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July 2023

Ammonia Analytics



Fertilizers

illuminating the markets®

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Commodity Markets Intelligence

Consulting & Forecasts

Events

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ANALYTICS DASHBOARD: Q2 2023

Swift price correction on price-, macro- and energy- driven demand destruction shifts our medium-term view

Price data ($/t, metric)	2023	2025	2030	2035	Δ 2025	Δ 2030	Δ 2035	CAGR
fob Middle East	375	397	470	547	22	95	172	3.0pc
fob Caribbean/USG	396	412	486	565	16	90	169	2.8pc
cfr NW Europe (inc. duty)	452	494	579	669	42	127	217	3.0pc

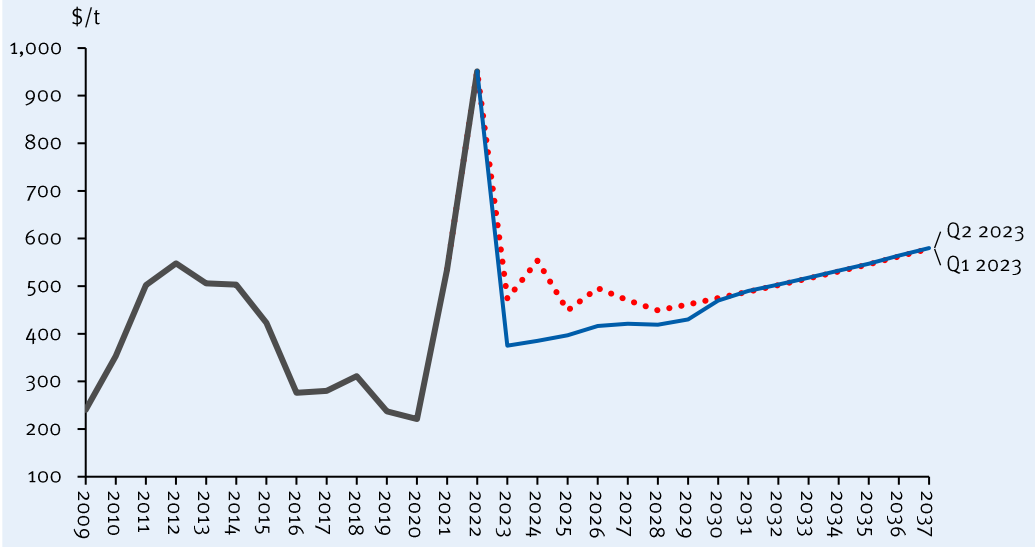
Operating stats (mn t/yr)	2023	2025	2030	2035	Δ 2025	Δ 2030	Δ 2035	CAGR
Global merchant capacity	47.8	48.9	49.6	49.6	1.1	1.8	1.8	0.3pc
Global merchant consumption	40.9	43.8	45.7	46.4	2.9	4.8	5.5	1.0pc
Global trade	16.3	17.9	19.0	18.7	1.6	2.7	2.4	1.1pc
Russian exports	0.5	1.5	2.6	2.5	1.0	2.1	2.0	13.0pc
Chinese imports	0.7	0.4	0.6	1.0	-0.3	-0.1	0.3	2.5pc
US imports	2.2	2.0	2.2	2.1	-0.2	--	-0.1	-0.5pc
Indian imports	2.7	2.7	3.0	3.1	--	0.3	0.4	0.9pc
Moroccan imports	1.5	1.9	2.0	2.1	0.4	0.5	0.6	2.6pc

Energy prices ($/mn Btu)	2023	2025	2030	2035	Δ 2025	Δ 2030	Δ 2035	CAGR
Henry Hub	2.72	3.91	4.91	6.10	1.2	2.2	3.4	6.4pc
European spot (TTF)	13.29	14.68	8.07	12.94	1.4	-5.2	-0.4	-0.2pc
Asian LNG	12.84	14.82	8.55	14.56	2.0	-4.3	1.7	1.0pc
Oil (North Sea Dated $,bl)	81	85	102	124	4	21	43	3.6pc

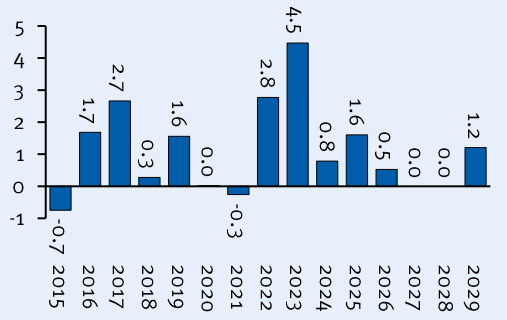
Updates

▼	**Supply increase:**	Eurochem began exporting from Ust-Luga, the first seaborne Russian trade since the outbreak of war
▲	**Supply decrease:**	Gulf Coast Ammonia's 1.3mn t/yr plant delayed by six months until late-2023
▼	**Supply increase:**	Several US blue ammonia projects included in our forecast; IRA support is accelerating timelines
▼	**Demand decrease:**	Poor economic conditions in Europe hamper our demand outlook, particularly from industrial buyers
▼	**Trade decrease:**	H1 2023 trade down 300,000t vs. 1H22 – price driven demand destruction and reduced DAP production
	Price:	Baltic fob price assessment removed as trade will not be possible for the foreseeable

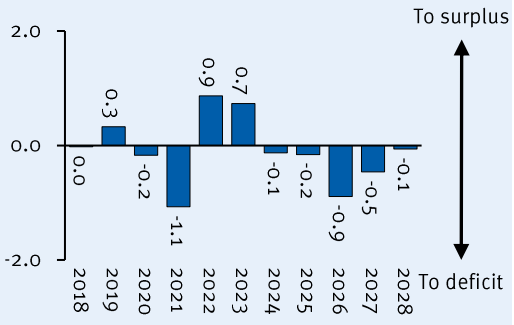
fob Middle East $/t



Capacity forecast mn t/yr



Forecast S/D Balance mn t/y



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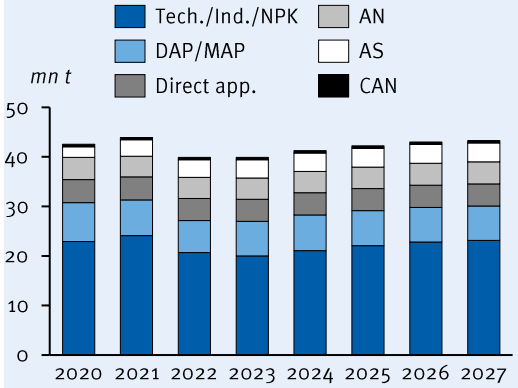
EXECUTIVE SUMMARY: Demand overview

Global merchant ammonia demand is expected to reach 40.9mn t in 2023, increasing to 46.7mn t by 2037

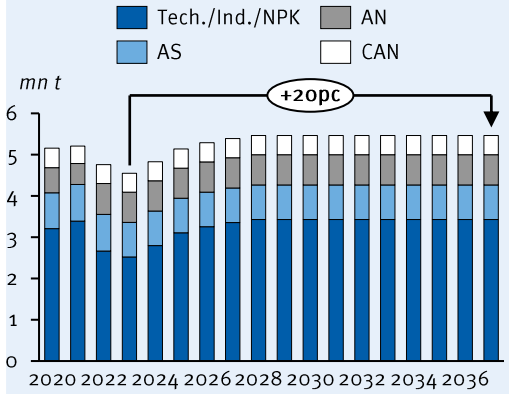
1. Most of the merchant ammonia demand gains during our forecast will be driven by a recovery in the industrial and technical demand sectors. Phosphates- and nitrates-driven demand will remain roughly steady, while China's AS production increase will drive demand in the short-term.
2. In Europe, we will see a gradual recovery in merchant demand over the next five years following the nadir in 2022-2023. Recent drops in industrial demand drove the fall, and the same sector will be responsible for most of the recovery.
3. High ammonia prices and reduced demand for industrial products as inflation escalated sharply reduced US merchant ammonia demand in 2022. The correction in ammonia prices will allow for a gradual recovery over the next few years, particularly in the industrial sectors. And an ever decreasing preference for direct application ammonia will see total merchant demand decline in the long-term, to 6.9mn t in 2037, from a future peak of 7.1mn t in 2023.
4. OCP is targeting a significant uptick in its TSP trade this year, but increased offtake has been minimal and we do not expect a significant shift in OCP's product mix in the long-term. DAP and NPK/NPS production has suffered nonetheless and short-term ammonia demand has been hindered.
5. China's environmental concerns have prompted new regulation on non-organic fertilizers, driving expectations of a sustained fall in ammoniated phosphates production, but new AS capacity will offset the decline in associated ammonia demand
6. Merchant ammonia demand is expected to reach 46.7mn t in 2037, with Industrial applications being the most dominant form of demand.

Short-term

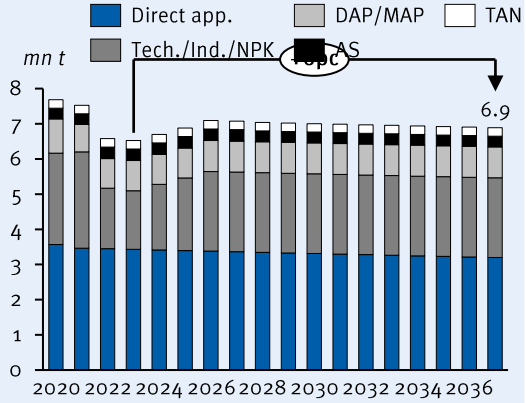
1. Global merchant demand to fall to 41mn t in 2023



2. W. Europe demand rising in medium-term

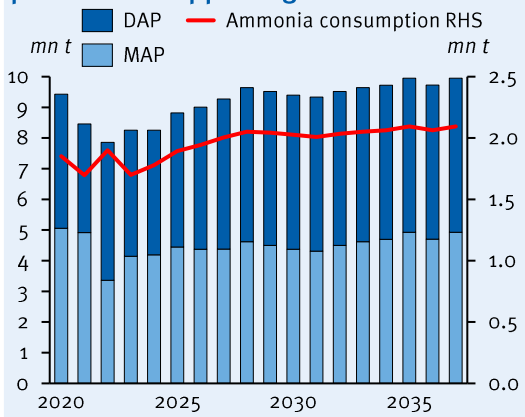


3. US ammonia demand to stabilise in 2023

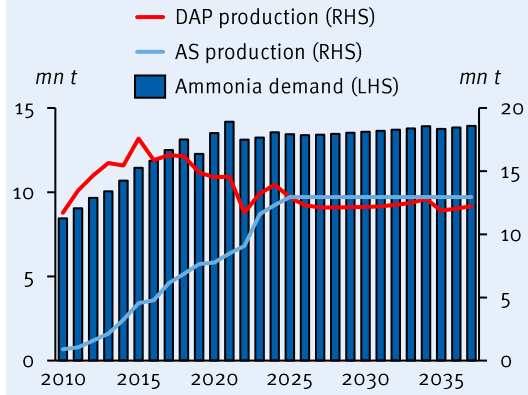


Medium-term

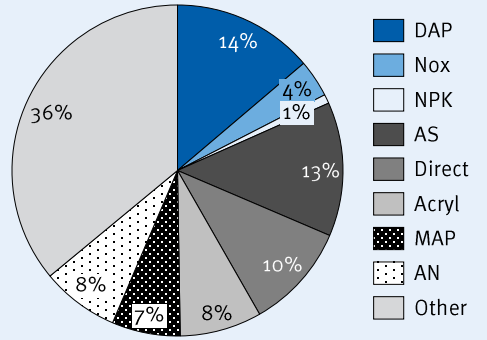
4. Rising Moroccan phosphate production supporting demand



5. Chinese restrictions to hit DAP production



6. Global merchant ammonia demand to reach 46.7mn t/yr by 2037



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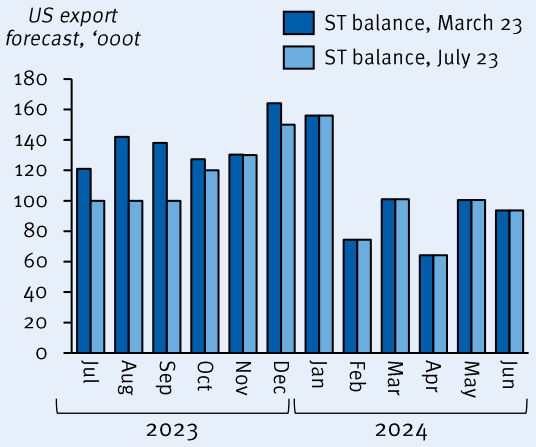
EXECUTIVE SUMMARY: Supply overview

