maritime Organisation's (IMO) October decision to postpone a vote on its net zero framework. But developers also point to domestic challenges, such as regulatory bottlenecks, uneven grid access and slow progress on securing offtake agreements.

India's latest renewable ammonia tender, for which auctions were concluded in August, has left unresolved details and outstanding questions. Letters of award have been issued, but producers still need to sign supply agreements with state-owned Solar Energy Corporation of India (SECI), which will then sign sales contracts with fertiliser companies. These agreements were initially expected to materialise by the end of 2025, but are now likely to be delayed by several months into 2026. The main obstacle is that the payment security mechanism — a financial safeguard — still lacks critical detail, including whether it guarantees full recovery of payments in case of buyer default, as well information about the repayment timeline and the funding source.

Meanwhile, momentum behind a planned e-methanol tender has faded. Authorities had originally aimed to launch the tender in March 2026, but the timeline has been pushed back after the IMO deferred its net zero framework vote.

The government's 5mn t/yr hydrogen target would require roughly 125GW of additional renewable energy capacity

Beyond policy, India faces structural challenges in its power sector. The government's 5mn t/yr hydrogen target would require roughly 125GW of additional renewable energy capacity, and while India's renewable buildout — particularly for solar — has accelerated, transmission infrastructure has not kept pace. Developers list an inadequate grid buildout and missing last-mile connectivity for hydrogen and ammonia projects among the hurdles that need to be overcome.

Greater alignment among states is also required. A patchwork of rules, fees and levies is inflating project risks and complicating electricity delivery from renewable assets to hydrogen production sites. These uncertainties are adding to pressure on projects that are already racing against subsidy-linked timelines.

Carry on regardless?

Some developers are pressing ahead, and winners of the first renewable hydrogen tender are targeting offtake agreements and final investment decisions (FIDs) in 2026, ahead of a 2027 commissioning deadline. But most projects are not expected to stay on schedule. This is also testing electrolyser manufacturers, and calling into question their eligibility for government support. Many renewable hydrogen projects remain in early development and are a long way from placing equipment orders, deterring electrolyser manufacturers from commissioning factories.

Many hydrogen projects remain in early development... deterring electrolyser manufacturers from commissioning factories

In 2026, these challenges will provide a critical test of early policy initiatives' ability to yield tangible progress. Renewable hydrogen in India has retained more of its momentum than it has in many other countries, but 2026 will determine whether this can be translated into project FIDs and construction — or whether timelines are stretched further into the next decade.

INTERVIEW

Asia most primed for clean NH3 investment: Vopak

Netherlands-headquartered Vopak operates storage and handling terminals at ports around the world and has plans for clean ammonia infrastructure in various locations. Argus spoke to Vopak's executive vice-president for global business development, Maarten Smeets, about the company's plans at the Argus Clean Ammonia conference in Rotterdam last month. Edited highlights follow:

Vopak has announced its participation in multiple low-carbon ammonia projects. Which projects are currently at the top of its priority list?
Our most advanced project is in Antwerp, where we are in the front-end engineering design phase. We are preparing to build an import facility there. A final investment decision is planned for the second half of 2026. We have a fantastic footprint in India with Aegis Vopak Terminals — that project is under construction. The environment in India is business-friendly and it's an important import market for the fertiliser business. But when green ammonia becomes available domestically, and if product flows reverse, we'll be well positioned. So we're fairly bullish on that project. If you then look even further to the east, in Japan we are co-operating with IHI. There, we are waiting for the outcome of the government's contract-for-difference scheme before things move ahead.

'We're putting our pawns everywhere on the board. If you look at where we believe most of the capital will land, it will probably land a bit further to the east'

So we're putting our pawns everywhere on the board. If you look at where we believe most of the capital will land, it will probably land a bit further to the east. China is also coming up with the next five-year plan and it will probably go more green. If China and India bring those green molecules, they will find a way to the world market. In both of these countries, we have a pretty OK footprint. In China we have seven terminals, in India we have 13. Here, we are pretty well positioned to capture some of these flows, which will go to OECD countries that can afford it, such as Japan.

In Europe, there is a bit of uncertainty on the regulatory part. But there is another dimension, which is that due to the high-cost environment, imports of grey ammonia could increase. That will build with blue, and if green happens, that will be really fantastic. The ARA [Amsterdam-Rotterdam-Antwerp] region remains a very strong foothold for us.

What led to the pause of the Houston Ship Channel low-carbon ammonia plant with LSB, Air Liquide and Inpex? Could it be resumed at a later date?
Definitely. We have a very nice footprint in that area. We are keen to keep on developing it. We were one of the front-runners at that stage in time. Sometimes if you storm out of the gate first, you would be the first one to get burned. It's nothing to be ashamed of, and actually we are very proud of all the partners that we are working with. Unfortunately, one of the parties backing [the project] in the end took a decision to not participate in the auctions, removing some of the basis needed to underpin the project. We are very happy to develop projects, but need a line of sight on offtake.

'We understand how to develop ammonia infrastructure. Now it is about finding the combination of the right piece of land and the right customer that underpins it'

We continue to look for export projects on the Gulf coast with other parties. It's a good place to be. It's still an area that is favourable to develop some of these projects. We understand the ship-to-shore interface very well. We understand how to develop ammonia infrastructure. Now it is about finding the right combination of the right piece of land and the right customer that underpins it.