Delay to GCA's start-up shifts our balance, as tracked green ammonia project capacity exceeds 122mn t/yr

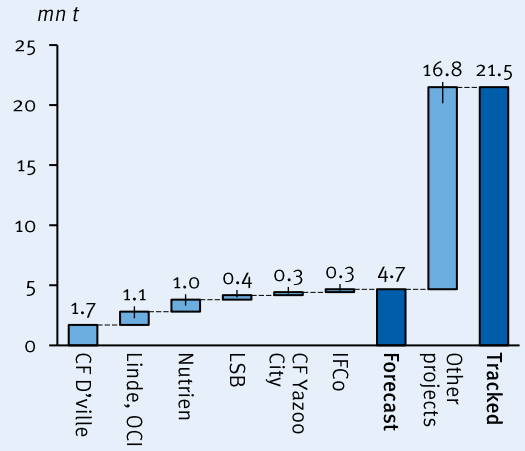
1. Gulf Coast Ammonia's 1.3mn t/yr plant has been delayed from a June start-up to late-2023. This is shown in changes to our short-term export forecast for the US between March and July.
2. The US is leading the way regarding forecast blue ammonia projects, spurred on by the tax credits included in the IRA. We are currently including six projects in our forecast with a combined capacity of 4.7mn t/yr, and a further nine which are not included, totaling 16.8mn t/yr capacity.
3. The rate of merchant ammonia capacity expansions globally has slowed since 2020, falling from a 16.5pc increase between 2015 and 2020 to a forecast 3.0pc increase between 2020 and 2025. And the pace of merchant capacity buildout is not expected to improve given the shift to low-carbon investment.
4. Our total capacity for tracked green ammonia projects now exceeds 122mn t/yr, up from 98mn t/yr in the last edition of the analytics report. Australia, Africa, the Middle East and Latin America are leading the way regarding proposed projects, and Saudi Arabia is home to the only world-scale forecast project.
5. **GROSS AMMONIA:** Most grey ammonia projects continue to be purpose built for urea production, though such as is the trend with merchant capacity buildout, the rate at which urea projects are being announced has slowed and with it, grey ammonia units.
6. **GROSS AMMONIA:** Russia has more than twice the proposed gross grey capacity in the pipeline than any other region, but sanctions following its invasion in Ukraine has made it difficult to secure access to vital building equipment and materials, delaying many of them.

Short term

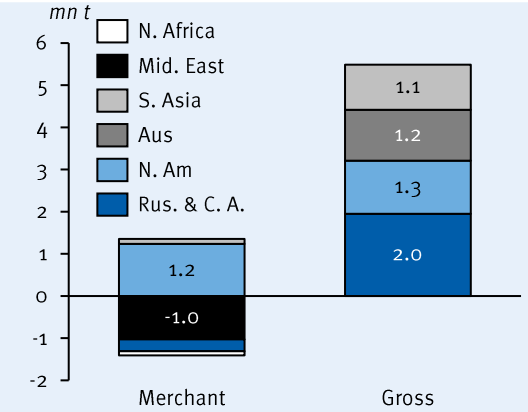
1. US export forecast shows GCA delay



2. US blue ammonia forecast projects

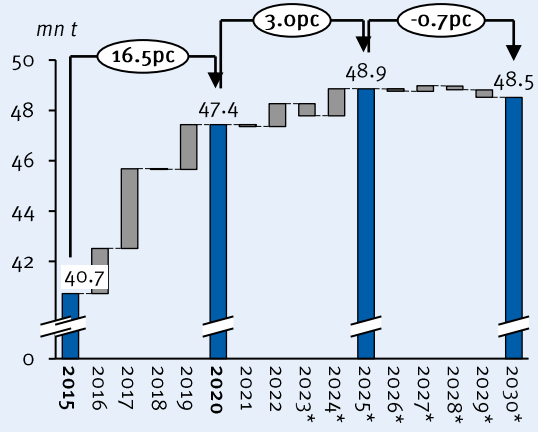


5. GROSS: Forecast grey capacity changes, gross vs merchant

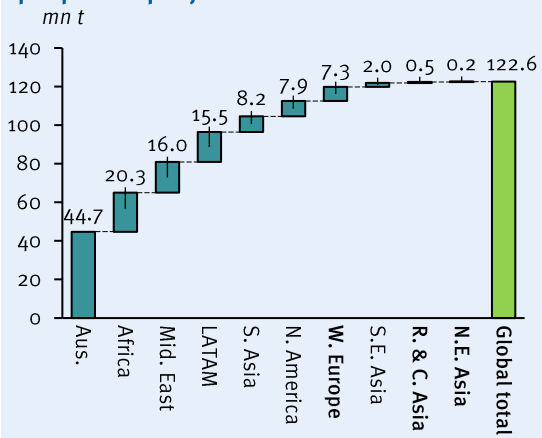


Medium term

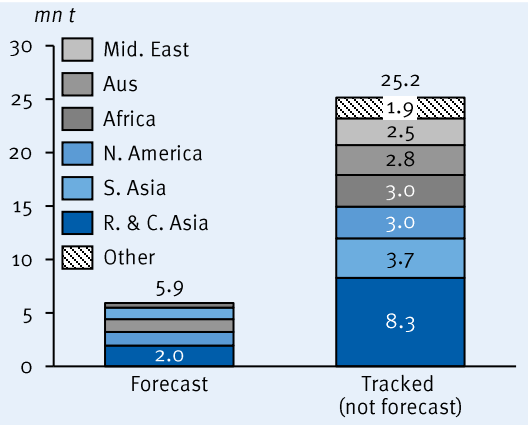
3. Global grey merchant capacity changes, historical and forecast*



4. Regional green ammonia build-up – proposed projects



6. GROSS: Grey project gross capacity by region



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SPOTLIGHT: Crop prices, 2015-2026

Grain corridor renewed for 2 months and El Niño conditions arrive in June

CORN

- Corn prices have been largely stable, only experiencing occasional drops. Any declines in US prices are directly related to cancellations in Chinese exports and in anticipation of abundant new crop supplies. Brazil is also observing healthy corn supplies and is optimistic in its forecast for its secondary corn crop, known as the Safrinha crop. This has subsequently led to softer prices in the Brazilian market.

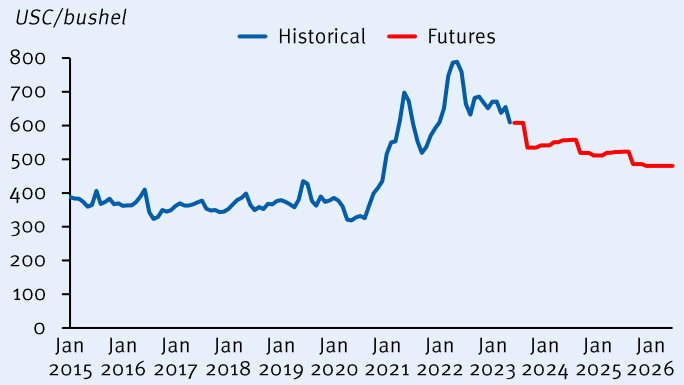
SOY

- Global soybean prices have been in decline over the last four months. An abundant Brazilian harvest and larger-than-anticipated US reserves fuelled the decline, and counteracted lower Argentinian production levels. But, the future for Argentina looks promising with increased rainfall levels anticipated. An upcoming El Nino weather pattern, predicted to impact South America from September, is expected to bring more rainfall and milder temperatures to most of Uruguay and Northeastern Argentina, which will support regional production.

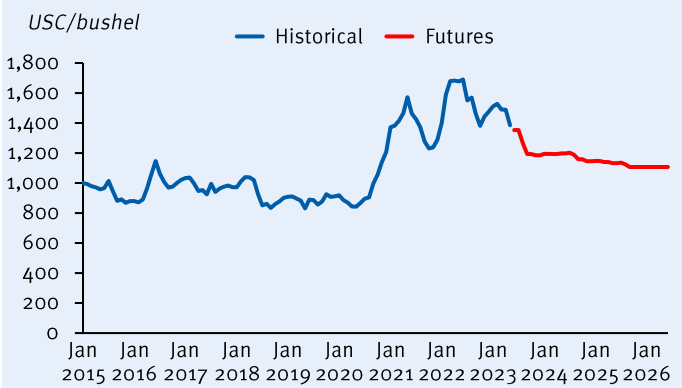
OTHER CROPS

- In May, global wheat prices reached their lowest point since early 2021. This decline was primarily driven by good supplies and the recent extension of the Black Sea Grain Initiative. But the rate of decrease in wheat prices has been somewhat mitigated by minor disruptions in US supply following lower-than-average rainfall across the US.
- Chinese demand drove rice prices higher across April and May, as well as concerns for Indian and southeast Asian production prospects with the soon-to-emerge El Niño weather pattern likely to cause suboptimal monsoon rainfall in the regions.
- Rising crude palm oil (CPO) production in Indonesia and Malaysia has put downward pressure on CPO prices across the last quarter.

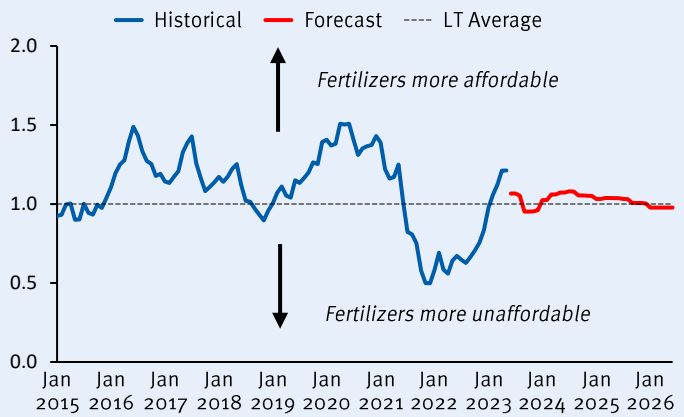
Corn CBOT futures month 1, Houston close, settlement, USC/bushel, fob



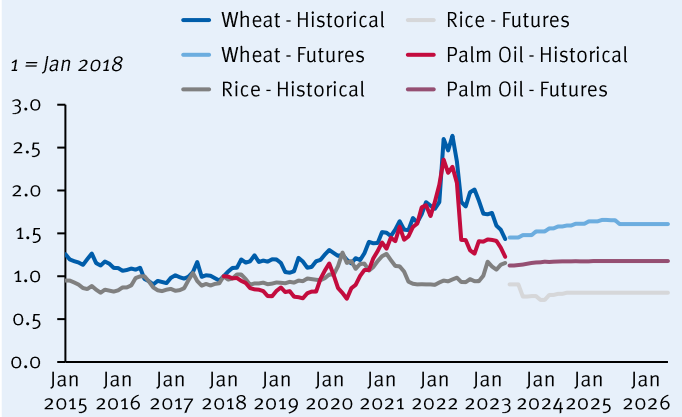
Soybeans CBOT futures month 1, Houston close, settlement, USC/bushel, fob



Fertilizer Affordability Index



Other crop indices



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AMMONIA DEMAND: India, 2022-2037

Increase in Indian ammonia demand to 3.6mn t with Greenstar's project completion at Tuticorin site