How do you see ammonia compared with other alternative fuels?
We see that ammonia is still one of the best carriers of hydrogen, if we want to go to a hydrogen economy. But it is also fair to say that we are placing our bets ➲

INTERVIEW

on multiple products. We are very big in the world's three large bunker hubs — Rotterdam, Singapore and Fujairah. In Rotterdam, we have started with LNG bunkering, where we have seen healthy growth. In Singapore, we have done trials for methanol bunkering. We have also done trials for ammonia bunkering. We will be able to bunker methanol, no problem. We have been storing methanol for more than 50-60 years across the globe.

We believe there is a bit of work to be done on the ammonia side to make people more comfortable with it. And it is questionable in some of those global leading ports. Can you see a world in 20-30 years where there are 50 or so ammonia bunker vessels sailing around the port of Singapore? A fuel oil spill is nasty for the environment, but ammonia spills will have a way more severe impact. So probably some of the regulations around it might be a bit more stringent.

'We believe there is a bit of work to be done on the ammonia side to make people more comfortable with it. It is questionable in some of the global leading ports'

Maybe it requires hard piping instead of flexible hoses, those kinds of things. There are workarounds. But are we excited about the opportunity? Very much so. It requires more infrastructure, so that's what we're there for. And we are pretty agnostic whether it's LNG, whether it's methanol, whether it's biofuels or whether it's all of them. It's also fair to say it will probably be a mix of all of them.

Can you provide an update on your projects in Rotterdam, Japan and Oman?
In Rotterdam, we are developing many of these projects together with Gas Unis. We remain very committed to doing so. We're studying the landscape. We are looking to find the right location within the port and we're pretty close.

In Japan, the outcomes of the contracts-for-difference scheme are starting to be announced, so once that happens we hope we can continue to move pretty fast to the next stage. IHI is looking at it from the power side, which means there is natural offtake there. But in the end, it requires government support to kick in. Once the projects are awarded, we expect we will be able move ahead. So we are probably targeting an end-of-2030 timeline to be up and running.

We have just started the journey in Oman, really. Hopefully, we can build infrastructure that supports the energy transition. We have people on the ground there now — two or three people. Will the first project be a green ammonia export project? Most likely not. But is that on the cards? Most definitely.

IN BRIEF

Japan's KHI to build 40,000m³ liquefied hydrogen carrier

Japanese engineering firm Kawasaki Heavy Industries (KHI) will build a 40,000m³ liquefied hydrogen carrier for hydrogen venture Japan Suiso Energy's (JSE) supply chain demonstration by 2030-31. JSE — jointly owned by KHI and Japanese hydrogen supplier Iwatani — aims to use the vessel to demonstrate maritime liquefied hydrogen shipping. It initially intended to ship hydrogen from Australia for this, but is now planning to use hydrogen from domestic producers and is targeting a smaller scale. KHI and JSE also plan to build a 50,000m³, or 3,500t, liquefied hydrogen tank, a high-pressure hydrogen pipeline and a hydrogen liquefaction facility in the Kawasaki coastal area.

Woodside starts ammonia output at Texas plant

Australian independent Woodside Energy's 1.1mn t/yr ammonia plant in Beaumont, Texas, has produced its first gas-based ammonia, marking the initial phase of operations and commissioning of the facility. The plant is set to begin commercial ammonia output early this year. Production of low-carbon ammonia — achieved through CO_2 capture and sequestration — is scheduled to begin in the second half of the year. Deliveries of conventional ammonia to contracted buyers are expected to start next year, while agreements for low-carbon ammonia sales remain under negotiation.

Zhanjiang, China

Baosteel starts China's first near-zero carbon steel line

China's leading steel maker, Baosteel, has started operations at the 1mn t/yr near-zero carbon steel production line at its Zhanjiang plant, the largest of its kind in the country. The line uses the company's HyRESP technology to make high-quality flat steel products using hydrogen-based direct-reduced iron (DRI) and ferrous scraps with nearly no carbon emissions. The hydrogen-based shaft furnace that produces the feedstock DRI, the electric-arc furnace used for smelting and the low-carbon rolling process could reduce carbon emissions by 50-80pc compared with the conventional blast furnace method, Baosteel says.

Chinese firms start 30MW green H2 gas turbine plant

Chinese component manufacturer Mingyang Group and energy firm Shenzhen Energy say they have achieved stable power generation from a 30MW pure hydrogen gas turbine in Inner Mongolia autonomous region. The facility is the largest to date to showcase the 'power-to-hydrogen-to-power' cycle, designed to reduce renewable energy curtailment and provide grid frequency regulation, the firms say. The turbine is supported by Shenzhen Energy's renewable ammonia project in Inner Mongolia's Otog administrative division, which includes 505MW of renewable capacity — a 500MW wind farm, a 5MW off-grid solar array, 240MW of electrolyser capacity and hydrogen storage facilities. Hydrogen supply is supplemented by Shenzhen Energy's 250MW solar-to-hydrogen facility in the Otog Front division.

Germany seeks feedback on joint Australia H2Global auction

Germany has launched a market consultation on the design of a planned joint auction with Australia for renewable hydrogen and its derivatives under the H2Global double auction model. The government is seeking feedback from industry on the structure of the joint scheme until 16 February. The auction is expected to have a budget of €400mn, split evenly between Germany and Australia. The consultation focuses on key design parameters, including eligible hydrogen derivatives, contract durations, sustainability requirements, delivery points and the interaction between Australian supply and European demand.