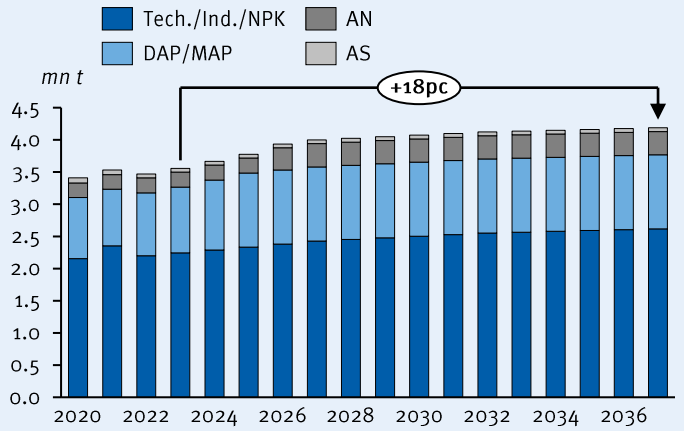
AMMONIA

- Merchant ammonia demand in India is expected to grow in 2023 to 3.6mn t, up from 3.5mn t in 2022. This is supported by the completion of Greenstar's DAP/NPK granulation expansion in capacity at its Tuticorin site. The total granulation capacity at this site is now at 900,000 t/yr. Deepak's TAN unit will begin operating in late-2025, increasing merchant demand by an estimated 120,000t/yr. India's total DAP capacity is now expected to be at 8.4mn t/yr, up from 7.8mn t/yr in 2022.
- Across the medium term, merchant ammonia demand will be driven by these phosphate and ammonium nitrates capacity expansions to 4.0mn t by 2027. At this stage, merchant consumption will plateau as downstream projects beyond this point are non-existent as of yet

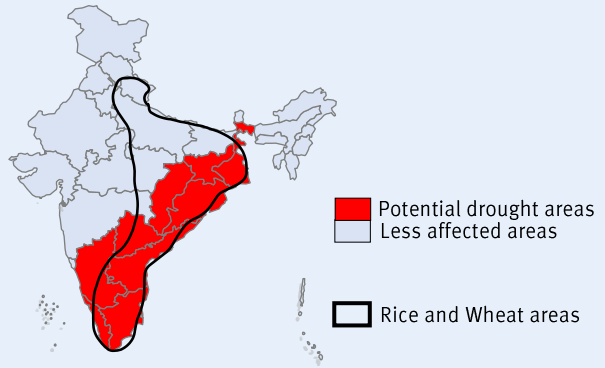
AGRICULTURE

- After experiencing three consecutive years of higher-than-average monsoon rains because of La Niña conditions, India is projected to receive less rainfall during the 2023 monsoon season due to the imminent El Niño conditions. This could potentially lead to water shortages that may impact the demand for fertilizer in 2023. But, this scenario is deemed unlikely given the water reserves accumulated over recent years. Despite current reservoir levels ensuring water availability in the short term, there might be risks to medium-term fertilizer demand if the El Niño conditions are prolonged.
- Rice production is expected to rise slightly in the 2023-24 season, from 130.8mn t in 2022-23 up to 130.9mn t, with favourable conditions expected as a result of high water availability after years of excess rainfall mentioned previously. This will support the growth in fertilizer demand for 2023.
- In September 2022, India implemented a ban on the exports of broken rice. But, on May 24th, India lifted this ban, permitting exports to other countries. This decision was made with the intention to aid these countries in meeting their food security requirements, and was in response to requests from their respective governments.

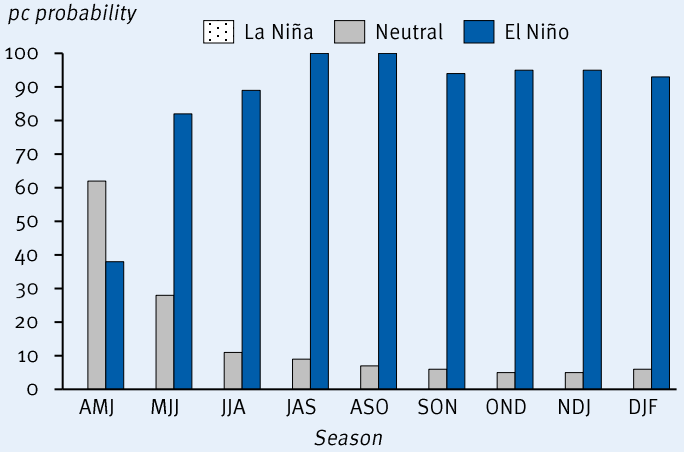
India ammonia demand growth, 2023-37



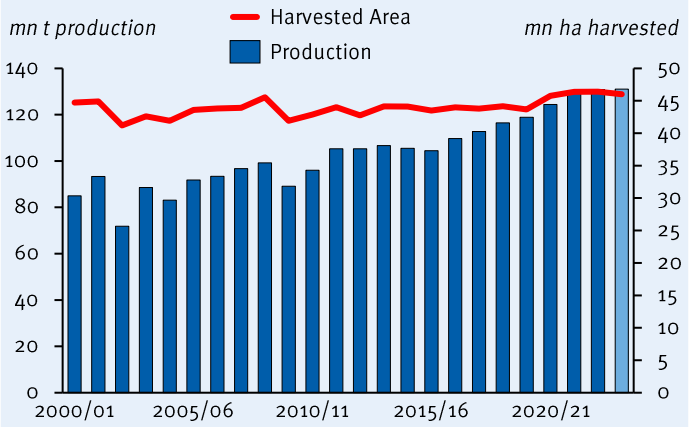
Effect of El Niño on Indian agricultural areas



El Niño probability April 2023 – February 2024



India rice production and harvested area 2000-24



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AMMONIA DEMAND: China, 2022-2037

Chinese merchant ammonia demand to reach 13.4mn t supported by increasing DAP production in short-term

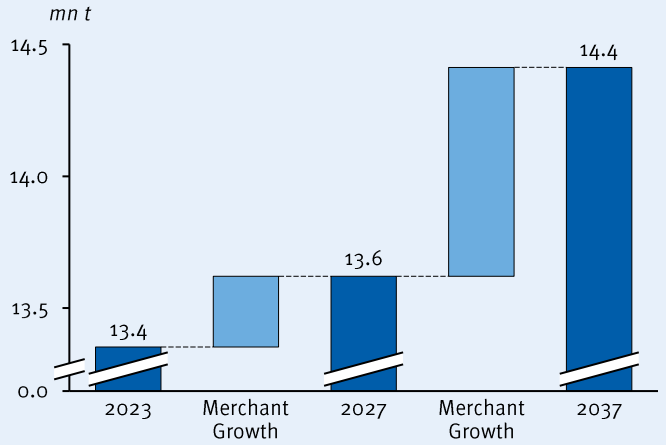
AMMONIA

- Chinese merchant ammonia demand is expected to reach 13.4mn t in 2023, a 730,000 t rise on the previous year. This rise in the short-term will primarily be driven by increasing DAP and AN production in the country until 2024. DAP production is expected to rise from 11.7mn t in 2022 to 13.2mn t in 2023. Over the past three years, the Chinese phosphate market has been significantly impacted by Covid 19 restrictions and fertilizer export controls. But, with the lifting of restrictions at the end of 2022, declining import prices, and the anticipated relaxation of fertilizer export controls by mid-2023, the merchant market is expected to make a recovery.
- In the medium term, we expect merchant ammonia demand in China to reach 13.6mn t by 2027, and to 14.4mn t by 2037. Continued growth in AS production will support the growth in consumption and offset the longer-term declines in DAP production as a result of environmental regulations for the production of DAP and other non-organic fertilizers.

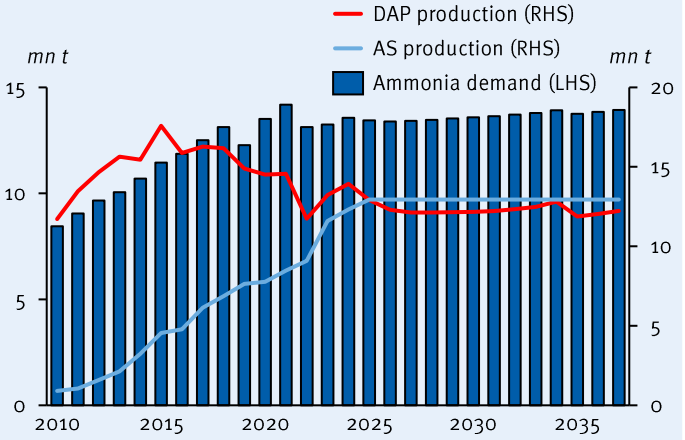
AGRICULTURE

- Heavy rainfall in May in China's Hegan region promped farmers to rush their harvesting process in order to mitigate losses, subsequently selling the grain as feed wheat. *Agritel's* production forecast for the 2023-24 season currently exceeds USDA's, standing at 141.8mn t versus 140.0mn t. Both of these forecasts are improvements on previous season production, implying a potential increase in fertilizer demand this year.
- China is the world's second-largest corn producer, producing an average 260mn t per year between 2016 and 2020. This production accounts for 23pc of the global corn production, cultivated from 21pc of the world's corn-growing areas. Because of the limited area to expand these planting areas, China's ability to become self-sufficient in corn production heavily depends on its capacity to improve grain yield per unit area. Improving the grain yield would require sufficient fertilizer application, suggesting a rise in fertilizer demand across the medium-term. The USDA predicts corn production to reach 277.2mn t in the 2022-23 season.

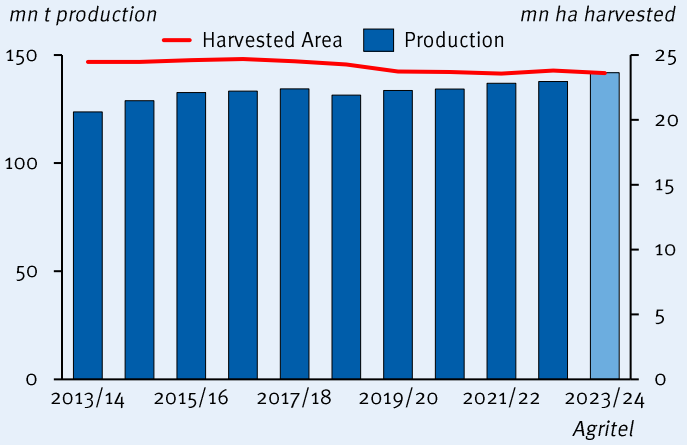
China ammonia demand growth, 2023-37



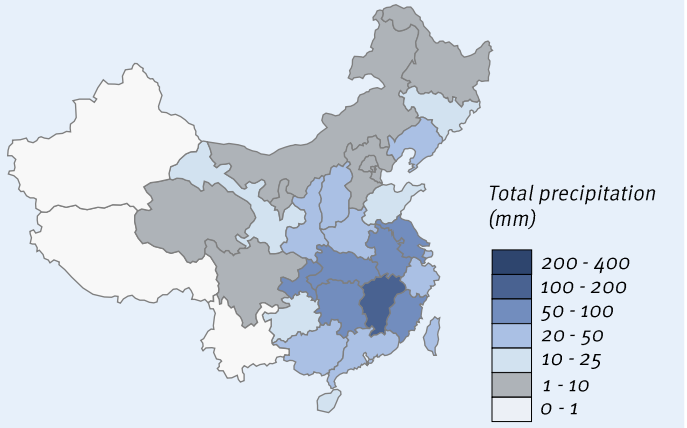
Chinese DAP production vs ammonia demand



Chinese wheat production and harvested area



China rainfall 30 April – 6 May 2023



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AMMONIA DEMAND: US, 2022-2037

Stable US demand at 6.5mn t, but drought concerns may threaten 2023 forecast

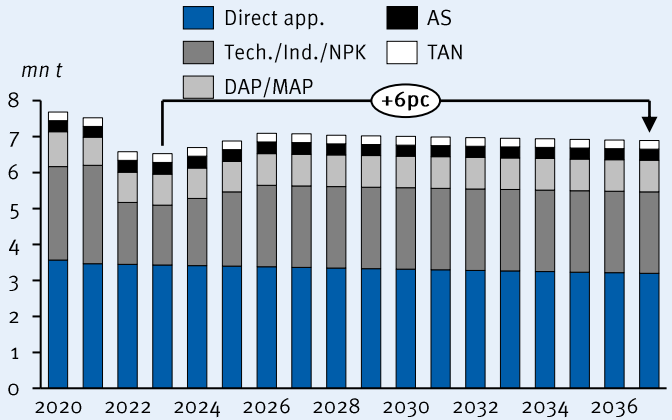
AMMONIA

- Expected merchant ammonia demand in the US for 2023 is projected to be slightly down from 2022 levels, standing at around 6.5mn t, compared to 6.6mn t in 2022. A significant portion of this demand is dedicated to direct application and utilization in technical and industrial processes. The US is one of the few markets that boasts a substantial direct application ammonia sector.
- Demand from the US market has been affected by affordability issues in 2022 and early-2023. Farmers are likely to have reduced consumption to limit their exposure to high prices, and difficult macroeconomic conditions led to a fall in industrial consumption. Since prices have fallen recently, and as the economy recovers, we expect a medium-term recovery in merchant demand.
- Merchant demand is expected to rise consistently until 2027, at which point demand is forecast to decline to 6.9mn t by 2037, as the popularity of direct application in the US declines.