COMPLETE HYDROGEN PRODUCTION COSTS

No-C Hydrogen									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Netherlands Terneuzen	Wind + ALK	Green	€/kg	7.04	8.27	+0.05	5.76	6.76	+0.01
Netherlands	Grid + PPA + ALK	Green	€/kg	7.21	8.46	+0.02	5.23	6.14	-0.03
UK Harwich	Wind + ALK	Green	£/kg	5.12	6.90	+0.05	3.97	5.35	+0.01
UK	Grid + PPA + ALK	Green	£/kg	6.92	9.33	+0.11	5.14	6.93	+0.07
Germany Bremen	Wind + ALK	Green	€/kg	7.38	8.66	+0.04	6.03	7.08	nc
Germany	Grid + PPA + ALK	Green	€/kg	6.21	7.29	+0.02	4.24	4.97	-0.03
France Sete	Wind + ALK	Green	€/kg	7.78	9.13	+0.04	6.31	7.40	nc
France	Grid + PPA + ALK	Green	€/kg	6.35	7.46	nc	4.11	4.83	-0.05
Spain Teruel	Diurnal + ALK	Green	€/kg	4.90	5.75	+0.06	3.06	3.60	+0.01
Spain	Grid + PPA + ALK	Green	€/kg	4.86	5.71	nc	3.09	3.63	-0.04
Italy	Grid + PPA + ALK	Green	€/kg	8.09	9.49	+0.03	5.66	6.64	-0.02
Portugal	Grid + PPA + ALK	Green	€/kg	5.06	5.94	nc	3.33	3.91	-0.05
US Wilbarger	Diurnal + ALK	Green	$/kg	6.87	6.87	+0.07	4.86	4.86	+0.01
Canada Newfoundland	Wind + ALK	Green	C$/kg	13.82	10.07	+0.05	11.66	8.49	+0.01
Oman Duqm	Diurnal + ALK	Green	$/kg	3.91	3.91	+0.04	2.56	2.56	+0.01
Saudi Arabia Tabuk	Diurnal + ALK	Green	$/kg	3.71	3.71	+0.04	2.34	2.34	+0.01
UAE Abu Dhabi	Diurnal + ALK	Green	$/kg	5.10	5.10	+0.05	3.45	3.45	+0.01
Qatar Mesaleed	Diurnal + ALK	Green	$/kg	5.84	5.84	+0.04	4.25	4.25	nc
Namibia Walvis Bay	Diurnal + ALK	Green	$/kg	7.88	7.88	+0.10	4.01	4.01	+0.01
South Africa Coega	Diurnal + ALK	Green	$/kg	7.27	7.27	+0.06	4.88	4.88	nc
Japan Fukushima	Wind + ALK	Green	¥/kg	2,017	12.88	+0.06	1,695	10.82	+0.01
China Jilin	Diurnal + ALK	Green	Yn/kg	22.64	3.24	+0.03	17.22	2.46	nc
India Kutch	Diurnal + ALK	Green	Rs/kg	328.92	3.65	+0.02	255.91	2.84	nc
South Korea Ulsan	Wind + ALK	Green	W/kg	29,012	20.10	+0.06	26,240	18.18	+0.01
Vietnam Phu Yen	Wind + ALK	Green	$/kg	9.34	9.34	+0.04	7.86	7.86	nc
Australia Burrup	Diurnal + ALK	Green	A$/kg	9.39	6.28	+0.06	6.38	4.27	+0.02
Brazil Piaui	Diurnal + ALK	Green	$/kg	4.94	4.94	+0.06	2.88	2.88	+0.01
Chile Mejillones	Diurnal + ALK	Green	$/kg	4.50	4.50	+0.05	2.93	2.93	+0.01

Low-C hydrogen									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Netherlands	ATR + CCS	Blue	€/kg	4.03	4.73	+0.01	2.96	3.47	-0.02
UK	ATR + CCS	Blue	£/kg	3.50	4.71	+0.09	2.59	3.49	+0.06
Germany	ATR + CCS	Blue	€/kg	3.90	4.58	-0.01	2.98	3.49	-0.04
Spain	ATR + CCS	Blue	€/kg	3.87	4.54	-0.01	2.73	3.21	-0.04
France	ATR + CCS	Blue	€/kg	3.99	4.69	+0.05	2.80	3.29	+0.02
US Gulf coast	ATR + CCS	Blue	$/kg	3.04	3.04	+0.05	1.68	1.68	+0.01
Canada	ATR + CCS	Blue	C$/kg	4.02	2.93	+0.33	2.20	1.60	+0.29
Japan	ATR + CCS	Blue	¥/kg	759	4.84	+0.03	565	3.61	+0.01
South Korea	ATR + CCS	Blue	W/kg	6,935	4.80	+0.06	5,148	3.57	+0.03
Australia	ATR + CCS	Blue	A$/kg	5.69	3.80	-0.04	3.76	2.51	-0.07
Trinidad	ATR + CCS	Blue	$/kg	4.37	4.37	+0.05	2.58	2.58	+0.01
Russia west	ATR + CCS	Blue	$/kg	2.65	2.65	+0.03	1.25	1.25	-0.01
Russia east	ATR + CCS	Blue	$/kg	2.57	2.57	+0.04	1.17	1.17	nc
Saudi Arabia	ATR + CCS	Blue	$/kg	2.39	2.39	+0.03	1.27	1.27	+0.01