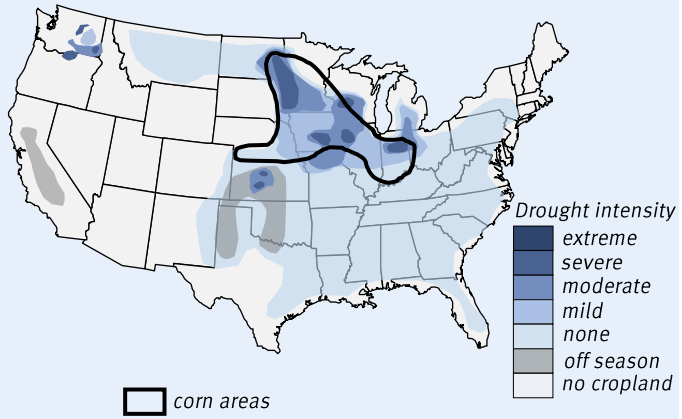
AGRICULTURE

- Expectations for US corn acreage remain high, thRough *Argus'* agricultural hand, *Agritel,* anticipates a lower yield potential compared to the USDA's projection of 177 bushels per acre. This is because yields have never surpassed 180 bushels per acre, as well as early crop ratings indicating below-average conditions, because of droughts across May and June in the western corn belt. With *Agritel's* current yield expectations, the production forecast stands at 372mn t, lower than the USDA's forecast of 388mn t made in May. This production is still higher than the previous year, which suggests that ammonia demand could rise in 2023 as the US uses direct ammonia as a major fertilizer, unlike many other countries.
- Projected US rice production for the 2023/24 season is set to reach 192.7mn t, marking a 20pc increase compared to the previous year. The primary cause for this surge is an expansion in planted areas from the prior season, rising to 2.58mn acres from the 2.17mn acres cultivated in 2022/23.

US merchant ammonia demand, 2020-2037

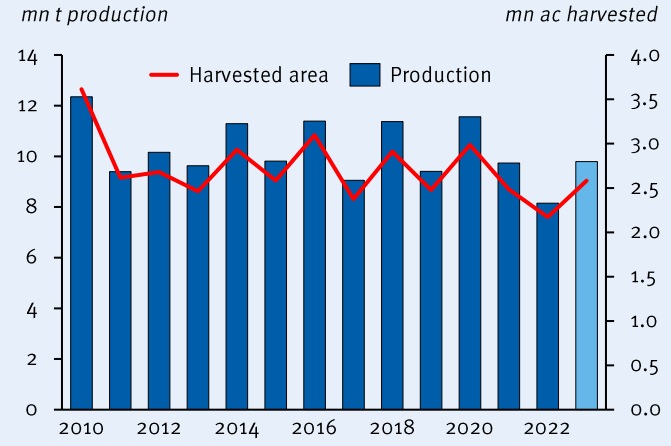


USA drought intensity June 2023*

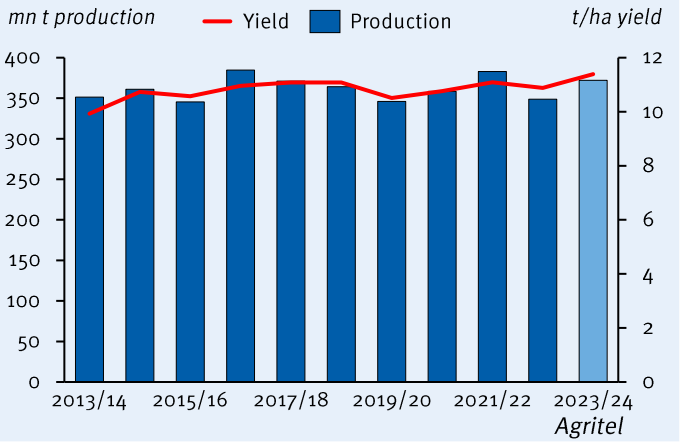


*Source - FAO

US rice production and harvested area 2010-2023



US corn production and yield 2013-2024



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AMMONIA DEMAND: North Africa, 2022-2037

OCP is pushing TSP, but DAP/MAP production unlikely to be affected. African demand at 2.4mn t in 2023

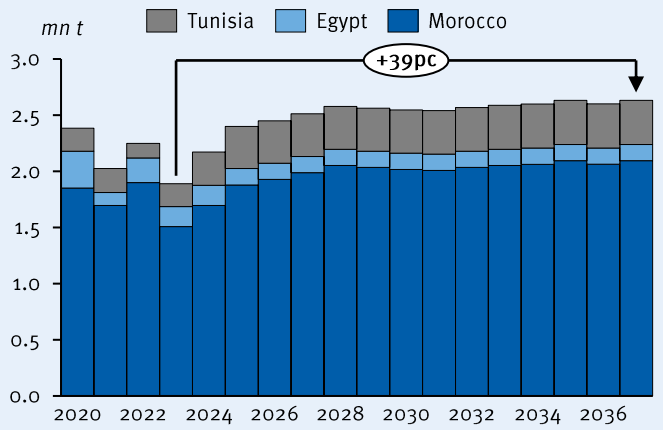
MOROCCO

- Moroccan merchant ammonia demand is expected to decline in 2023. Phosphates producer OCP had high ammonia stocks at the beginning of the year, reducing the import requirement. This combined with the expected decline in DAP production, from 4.5mn t in 2022 to sub 401mn t in 2023, has prompted us to revise down our import forecast for Morocco by 400,000t compared to 2022. Merchant ammonia demand in 2023 is expected to fall to 1.5mn t. These factors will not impact the country's demand for long; we forecast a recovery to 1.9mn t by 2025.
- Across the medium term, we expect merchant ammonia demand to rise to 2.0mn t, as a result of growing phosphate capacity, with expectations of OCP adding 7.0mn t/yr of new DAP, MAP and other phosphate products capacity by 2028. This forecast could be threatened by OCP's long term-investment strategy into TSP, potentially sacrificing ammonia related products such as DAP and MAP, but until we see more consistent TSP offtake, we are hesitant to displace flexible capacity from DAP/MAP.
- By the end of the forecast period in 2037, demand is expected to reach 2.1mn t/yr, but there is minimal additional demand growth forecast beyond 2028 because there are no capacity expansions currently expected to come online after this point.

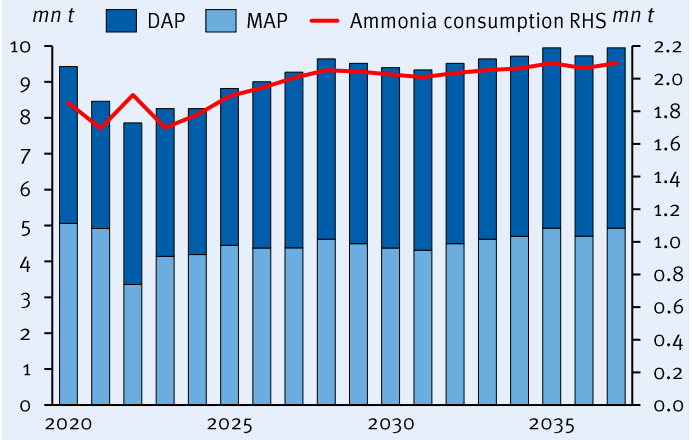
TUNISIA

- Tunisian ammonia demand mostly comes from the domestic phosphate industry. An increase in MAP and DAP production from 2022 to 2023 is expected, and these increases are expected to bring a rise in merchant ammonia demand to 200,000t in 2023, up from 130,000t in 2022.
- Over the next few years Tunisian merchant consumption will slowly grow as the impact of losing Russian product lessens. Supply chains in the country have been impacted by political instability, with producer GCT having to reduce downstream production at times over the past two years for this reason.

Merchant demand by country, 2020-37



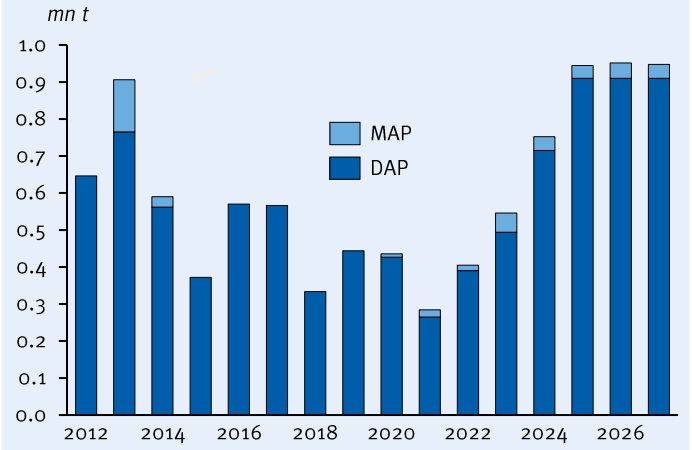
Moroccan DAP & MAP production 2020-2037



Moroccan phosphate facilities



Tunisia MAP and DAP production 2012-2027



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0	Executive Summary
1	Demand
2	Supply
3	Trade
4	Costs and Inputs
5	Balance and Prices
6	Green Ammonia
7	CF Industries, USA

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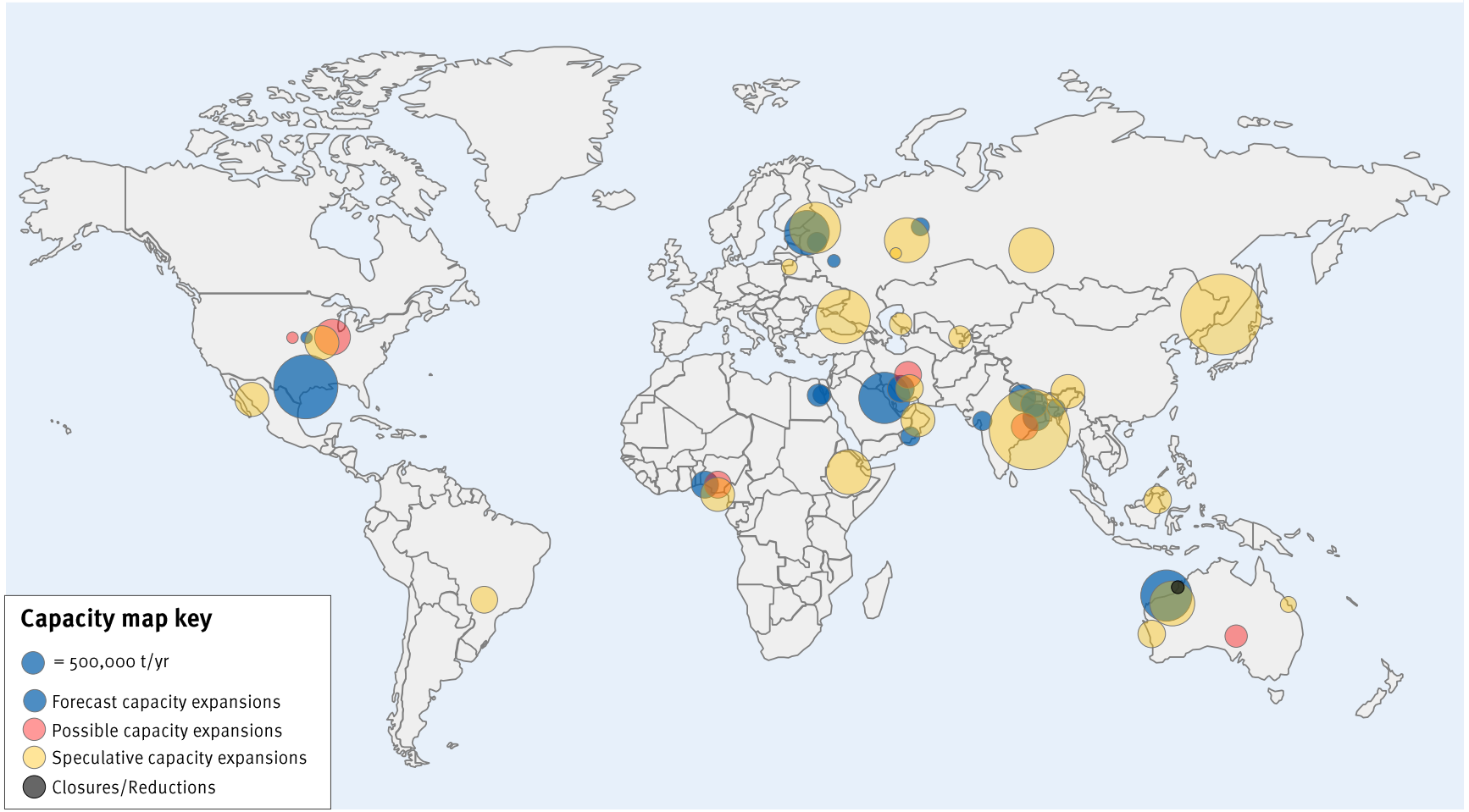
Global gross grey ammonia capacity forecast, 2022-37

We are tracking a combined 38.5mn t/yr of new gross grey ammonia capacity – 12.9mn t/yr in our forecast

Our ammonia capacity forecast is based on our selection of firm and probable ammonia capacity projects, all of which are financed, have received all required permits and have started construction. Projects that do not meet these criteria are excluded from our base forecast and reviewed for progress each quarter.