COMPLETE HYDROGEN PRODUCTION COSTS

BAT+ hydrogen									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Netherlands	SMR + CCS	Blue	€/kg	3.39	3.98	+0.02	2.45	2.87	nc
UK	SMR + CCS	Blue	£/kg	2.91	3.92	+0.09	2.10	2.83	+0.06
Germany	SMR + CCS	Blue	€/kg	3.30	3.87	+0.01	2.48	2.91	-0.01
Spain	SMR + CCS	Blue	€/kg	3.37	3.95	+0.02	2.36	2.77	-0.01
France	SMR + CCS	Blue	€/kg	3.45	4.04	+0.06	2.39	2.80	+0.03
US Gulf coast	SMR + CCS	Blue	$/kg	2.51	2.51	+0.05	1.31	1.31	+0.02
Canada	SMR + CCS	Blue	C$/kg	3.36	2.44	+0.13	1.74	1.26	+0.10
Japan	SMR + CCS	Blue	¥/kg	609	3.89	+0.05	437	2.79	+0.02
South Korea	SMR + CCS	Blue	W/kg	5,597	3.88	+0.06	4,012	2.78	+0.03
Australia	SMR + CCS	Blue	A$/kg	4.87	3.26	-0.04	3.16	2.11	-0.08
Trinidad	SMR + CCS	Blue	$/kg	3.72	3.72	+0.04	2.13	2.13	nc
Russia west	SMR + CCS	Blue	$/kg	2.18	2.18	+0.04	0.94	0.94	nc
Russia east	SMR + CCS	Blue	$/kg	2.12	2.12	+0.04	0.88	0.88	nc
Saudi Arabia	SMR + CCS	Blue	$/kg	1.93	1.93	+0.03	208	208	+4

BAT+ hydrogen						6 Jan
				Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec
Netherlands	SMR + CCS retrofit	Blue	€/kg	2.50	2.93	-0.01
UK	SMR + CCS retrofit	Blue	£/kg	2.12	2.86	+0.06
Germany	SMR + CCS retrofit	Blue	€/kg	2.53	2.97	-0.02
Spain	SMR + CCS retrofit	Blue	€/kg	2.41	2.83	-0.01
France	SMR + CCS retrofit	Blue	€/kg	2.44	2.87	+0.03
US Gulf coast	SMR + CCS retrofit	Blue	$/kg	1.24	1.24	+0.02
Canada	SMR + CCS retrofit	Blue	C$/kg	1.80	1.31	+0.11
Japan	SMR + CCS retrofit	Blue	¥/kg	411	2.62	+0.02
South Korea	SMR + CCS retrofit	Blue	W/kg	3,781	2.62	+0.03
Australia	SMR + CCS retrofit	Blue	A$/kg	3.02	2.02	-0.07
Trinidad	SMR + CCS retrofit	Blue	$/kg	2.04	2.04	nc
Russia west	SMR + CCS retrofit	Blue	$/kg	0.88	0.88	nc
Russia east	SMR + CCS retrofit	Blue	$/kg	0.82	0.82	nc

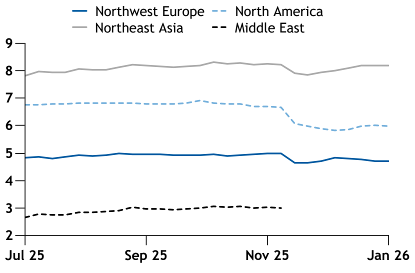
BAT+ hydrogen										6 Jan
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Australia	Coal gasification + CCS	5,500	Blue	A$/kg	5.87	3.93	+0.06	3.50	2.34	+0.01
Australia	Coal gasification + CCS	6,000	Blue	A$/kg	6.32	4.23	+0.06	3.95	2.65	+0.02
China	Coal gasification + CCS	3,800	Blue	Yn/kg	24.98	3.57	+0.05	16.86	2.41	+0.02
China	Coal gasification + CCS	5,500	Blue	Yn/kg	24.53	3.51	+0.04	16.41	2.35	+0.01
Indonesia	Coal gasification + CCS	5,500	Blue	$/kg	3.59	3.59	+0.04	2.36	2.36	+0.01
Indonesia	Coal gasification + CCS	3,800	Blue	$/kg	3.42	3.42	+0.03	2.19	2.19	+0.01
South Africa	Coal gasification + CCS	4,800	Blue	$/kg	4.76	4.76	+0.06	2.46	2.46	+0.01
South Africa	Coal gasification + CCS	6,000	Blue	$/kg	4.91	4.91	+0.08	2.60	2.60	+0.02
Russia west	Coal gasification + CCS	6,000	Blue	$/kg	3.46	3.46	+0.04	1.75	1.75	-0.01
US east coast	Coal gasification + CCS	6,000	Blue	$/kg	4.05	4.05	+0.01	2.39	2.39	-0.02

COMPLETE HYDROGEN PRODUCTION COSTS

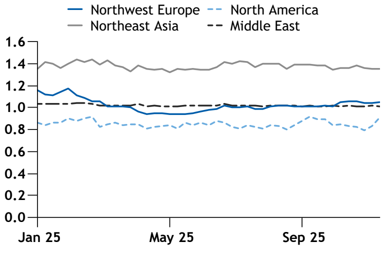
Baseline hydrogen									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Netherlands	SMR	Grey	€/kg	3.48	4.08	+0.02	2.64	3.10	nc
UK	SMR	Grey	£/kg	2.87	3.87	+0.08	2.16	2.91	+0.06
Germany	SMR	Grey	€/kg	3.40	3.99	nc	2.67	3.14	-0.02
Spain	SMR	Grey	€/kg	3.45	4.05	+0.02	2.55	2.99	-0.02
France	SMR	Grey	€/kg	3.52	4.13	+0.05	2.58	3.03	+0.03
US Gulf coast	SMR	Grey	$/kg	2.09	2.09	+0.04	1.02	1.02	+0.02
Canada	SMR	Grey	C$/kg	3.39	2.47	+0.13	1.95	1.42	+0.11
Japan	SMR	Grey	¥/kg	477	3.04	+0.04	324	2.07	+0.02
South Korea	SMR	Grey	W/kg	4,444	3.08	+0.05	3,036	2.10	+0.02
Australia	SMR	Grey	A$/kg	4.07	2.72	-0.05	2.55	1.70	-0.08
Trinidad	SMR	Grey	$/kg	3.14	3.14	+0.04	1.73	1.73	+0.01
Russia west	SMR	Grey	$/kg	1.77	1.77	+0.03	0.67	0.67	nc
Russia east	SMR	Grey	$/kg	1.71	1.71	+0.03	0.61	0.61	nc
Saudi Arabia	SMR	Grey	$/kg	1.54	1.54	+0.03	0.66	0.66	+0.01

Hydrogen decarbonisation spreads				6 Jan
	Incl. capex		Excl. capex	
	$/kg	± 30 Dec	$/kg	± 30 Dec
Northwest Europe				
No-C to BAT+	4.72	+0.01	4.22	nc
Low-C to BAT+	0.69	-0.03	0.56	-0.01
BAT+ to baseline	-0.10	+0.01	-0.23	nc
North America				
No-C to BAT+	5.99	-0.03	5.39	-0.05
Low-C to BAT+	0.50	+0.09	0.35	+0.08
BAT+ to baseline	0.20	nc	0.07	+0.01
Northeast Asia				
No-C to BAT+	8.19	nc	7.70	-0.02
Low-C to BAT+	0.94	-0.01	0.80	-0.01
BAT+ to baseline	0.82	nc	0.70	nc
Net exporter				
No-C to BAT+	2.95	+0.03	1.78	+0.04
Low-C to BAT+	0.51	nc	0.39	+0.01
BAT+ to baseline	0.45	+0.01	0.35	nc

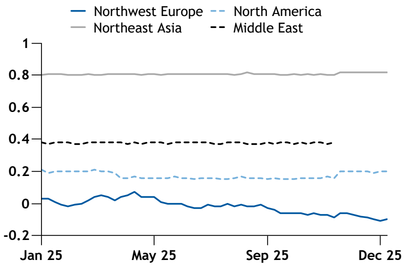
Decarb spread No-C to BAT+ *$/kg*



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



Decarb spread BAT+ to baseline *$/kg*



COMPLETE HYDROGEN PRODUCTION COSTS

Decarbonisation spreads relevant for subsidy mechanisms								6 Jan
		Incl. capex			Excl. capex			
	Unit	Spread	Spread in $/kg	± 30 Dec	Spread	Spread in $/kg	± 30 Dec	
France								
No-C to Baseline[1]	€/kg	4.26	5.00	-0.01	3.73	4.37	-0.02	
Germany								
No-C to BAT+[2]	€/kg	4.08	4.79	+0.03	3.56	4.17	+0.02	
Netherlands								
No-C to baseline[3]	€/kg	3.56	4.18	+0.02	3.12	3.66	+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									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Netherlands									
2027	ATR + CCS	Blue	€/kg	3.84	4.50	+0.09	2.77	3.25	+0.06
2028	ATR + CCS	Blue	€/kg	3.74	4.39	+0.09	2.67	3.13	+0.05
2029	ATR + CCS	Blue	€/kg	3.65	4.29	nc	2.58	3.03	nc
UK									
2027	ATR + CCS	Blue	£/kg	3.27	4.40	+0.07	2.36	3.18	+0.04
2028	ATR + CCS	Blue	£/kg	3.21	4.32	nc	2.30	3.10	nc
Germany									
2027	ATR + CCS	Blue	€/kg	3.73	4.38	+0.08	2.37	3.29	+0.04
2028	ATR + CCS	Blue	€/kg	3.63	4.26	+0.07	2.81	3.18	+0.05
2029	ATR + CCS	Blue	€/kg	3.54	4.16	nc	2.71	3.08	nc
France									
2027	ATR + CCS	Blue	€/kg	3.74	4.38	nc	2.55	2.99	nc
Spain									
2027	ATR + CCS	Blue	€/kg	3.70	4.34	nc	2.56	3.00	nc

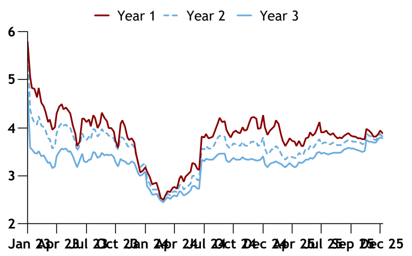
BAT+ hydrogen forward									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Netherlands									
2027	SMR + CCS	Blue	€/kg	3.27	3.84	+0.06	2.33	2.73	+0.04
2028	SMR + CCS	Blue	€/kg	3.20	3.76	+0.06	2.25	2.64	+0.02
2029	SMR + CCS	Blue	€/kg	3.14	3.69	nc	2.19	2.57	nc
UK									
2027	SMR + CCS	Blue	£/kg	2.77	3.73	+0.05	1.96	2.64	+0.02
2028	SMR + CCS	Blue	£/kg	2.72	3.67	nc	1.92	2.59	nc
Germany									
2027	SMR + CCS	Blue	€/kg	3.19	3.75	+0.06	2.37	2.79	+0.03
2028	SMR + CCS	Blue	€/kg	3.12	3.66	+0.05	2.30	2.70	+0.02
2029	SMR + CCS	Blue	€/kg	3.06	3.59	nc	2.24	2.63	nc
France									
2027	SMR + CCS	Blue	€/kg	3.30	3.88	nc	2.25	2.64	nc
Spain									
2027	SMR + CCS	Blue	€/kg	3.25	3.81	nc	2.24	2.63	nc