- **Firm:** Projects are fully financed, and the EPC contractor has commenced construction. Typically, most heavy engineering will have been delivered to the site and all required gas contracting and infrastructure will be in place. We regard firm projects as having passed the point of FID.
- **Probable:** Projects will have been financed and the groundwork at least will have started. But there will be an area or areas of concern threatening to push back the targeted completion date, such as incomplete gas pipelines, political risks or sanctions. Many probable projects have passed the point of FID.
- **Possible:** Projects that at present are either at the feasibility stage or have progressed to construction but face significant delays from political or physical impediments. We believe these projects have strong potential to proceed to or recommence construction over the next 18 months.
- **Speculative:** Projects that are still at the scoping stage or in early feasibility. EPC contracting and gas supplies will not have been agreed in most cases, and the financing process will be at the early stages or has yet to commence.

Merchant ammonia capacity expansions



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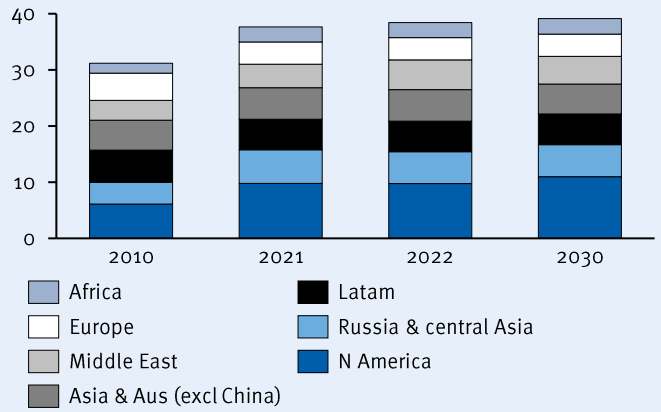
Global merchant grey ammonia capacity forecast, 2022-37

We are tracking a combined 7.3mn t/yr of new merchant grey ammonia capacity – 1.4mn t/yr in our forecast

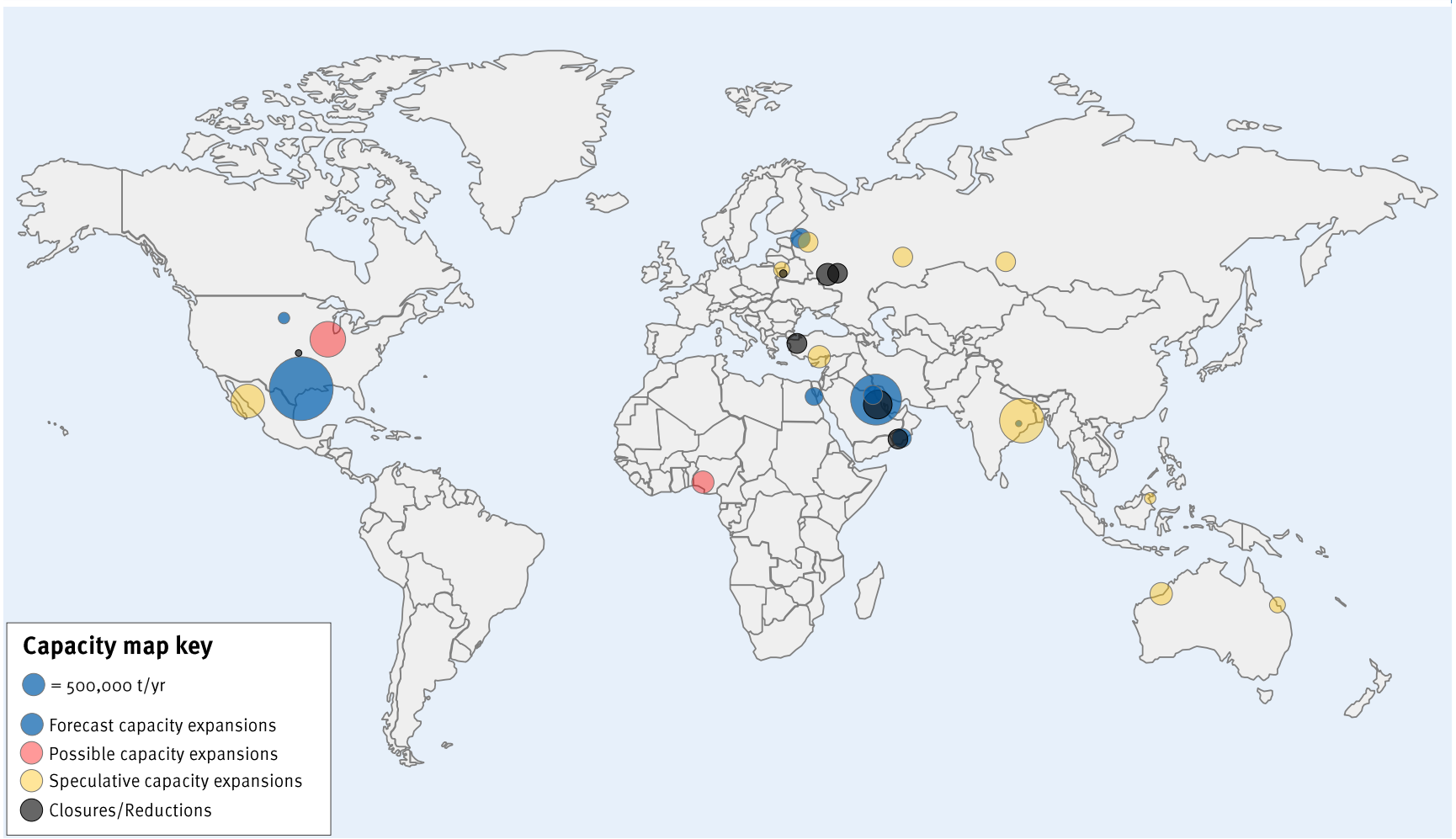
Capacity additions shown here are those that will affect the merchant ammonia market. Closures therefore indicate the permanent shutdown of a plant, a reduction in gross capacity or a reduction in merchant ammonia capacity as downstream capacity is increased. The closures included in our forecast represent net reductions in merchant ammonia capacity as companies look to increase downstream processing capacity. As upgrading margins swing out of favour of the merchant ammonia market, producers look to decrease their exposure to the merchant ammonia market.

OQ in Oman, for example, announced plans to shift its new merchant capacity towards urea production. And Gemlik Gübre's existing ammonia plant's purpose will be switched to urea and UAN production.

Argus merchant ammonia capacity forecast



Merchant ammonia capacity expansions



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Global grey ammonia capacity forecast (excluding China)

We are currently forecasting 12.9mn t/yr gross and 1.5mn t/yr merchant grey ammonia capacity in our base case

Project specifications							Forecast	Project milestones						Start of commercial ops	
Project location			Gross capacity		Merchant			Contracts			Progress indicators			Project completion date	
Name	Site	Country	t/d	'000 t/yr	'000 t/yr	Major product	Rating	EPC	Gas supply	Financing	Groundwork	Construction	Commissioning	Original target	Argus forecast
MSPC (MIS)	Khuzestan	Iran	2,050	707	–	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	4Q19	Feb-22
Ma'aden	Ras al-Khair	Saudi	3,300	1,139	1,139	Merchant	Firm	Signed	In place	Finalised	Complete	Complete	Complete	1Q22	Mar-22
HURL	Gorakhpur	India	2,200	759	–	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	4Q20	May-22
Dangote	Lekki II	Nigeria	2,200	759	–	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	4Q18	Jun-22
SMC	Salalah	Oman	1,000	345	345	Merchant	Firm	Signed	In place	Finalised	Complete	Complete	Complete	Jul-21	Sep-22
Koch	Enid, OK	US	–	–	(90)	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	n/a	4Q22
Metafrax	Gubakha	Russia	900	311	–	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	4Q20	4Q22
HURL	Sindri	India	2,200	759	–	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	4Q21	Nov-22
Acron	Dorogobuzh	Russia	285	100	–	Nitrates	Firm	Signed	In place	Finalised	Complete	Complete	Complete	n/a	Apr-23
Koch	Fort Dodge, IA	US	230	85	–	Nitrates	Firm	Signed	In place	Finalised	Complete	Complete	Complete	4Q22	Jun-23
HURL	Barauni	India	2,200	759	–	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	3Q21	Oct-22
Incitec Pivot	Gibson Island	Australia	(850)	(280)	–	Urea	Firm	Signed	In place	Finalised	Complete	Complete	Complete	Dec-22	Dec-22
NCIC	Ain Sokhna	Egypt	1,275	440	153	Merchant/Urea/CAN	Firm	Signed	In place	Finalised	Complete	Under way	Underway	2H22	2Q23
KuibyshevAzot	Togliatti	Russia	–	–	(328)	Urea	Firm	Signed	In place	Finalised	Complete	Under way	Underway	4Q21	2Q23
GCA	Texas City, TX	US	3,600	1,260	1,260	Merchant	Firm	Signed	Under way	Finalised	Under way	Under way	Not started	1H23	4Q23
Gemlik Gübre	Gemlik	Turkey	(610)	–	(360)	Urea/Nitrates	Firm	Signed	In place	Finalised	Complete	Under way	Not started	2023	2H23
Ma'aden	Ras al-Khair	Saudi	–	–	(670)	Phosphates	Firm	Signed	In place	Finalised	Complete	Under way	Not started	2021	2026
Total FIRM				**7,143**	**1,449**										
ToAz	Togliatti	Russia	–	–	(421)	Urea	Probable	Signed	In place	Finalised	Complete	Under way	Not started	3Q20	4Q23
Koch	Beatrice, NE	US	–	–	(25)	Nitrates	Probable	Signed	In place	Finalised	Complete	Not started	Not started	4Q22	4Q23
Deepak Fertz	Taloja	India	1,500	518	120	Merchant/Nitrates	Probable	Signed	In place	Finalised	Complete	Under way	Not started	1H23	Jul-23
Shchekinoazot	Efremov	Russia	1,500	525	119	Urea	Probable	Signed	In place	Finalised	Complete	Under way	Not started	2022-23	2H24
BCIC	Polash	Bangladesh	1,600	552	–	Urea	Probable	Signed	In place	Finalised	Complete	Under way	Not started	1H22	2H24
Acron	Novgorod II, III	Russia	1,090	375	–	Urea/Nitrates	Probable	Signed	In place	Finalised	Complete	Under way	Not started	2023	2H24
Abu Qir Fertz	Abu Qir III	Egypt	–	–	(100)	Urea	Probable	Signed	In place	In progress	Complete	Not started	Not started	2025	2H25
Deepak Fertz	Taloja	India	–	–	(120)	TAN	Probable	Signed	In place	Finalised	Complete	Under way	Not started	1H23	2H25
HURL	Talcher	India	2,200	759	–	Urea	Probable	Signed	Coal gas.	Finalised	Under way	Not started	Not started	3Q21	2H26
Nigeria	Nigeria	Nigeria	2,290	790	–	Urea	Probable	No EPC	Agreed	Under way	Not started	Not started	Not started	2027	2H27
Eurochem	Kingisepp	Russia	3,000	1,050	350	Urea	Probable	Signed	In place	Finalised	Under way	Under way	Not started	1H24	2H28
Perdaman	Burrup	Australia	3,500	1,208	–	Urea	Probable	Signed	Agreed	Finalised	under way	Not started	Not started	2Q24	2H28
Total PROBABLE				**5,777**	**(77)**										
Total capacity forecast (FIRM + PROBABLE)				**12,920**	**1,372**										