COMPLETE HYDROGEN PRODUCTION COSTS

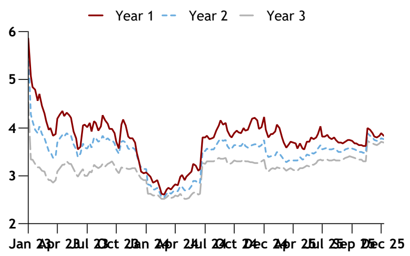
Baseline hydrogen forward — 6 Jan

	Process	Legacy colour	Unit	Incl. capex			Excl. capex		
				Cost	Cost in $/kg	± 30 Dec	Cost	Cost in $/kg	± 30 Dec
Netherlands									
2027	SMR	Grey	€/kg	3.37	3.96	+0.04	2.53	2.97	+0.01
2028	SMR	Grey	€/kg	3.32	3.89	+0.02	2.47	2.90	-0.01
2029	SMR	Grey	€/kg	3.28	3.84	nc	2.43	2.86	nc
UK									
2027	SMR	Grey	£/kg	2.80	3.77	+0.01	2.08	2.81	nc
2028	SMR	Grey	£/kg	2.78	3.75	nc	2.06	2.78	nc
Germany									
2027	SMR	Grey	€/kg	3.31	3.88	+0.02	2.58	3.03	nc
2028	SMR	Grey	€/kg	3.26	3.82	+0.02	2.53	2.97	nc
2029	SMR	Grey	€/kg	3.21	3.77	nc	2.49	2.92	nc
France									
2027	SMR	Grey	€/kg	3.39	3.98	nc	2.45	2.88	nc
Spain									
2027	SMR	Grey	€/kg	3.34	3.92	nc	2.45	2.87	nc

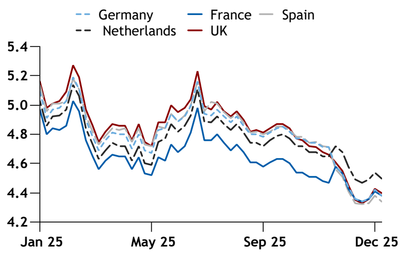
German SMR costs *$/kg*



Dutch SMR+CCS costs *$/kg*



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



Direct reduction iron costs (2 Jan) — *$/t*

Specification	Cost	±
Natural gas DRI, ex-works NW Europe	395.42	+11.81
DRI spread No-C hydrogen (renewables+PEM) vs natural gas NW Europe	437.74	-8.52
DRI spread BAT+ hydrogen (SMR+CCS) vs natural gas NW Europe	164.56	-2.72

Renewable hydrogen certificate revenue (RH2CR) — 6 Jan

	€/kg	± 30 Dec	$/kg	± 30 Dec
Germany RH2CR from GHG reduction obligations	7.32	+2.56	8.59	+2.99
Netherlands RH2CR from renewable fuel units	5.60	+0.03	6.57	+0.02

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.

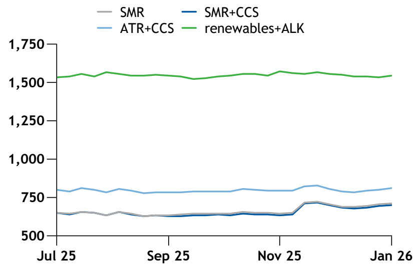
COMPLETE AMMONIA PRODUCTION COSTS

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

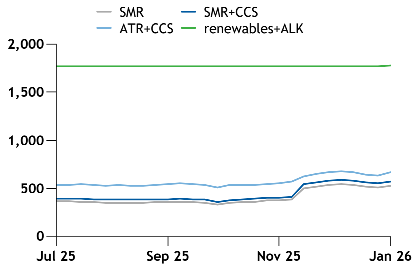
CO2e emissions on a gate-to-gate basis; purity >99.5pc; temperature -33°C

Regional ammonia cost markers						6 Jan
			Incl. capex		Excl. capex	
	Process	Unit	Cost	± 30 Dec	Cost	± 30 Dec
Baseline						
Northwest Europe	SMR	€/t	711	+8	500	+2
Northwest Europe	SMR	$/t	834	+7	587	+1
North America	SMR	$/t	528	+18	261	+12
Northeast Asia	SMR	$/t	652	+11	406	+5
BAT+						
Northwest Europe	SMR+CCS	€/t	700	+8	468	+3
Northwest Europe	SMR+CCS	$/t	822	+8	549	+2
North America	SMR+CCS	$/t	570	+20	274	+12
Northeast Asia	SMR+CCS	$/t	804	+12	532	+5
Low-C						
Northwest Europe	ATR+CCS	€/t	809	+7	549	+1
Northwest Europe	ATR+CCS	$/t	949	+6	644	-1
North America	ATR+CCS	$/t	666	+35	336	+27
Northeast Asia	ATR+CCS	$/t	976	+12	672	+4
No-C						
Northwest Europe	Island renewable+PEM	€/t	1,546	+13	1,226	+3
Northwest Europe	Island renewable+PEM	$/t	1,814	+10	1,439	nc
North America	Island renewable+PEM	$/t	1,782	+15	1,367	+4
Northeast Asia	Island renewable+PEM	$/t	2,423	+11	2,070	+2
Exporter						
Exporter baseline	SMR	$/t	494	+5	243	-2
Exporter BAT+	SMR+CCS	$/t	578	+5	302	-1
Exporter low-C	ATR+CCS	$/t	677	+6	369	-1
Exporter no-C	Island renewable+PEM	$/t	1,171	+14	712	+2

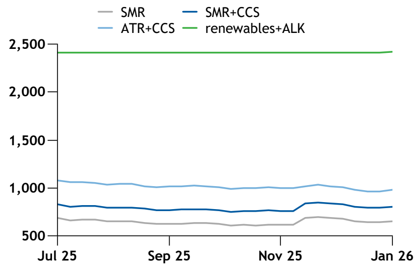
NW Europe ammonia average €/t



North America ammonia average $/t



Northeast Asia ammonia average $/t



COMPLETE AMMONIA PRODUCTION COSTS

No-C ammonia									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 30 Dec	Cost	Cost in $/t	± 30 Dec
Netherlands Terneuzen	Wind + ALK	Green	€/t	1,484	1,742	+10	1,181	1,386	+2
UK Harwich	Wind + ALK	Green	£/t	1,071	1,444	+11	802	1,081	+2
Germany Bremen	Wind + ALK	Green	€/t	1,528	1,793	+9	1,224	1,437	+1
France Sete	Wind + ALK	Green	€/t	1,626	1,908	+11	1,274	1,496	+1
Spain Teruel	Diurnal + ALK	Green	€/t	1,045	1,227	+14	635	745	+1
US Wilbarger	Diurnal + ALK	Green	$/t	1,480	1,480	+17	1,025	1,025	+5
Canada Newfoundland	Wind + ALK	Green	C$/t	2,861	2,084	+13	2,347	1,709	+3
Oman Duqm	Diurnal + ALK	Green	$/t	803	803	+9	518	518	+1
Saudi Arabia Tabuk	Diurnal + ALK	Green	$/t	763	763	+10	469	469	+2
UAE Abu Dhabi	Diurnal + ALK	Green	$/t	1,030	1,030	+10	688	688	+2
Qatar Mesaleed	Diurnal + ALK	Green	$/t	1,170	1,170	+9	844	844	+1
Namibia Walvis Bay	Diurnal + ALK	Green	$/t	1,746	1,746	+25	811	811	+2
South Africa Coega	Diurnal + ALK	Green	$/t	1,583	1,583	+17	980	980	+2
Japan Fukushima	Wind + ALK	Green	¥/t	405,656	2,590	+14	334,710	2,137	+3
China Jilin	Diurnal + ALK	Green	Yn/t	4,708	673	+5	3,465	495	nc
India Kutch	Diurnal + ALK	Green	Rs/t	67,128	746	+6	50,925	566	+1
South Korea Ulsan	Wind + ALK	Green	W/t	5,782,362	4,006	+13	5,162,189	3,577	+3
Vietnam Phu Yen	Wind + ALK	Green	$/t	1,916	1,916	+10	1,553	1,553	+1
Australia Burrup	Diurnal + ALK	Green	A$/t	1,879	1,257	+13	1,270	849	+3
Brazil Piaui	Diurnal + ALK	Green	$/t	1,094	1,094	+14	589	589	+2
Chile Mejillones	Diurnal + ALK	Green	$/t	975	975	+11	600	600	+1

Low-C ammonia									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in $/t	± 30 Dec	Cost	Cost in $/t	± 30 Dec
Netherlands	ATR + CCS	Blue	€/t	820	963	+5	558	655	-2
UK	ATR + CCS	Blue	£/t	706	952	+19	483	651	+11
Germany	ATR + CCS	Blue	€/t	783	919	+1	557	654	-5
Spain	ATR + CCS	Blue	€/t	796	934	+3	517	606	-6
France	ATR + CCS	Blue	€/t	823	966	+12	531	623	+4
US Gulf coast	ATR + CCS	Blue	$/t	679	679	+11	346	346	+4
Canada	ATR + CCS	Blue	C$/t	896	653	+58	447	326	+50
Japan	ATR + CCS	Blue	¥/t	153,253	978	+10	105,715	675	+3
South Korea	ATR + CCS	Blue	W/t	1,405,102	974	+14	966,372	670	+7
Australia	ATR + CCS	Blue	A$/t	1,210	810	-2	736	493	-10
Trinidad	ATR + CCS	Blue	$/t	935	935	+14	495	495	+2
Russia west	ATR + CCS	Blue	$/t	597	597	+9	255	255	nc
Russia east	ATR + CCS	Blue	$/t	583	583	+10	241	241	+1
Saudia Arabia	ATR + CCS	Blue	$/t	543	543	+10	268	268	+4

Low-Carbon Ammonia benchmarks			6 Jan
	Unit	Cost	± 30 Dec
JKLAB CFR Ulsan, South Korea, incl. US 45Q tax credit	$/t	679.69	+11.02
JKLAB CFR Ulsan, South Korea, excl. US 45Q tax credit	$/t	815.69	+11.02
JKLAB CFR Niihama, Japan, differential	$/t	+0.24	+0.05
EULAB CFR ARA, incl. 45Q US tax credit	$/t	607.02	+11.15
EULAB CFR ARA, excl. 45Q US tax credit	$/t	743.02	+11.15