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Global grey ammonia capacity tracker (excluding China)

We are tracking 25.6mn t/yr gross and 5.9mn t/yr merchant grey capacity outside of our base case forecast

Project specifications							Forecast	Project milestones						Start of commercial ops	
Project location			Gross capacity		Merchant			Contracts		Progress indicators				Project completion date	
Name	Site	Country	t/d	'000 t/yr	'000 t/yr	Major product	Rating	EPC	Gas supply	Financing	Groundwork	Construction	Commissioning	Original target	Argus forecast
OCP	Akwa Ibom	Nigeria	2,270	750	525	Merchant/Phosphates	Possible	No EPC	In place	In progress	Not started	Not started	Not started	2H23	2H26
HPC	Hengam	Iran	2,200	759	—	Urea	Possible	Signed	In place	Finalised	Complete	Under way	Not started	2H12	Post-2028
SMC	Salalah	Oman	—	—	(345)	Urea	Possible	Signed	In place	Finalised	Not started	Not started	Not started	1H24	Post-2028
Cronus	Tuscola, IL	US	2,300	805	805	Merchant	Possible	Signed	No gas	No finance	Not started	Not started	Not started	2018	Post-2028
Monolith	Nebraska	US	930	250	250	Merchant	Possible	Agreed	In place	In progress	Not started	Not started	Not started	2024	Post-2028
Proman	Topolobampo	Mexico	2,200	759	759	Merchant	Possible	Signed	Agreed	Finalised	Delayed	Delayed	Not started	2022	Post-2028
Abu Qir Fertz	Ain Sokhna	Egypt	1,200	396	396	Merchant	Possible	No EPC	In place	Finalised	Not started	Not started	Not started	n/k	Post-2028
Total POSSIBLE				**3,719**	**2,390**										
Sirdaryo Minerals	Yangiyer	Uzbekistan	1,435	495	—	Complex fertz	Specul.	Signed	Agreed	Gov't-owned	Not started	Not started	Not started	2H23	2H27
Petrobras	Três Lagoas	Brazil	2,200	759	—	Urea	Specul.	Signed	Agreed	In progress	Complete	Abandoned	Delayed	2Q15	Post-2028
Strike Energy	Three Springs	Australia	2,300	792	—	Urea	Specul.	No EPC	Agreed	No finance	Not started	Not started	Not started	1Q26	Post-2028
NeuRizer	Leigh Creek	Australia	1,740	574	—	Urea	Possible	No EPC	Coal gas.	In progress	Not started	Not started	Not started	2024	Post-2028
Lavan	Lavan	Iran	2,000	690	—	Urea	Specul.	Signed	In place	Finalised	Complete	Not started	Not started	3Q17	Post-2028
Pupuk Kaltim	Bintuni Bay	Indonesia	2,500	825	155	Urea	Specul.	No EPC	Agreed	In progress	Not started	Not started	Not started	4Q27	Post-2028
Pusri Palembang	Pusri-IIIB	Indonesia	1,350	(281)	—	Urea	Specul.	No EPC	Agreed	No finance	Not started	Not started	Not started	2H24	Post-2028
PT Bukit Asam	Tanjung Enim	Indonesia	993	328	—	Urea	Specul.	Signed	Coal gas.	Gov't-owned	Not started	Not started	Not started	2H24	Post-2028
Gemlik Gubre	Gemlik	Turkey	610	200	—	Urea/Nitrates	Specul.	Signed	In place	In progress	Under way	Not started	Not started	2023	Post-2028
OCP	Dire Dawa	Ethiopia	3,000	1,035	—	Urea	Specul.	No EPC	Agreed	Gov't-owned	Not started	Not started	Not started	2H23	Post-2028
KazAzot	Aktau	Kazakhstan	1,440	475	—	Urea	Specul.	No EPC	No gas	Gov't-owned	Not started	Not started	Not started	n/k	Post-2028
Omifco	Omifco III	Oman	2,200	759	—	Urea	Specul.	No EPC	No gas	No finance	Not started	Not started	Not started	n/k	Post-2028
Grodno Azot	Grodno	Belarus	950	314	314	Merchant	Specul.	No EPC	In place	Finalised	Not started	Not started	Not started	n/k	Post-2028
Grodno Azot	Grodno	Belarus	—	—	(191)	Urea	Specul.	No EPC	In place	Finalised	Under way	Not started	Not started	n/k	Post-2028
Acron	Novgorod VII	Russia	3,500	1,225	297	Merchant/Urea	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
NFP	Nakhodka	Russia	5,200	1,800	—	Urea	Specul.	Signed	In place	Finalised	Not started	Not started	Not started	2H23	Post-2028
Ammoni 2	Mendeleyevsk	Russia	3,500	1,255	380	Merchant/Urea	Specul.	No EPC	No gas	No finance	Not started	Not started	Not started	2H26	Post-2028
SGESC	Tatarstan	Russia	800	264	—	Urea	Specul.	No EPC	No gas	In progress	Not started	Not started	Not started	n/k	Post-2028
KAO Azot	Kemerovo	Russia	3,500	1,225	380	Urea	Specul.	No EPC	In place	In progress	Not started	Not started	Not started	2H26	Post-2028

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Global grey ammonia capacity tracker (excluding China)

We are tracking 25.6mn t/yr gross and 5.9mn t/yr merchant grey capacity outside of our base-case forecast

Project specifications							Forecast	Project milestones						Start of commercial ops	
Project location			Gross capacity		Merchant	Major product		Contracts		Progress indicators				Project completion date	
Name	Site	Country	t/d	'000 t/yr	'000 t/yr		Rating	EPC	Gas supply	Financing	Groundwork	Construction	Commissioning	Original target	Argus forecast
...continued on from previous slide															
Oteko	Taman	Russia	4,550	1,570	349	Urea	Specul.	No EPC	No gas	No finance	Not started	Not started	Not started	n/k	Post-2028
Midwest	Mt Vernon, IN	US	2,200	759	–	Urea	Specul.	Signed	In place	In progress	Not started	Not started	Not started	2H18	Post-2028
AFE	Gladstone	Australia	700	231	231	Merchant	Specul.	No EPC	Agreed	In progress	Not started	Not started	Not started	1H22	Post-2028
Derby Fertilisers	Derby	Australia	3,500	1,208	407	Urea	Specul.	No EPC	Agreed	Agreed	Not started	Not started	Not started	4Q24	Post-2028
BVFCL	Namrup	India	2,200	759	–	Urea	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2015	Post-2028
Paradeep Phos	Paradeep	India	6,600	2,178	1,163	Merchant/N/P	Specul.	No EPC	Coal gas	No finance	Not started	Not started	Not started	n/k	Post-2028
Haifa Chemicals	Mishor Rotem	Israel	300	99	11	Merchant/NOP	Specul.	Signed	Accessible	In progress	Delayed	Delayed	Not started	n/k	Post-2028
Genesis Fertz	Canada	Canada	1,200	396	–	Urea	Specul.	No EPC	No gas	In progress	Not started	Not started	Not started	n/k	Post-2028
Brass Fertz	Brass Island	Nigeria	2,250	770	–	Urea	Specul.	Agreed	No gas	In progress	Not started	Not started	Not started	n/k	Post-2028
Turkmen Ind.	Balkan region	Tukmen.	1,884	650	–	Urea	Specul.	No EPC	No gas	In progress	Not started	Not started	Not started	n/k	Post-2028
Fertinal	Vera Cruz	Mexico	1,500	520	–	Urea	Specul.	No EPC	In place	In progress	Not started	Not started	Not started	n/k	Post-2028
Total SPECULATIVE				**21,874**	**3,496**										
Total capacity forecast (POSSIBLE + SPECUL.)				**25,593**	**5,886**										

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Grey ammonia capacity forecast, 2022-29 (excluding China)

We are forecasting 1.5mn t/yr of net merchant capacity to be added to the market by 2027

The capacity forecast presented here is the sum of the projects we have rated as firm and probable. Projects rated as possible and speculative are not included in our base-case view of the capacity forecast.

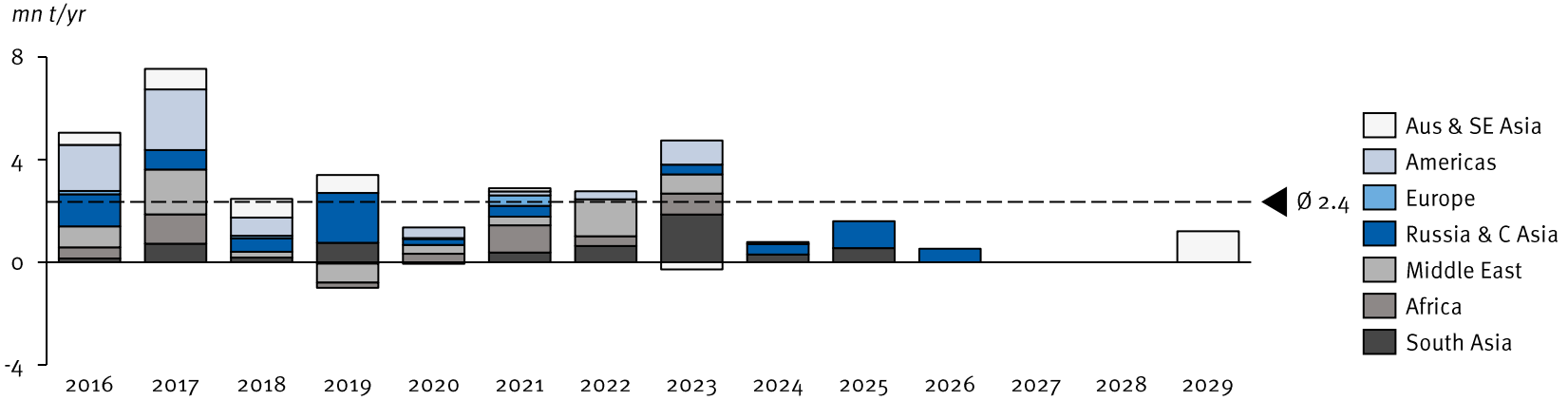
The adjacent charts show a pro-rated capacity forecast of both the gross and merchant ammonia markets. The pro-rated forecast includes each project by its start date. This means that if a project starts production in October 2020, only a quarter of the capacity is counted as featuring in 2020. The balance is carried over to the next year and, in this instance, would be counted in 2021. This is our pro-rated forecast.

We use our pro-rated forecast as the basis of its capacity database and out forecast of the market S/D balance.

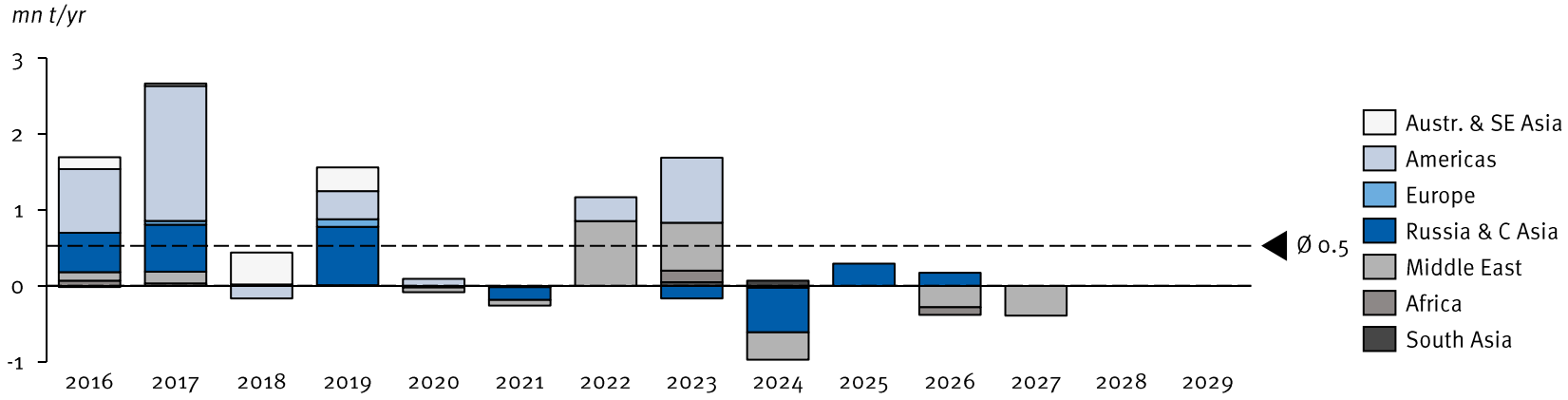
Another important point is how we qualify a project's start date. For ammonia projects, we are counting the commencement of full, stable commercial output. We do not consider the start of the commissioning process as the start date, even if the new ammonia plant has produced saleable product. We require the project to have completed a full month of stable ammonia production.

In the lower chart to the right, merchant capacity losses represent plant closures or downstream product capacity additions that reduce merchant availability. For example, if an ammonia-urea plant with merchant capacity increases urea production by 200,000 t/yr, merchant capacity at the plant will decrease by 115,000 t/yr of ammonia. We assume a consumption rate of 575kg of ammonia per 1t of urea.

Argus gross capacity forecast, pro-rated



Argus merchant capacity forecast, pro-rated



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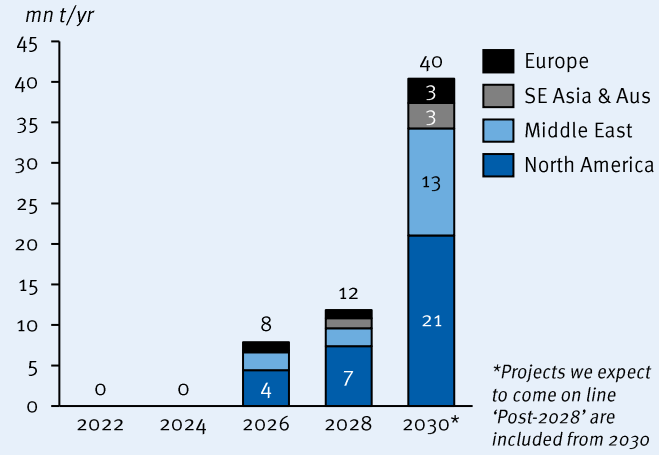
Global blue ammonia capacity forecast, 2022-37

US accounts for half of global proposed capacity and is home to furthest-progressed projects

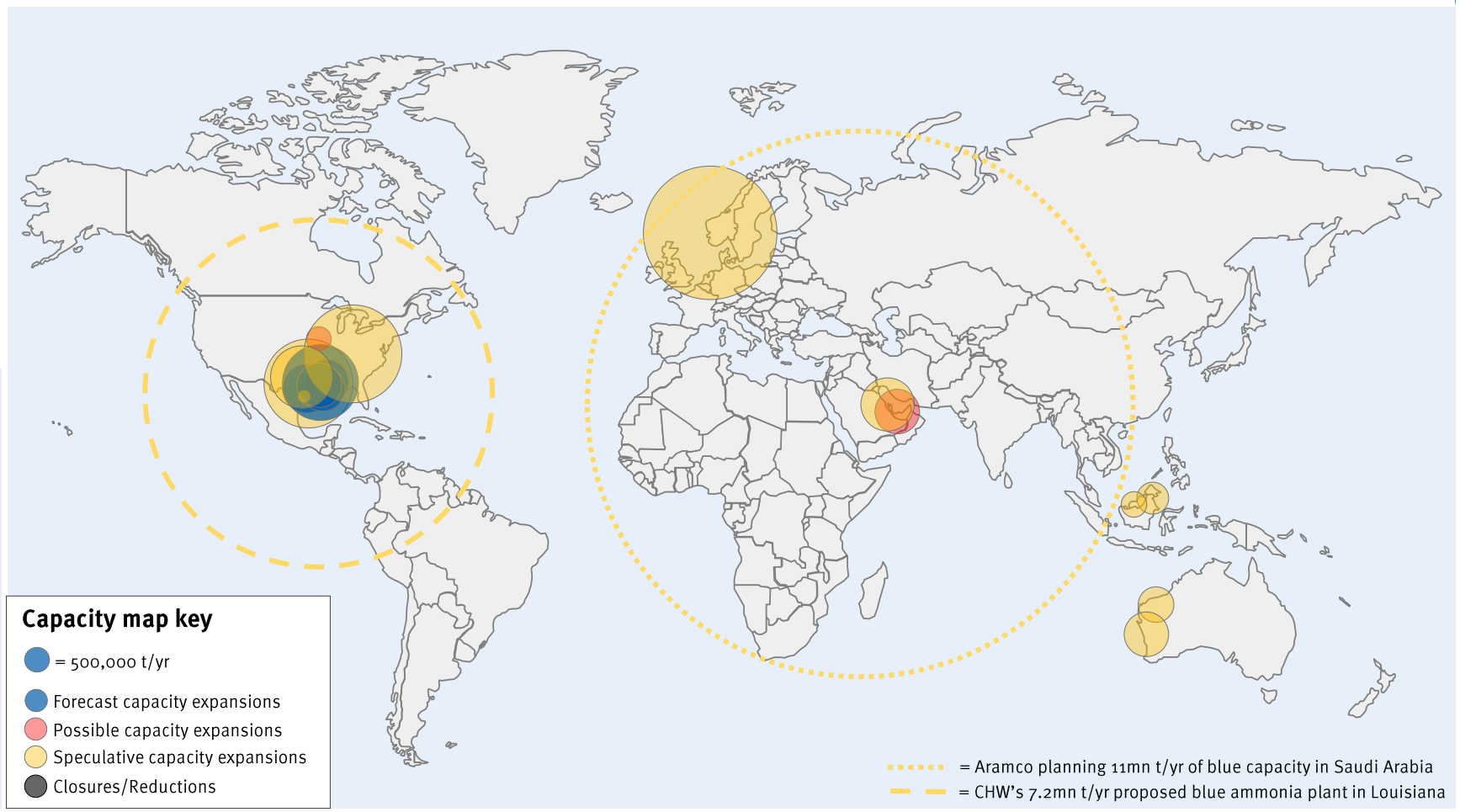
Capacity additions shown here are those that will affect the merchant ammonia market. Closures, therefore, indicate either the permanent shutdown of a plant, a reduction in gross capacity or a reduction in merchant ammonia capacity as downstream capacity is increased. The closures included in our forecast represent net reductions in merchant ammonia capacity as companies look to increase downstream processing capacity. As upgrading margins swing out of favour of the merchant ammonia market, producers look to decrease their exposure to this market.

The timeline below shows the potential capacity that would come on line if all of the projects that we are tracking continue to progress. These are not all included in our forecast.

Blue ammonia speculative timeline



Merchant ammonia capacity expansions



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Blue ammonia capacity tracker (excl. China)

IRA prompts further US investment interest; Aramco plan for 11mn t/yr blue capacity by 2030

Several of the projects included in our blue ammonia project forecast will result in a significant net change to US grey ammonia capacity availability. As we understand it, these projects are not intended to serve new end-use blue ammonia markets and supply from these retrofitted units will continue to serve existing markets. We therefore do not expect any material impact from these retrofits on our merchant ammonia balance.

Project specifications									Forecast	Project milestones						Start of commercial ops	
Project location			Gross capacity		Merchant	Δ Gross, grey	Δ Merchant, grey	Major product	Rating	Contracts		Progress indicators				Project completion date	
Name	Site	Country	t/d	'000 t/yr	'000 t/yr	'000 t/yr	'000 t/yr			EPC	Gas supply	Financing	Groundwork	Construction	Commissioning	Original target	Argus forecast
LSB Industries	El Dorado,	US	1,000	340	241	(340)	(241)	Merchant (Blue)	Probable	In place	In place	In place	Not started	Not started	Not started	2025	2H25
IFCo Phase 1	Wever	US	725	250	250	(250)	(250)	Merchant (Blue)	Probable	In place	In place	In place	Not started	Not started	Not started	1H26	2H25
Linde, OCI	Beaumont	US	3,000	1,100	1,100	–	–	Merchant (Blue)	Probable	Agreed	In place	In place	Underway	Not started	Not started	1Q25	2026
CF Ind, Exxon	Gulf Coast	US	4,928	1,700	1,700	(1,700)	(1,700)	Merchant (Blue)	Probable	No EPC	In place	In place	Not started	Not started	Not started	2027	2H27
CF Industries	Yazoo City	US	725	250	250	(250)	(250)	Merchant (Blue)	Probable	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
Nutrien	Donaldsonville	US	2,899	1,000	1,000	–	–	Merchant (Blue)	Probable	No EPC	In place	No finance	Not started	Not started	Not started	2027	Post-2028
Total PROBABLE				**4,640**	**4,541**	**(2,540)**	**(2,441)**										
Total capacity forecast (FIRM + PROBABLE)				**4,640**	**4,541**	**(2,540)**	**(2,441)**										
Ta'ziz	Ruwais	UAE	2,899	1,000	1,000	–	–	Merchant (Blue)	Possible	In place	In place	In place	Not started	Not started	Not started	2025	Post-2028
Total POSSIBLE				**1,000**	**1,000**	**–**	**–**										
WAH2	Pilbara	Australia	2,300	800	800	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2026-29	Post-2028
Barents Blue	Finnmark	Norway	3,000	1,035	1,035	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
QatarEnergy	Mesaieed	Qatar	3,500	1,200	1,200	–	–	Merchant (Blue)	Specul.	In place	In place	No finance	Not started	Not started	Not started	1Q26	Post-2028
Air Products	Louisiana	US	3,000	1,035	1,035	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2026	Post-2028
Petronas	Alberta	Canada	3,000	1,035	1,035	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2027	Post-2028
Mitsui	Perth	Australia	3,000	1,035	1,035	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2028	Post-2028
Jera, Uniper	US Gulf	US	3,000	1,000	1,000	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2028	Post-2028
Pilot Energy	Perth	Australia	120	40	40	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
PAU, Jogmec	Luwuk	Indonesia	2,000	700	700	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
H2biscus	Sarawak	Malaysia	1,740	600	600	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
Aramco	Saudi Arabia	KSA	31,884	11,000	11,000	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
Adams Fork	West Virginia	US	6,377	2,200	2,200	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	n/k	Post-2028
CF & Mitsui	Louisiana	US	3,000	1,000	1,000	–	–	Merchant (Blue)	Specul.	MoU	In place	No finance	Not started	Not started	Not started	2027	Post-2028
CHW	Louisiana	US	20,870	7,200	7,200	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2027	Post-2028
ExxonMobil	Baytown	US	860	297	297	–	–	Merchant (Blue)	Specul.	In place	In place	No finance	Not started	Not started	Not started	2028	Post-2028
IFCo Phase 2	Wever	US	913	315	315	(315)	(315)	Merchant (Blue)	Specul.	MoU	In place	No finance	Not started	Not started	Not started	1H26	Post-2028
Yara, Enbridge	Corpus Christi	US	4,058	1,400	1,400	–	–	Merchant (Blue)	Specul.	No EPC	In place	No finance	Not started	Not started	Not started	2028	Post-2028
Total SPECULATIVE				**31,892**	**31,892**	**(315)**	**(315)**										
Total capacity forecast (POSSIBLE + SPECUL.)				**32,892**	**32,892**	**(315)**	**(315)**										

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AMMONIA SUPPLY: Middle East, 2022-37

Aramco plans 11mn t/yr of blue ammonia capacity by 2030 and Neom's green ammonia project closes financing

The Neom green ammonia project reached financial closure during the first quarter, as interest in Middle East shifts to low carbon ammonia. The Ta'ziz project in the UAE is close to being included in out forecast.