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									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in *$/t*	± 30 Dec	Cost	Cost in *$/t*	± 30 Dec
Netherlands	SMR + CCS	Blue	€/t	706	828	+8	471	553	+1
UK	SMR + CCS	Blue	£/t	600	809	+19	400	539	+11
Germany	SMR + CCS	Blue	€/t	675	792	+4	472	554	-2
Spain	SMR + CCS	Blue	€/t	701	823	+7	452	530	nc
France	SMR + CCS	Blue	€/t	721	847	+14	460	539	+6
US Gulf coast	SMR + CCS	Blue	$/t	578	578	+12	279	279	+4
Canada	SMR + CCS	Blue	C$/t	771	561	+27	369	269	+20
Japan	SMR + CCS	Blue	¥/t	125,865	804	+12	83,323	532	+5
South Korea	SMR + CCS	Blue	W/t	1,159,864	804	+13	767,237	532	+6
Australia	SMR + CCS	Blue	A$/t	1,051	703	-5	627	419	-12
Trinidad	SMR + CCS	Blue	$/t	808	808	+12	414	414	+2
Russia west	SMR + CCS	Blue	$/t	505	505	+9	199	199	+1
Russia east	SMR + CCS	Blue	$/t	495	495	+10	189	189	+2
Saudia Arabia	SMR + CCS	Blue	$/t	454	454	+9	208	208	+4

BAT+ ammonia										6 Jan
					Incl. capex			Excl. capex		
	Process	kcal/kg NAR	Legacy colour	Unit	Cost	Cost in *$/t*	± 30 Dec	Cost	Cost in *$/t*	± 30 Dec
Australia	Coal gasification + CCS	5,500	Blue	A$/t	1,300	870	+14	689	461	+4
Australia	Coal gasification + CCS	6,000	Blue	A$/t	1,380	923	+14	769	514	+4
China	Coal gasification + CCS	3,800	Blue	Yn/t	5,255	751	+12	3,156	451	+4
China	Coal gasification + CCS	5,500	Blue	Yn/t	5,175	740	+9	3,076	440	+2
Indonesia	Coal gasification + CCS	5,500	Blue	$/t	758	758	+10	440	440	+2
Indonesia	Coal gasification + CCS	3,800	Blue	$/t	729	729	+10	410	410	+1
South Africa	Coal gasification + CCS	4,800	Blue	$/t	1,063	1,063	+17	467	467	+2
South Africa	Coal gasification + CCS	6,000	Blue	$/t	1,088	1,088	+19	492	492	+4
Russia west	Coal gasification + CCS	6,000	Blue	$/t	779	779	+10	337	337	-1
US east coast	Coal gasification + CCS	6,000	Blue	$/t	903	903	+8	472	472	-3

Baseline ammonia									6 Jan
				Incl. capex			Excl. capex		
	Process	Legacy colour	Unit	Cost	Cost in *$/t*	± 30 Dec	Cost	Cost in *$/t*	± 30 Dec
Netherlands	SMR	Grey	€/t	715	840	+6	503	590	nc
UK	SMR	Grey	£/t	589	794	+17	409	551	+12
Germany	SMR	Grey	€/t	688	808	+3	505	593	-3
Spain	SMR	Grey	€/t	710	833	+5	484	568	-1
France	SMR	Grey	€/t	728	855	+12	491	577	+6
US Gulf coast	SMR	Grey	$/t	498	498	+12	227	227	+4
Canada	SMR	Grey	C$/t	767	559	+26	403	294	+19
Japan	SMR	Grey	¥/t	101,567	648	+10	63,062	403	+5
South Korea	SMR	Grey	W/t	947,433	656	+11	592,062	410	+6
Australia	SMR	Grey	A$/t	900	602	-6	516	345	-12
Trinidad	SMR	Grey	$/t	697	697	+11	341	341	+2
Russia west	SMR	Grey	$/t	426	426	+8	149	149	+1
Russia east	SMR	Grey	$/t	416	416	+8	139	139	+2
Saudi Arabia	SMR	Grey	$/t	381	381	+9	158	158	+3

COMPLETE AMMONIA PRODUCTION COSTS

Ammonia decarbonisation spreads				6 Jan
	Incl. capex		Excl. capex	
	$/t	± 30 Dec	*$/t*	± 30 Dec
Northwest Europe				
No-C to BAT+	992	+2	890	-2
Low-C to BAT+	127	-2	95	-3
BAT+ to baseline	-12	+1	-38	+1
North America				
No-C to BAT+	1,212	-5	1,093	-8
Low-C to BAT+	96	+15	62	+15
BAT+ to baseline	42	+2	13	nc
Northeast Asia				
No-C to BAT+	1,619	-1	1,538	-3
Low-C to BAT+	172	nc	140	-1
BAT+ to baseline	152	+1	126	nc
Net exporter				
No-C to BAT+	593	+9	410	+3
Low-C to BAT+	99	+1	67	nc
BAT+ to baseline	84	nc	59	+1

E-SAF PRODUCTION COSTS

No-C e-SAF								6 Jan
			Incl. capex			Excl. capex		
	Process	Unit	Cost	Cost in *$/t*	±	Cost	Cost in *$/t*	±
Netherlands	PPA+ALK FT	€/t	8,610.22	10,105.89	+7.96	5,639.13	6,618.69	-60.60

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