After two grey ammonia plants were completed in the region during 2022, we are not forecasting any further grey capacity to be added in the coming years. Instead, recent project announcements have focussed on low-carbon ammonia production.

Saudi Arabia: ACWA Power and Air Products are working with Neom to construct a 1.2mn t/yr green ammonia plant in northwest Saudi Arabia. The owners managed to secure debt financing for the $8.5bn project in February. Total capital costs underwent severe inflation since the initial planned expenditure of $5bn. Construction commenced in the 1Q 2023.

Aramco has announced that it plans to build 11mn t/yr of blue ammonia capacity in Saudi Arabia by 2030. It will invest $100bn into the Jafurah natural gas project which could increase capacity by 2 Bcf/d. We estimate the 11mn t/yr of ammonia would require 1.15 Bcf/d, meaning that this could be newly-built capacity, but Aramco has not confirmed this.

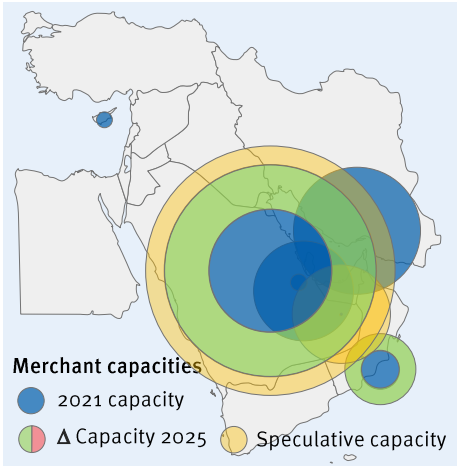
UAE: The Ta'ziz blue ammonia project has secured financing, passing a significant hurdle in the way of prospective ammonia projects. The 1mn t/yr renewable plant is expected to start producing at full scale in 2025. We are not currently including this project in our forecast, but this will change once construction is confirmed to have started.

Oman: OQ's SMC ammonia plant commissioned in August 2022 and has been operating consistently for several months following a shutdown soon after production began. The company is also planning a urea unit at the site that will consume most of the ammonia produced, but OQ has not yet released a timeline for this project, which is still in the planning stage.

Qatar: There have been no capacity changes in Qatar since 2015, but QAFCO plans to build a 1.2mn t/yr blue ammonia plant in the country by 2026. An EPC contract has been awarded to Thyssenkrupp and CCC, but no details on financing progress have been released.

Middle East ammonia supply — mn t/yr

	2015	2022	2023	2027	Δ'22-27
Saudi merch cap	1.1	2.1	2.2	2.1	--
Iran merch cap	1.0	1.2	1.2	1.2	--
Qatar merch cap	1.0	1.0	1.0	1.0	--
Oman merch cap	0.2	0.4	0.5	0.5	0.1
Merchant capacity	**3.6**	**5.0**	**5.3**	**5.1**	**0.1**
Gross capacity	**18.0**	**23.2**	**23.5**	**23.7**	**0.5**
Merch production	3.2	4.4	4.7	4.4	--
Gross production	16.0	19.8	20.0	20.0	0.2
Merch ops rate	89pc	88pc	89pc	86pc	
Gross ops rate	89pc	86pc	85pc	85pc	

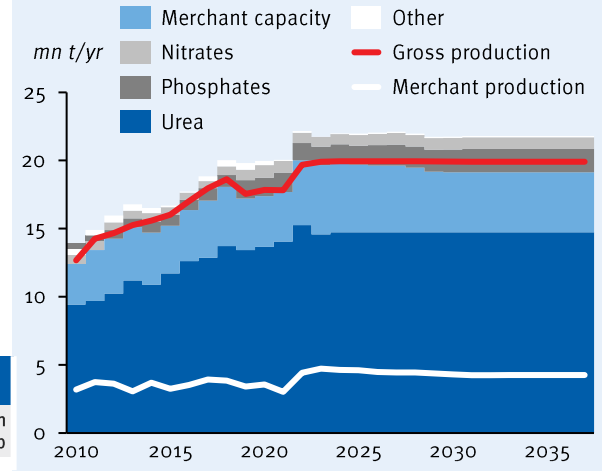


Middle East capacity changes — '000 t/yr

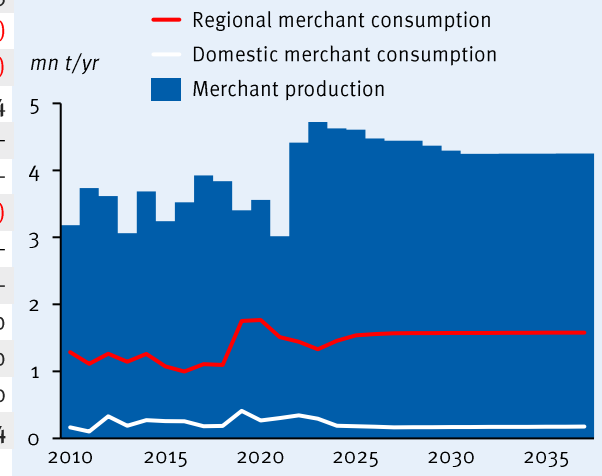
Name	Country	Start	Δ Gross cap	Δ Merch cap
Ma'aden	Saudi	Mar-22	1,139	1,139
SMC	Oman	Aug-22	345	345
Gemlik Gübre	Turkey	2H23	—	(360)
Ma'aden	Saudi	2026	—	(670)
Total firm + probable			**1,484**	**454**
HPC	Iran	2H23	759	—
Gemlik Gübre	Turkey	Post-2028	200	—
SMC	Oman	Post-2028	—	(330)
Lavan	Iran	Post-2028	690	—
Omifco	Oman	Post-2028	759	—
Ta'ziz (B)	UAE	2025	1,000	1,000
QAFCO (B)	Qatar	2026	1,200	1,200
Aramco (B)	Saudi	Post-2028	11,000	11,000
Total project capacity			**17,092**	**13,324**

(B) denotes 'blue' ammonia projects
**Indicates retrofitted CCS projects, whereby grey capacity is replaced by blue*

Middle East ammonia capacity, 2010-37



Middle East merchant ammonia, 2010-37



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AMMONIA SUPPLY: Russia and central Asia, 2022-37

Eurochem's project severely hampered by sanctions but others are progressing, several to complete in 2023

We expect four permanent changes to Russian ammonia capacity in 2023 as projects progress, despite ongoing sanctions being applied to Russia following its invasion of Ukraine. The changes will mean a net reduction of almost 750,000 t/yr of merchant capacity in Russia and central Asia compared with 2022.

Acron completed an upgrade to its ammonia production at a nitrates plant in Dorogobuzh in April 2023. The changes mean the plant now can produce 800,000 t/yr of ammonia, up from 700,000 t/yr before. All this extra capacity will be used as a feedstock to boost nitrates output at the plant.

A urea unit being built by KuibyshevAzot in Togliatti was completed in March 2023 and is undergoing testing before commercial operations begin in the second quarter. The unit will require 328,000 t/yr of ammonia that was previously being sold on the merchant market.

Acron is also building out urea and nitrates capacity at its Novgorod facility that includes an upgrade to its existing ammonia capacity which would provide an extra 375,000 t/yr of ammonia. The entirety of this product will be used for the production of urea and nitrates at the site when the facility comes on line in the second half of this year, so it will cause no change to the merchant balance.

There have been multiple delays caused by sanctions to Eurochem's 1mn t/yr ammonia project in Kingisepp, where it already operates.

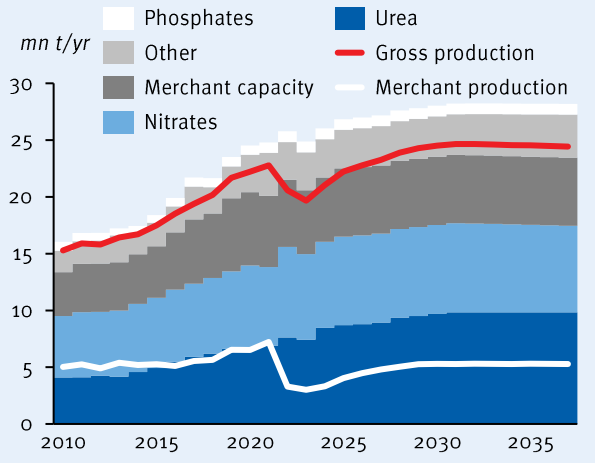
The producer plans to build out urea capacity as part of the project's scope, and we forecast that 350,000 t/yr of ammonia will be made available to the merchant market.

This project has been significantly hampered by sanctions applied to Russia and is reportedly unable to get key pieces of equipment to the site at present. We have pushed back our forecast for when production will begin to the second half of 2028, from the second half of 2024, to reflect these issues.

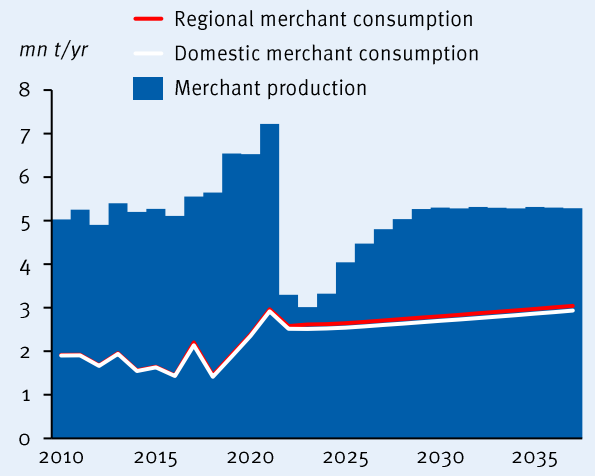
Shchekinoazot's integrated urea and ammonia project is progressing as expected. We forecast that the 525,000t/yr gross capacity (including 119,000t/yr merchant) will come online during the second half of 2024.

KuAz is reportedly planning an ammonia and urea plant, but no further capacity or timeline details have been released. Also, Phosagro may be planning a project to build out ammonia capacity at its Cherepovets facility to provide a feedstock for its existing phosphates operations.

Russia & C. Asia ammonia capacity, 2010-37

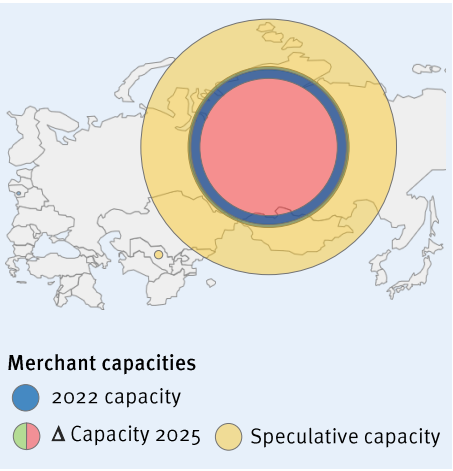


Rus. & C. Asia merchant ammonia, 2010-37



Russia and central Asia supply *mn t/yr*

	2015	2022	2023	2027	Δ'22-27
Russia merch cap	4.5	6.1	5.6	6.1	--
Uzbek. merch cap	0.4	0.4	0.4	0.4	--
Merchant capacity	**5.3**	**6.6**	**6.0**	**6.5**	**(0.1)**
Gross capacity	**19.4**	**25.0**	**26.8**	**29.0**	**4.0**
Merch production	5.3	3.3	3.0	4.8	0.8
Gross production	17.5	20.6	19.7	23.3	2.7
Merch ops rate	100pc	50pc	50pc	74pc	
Gross ops rate	90pc	84pc	74pc	80pc	



Russia and C. Asia capacity changes *'ooo t/yr*

Name	Country	Start	Δ Gross cap	Δ Merch cap
Metafrax	Russia	4Q '22	311	--
Acron	Russia	Apr-23	100	--
KuAz	Russia	2Q '23	--	(328)
ToAz	Russia	4Q '23	--	(421)
Acron	Russia	2H '23	375	--
Shchekinoazot	Russia	2H '24	525	119
Eurochem	Russia	1H '25	1,050	350
Total firm + probable			**2,361**	**(280)**
Total specul. + possible capacity			**6,232**	**1,529**
Total project capacity			**8,593**	**1,249**

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AMMONIA SUPPLY: South Asia, 2022-37

HURL completes three out of four renovation projects, most other capacity targeting downstream production

Three out of the four projects being progressed by HURL are now in operation. The company has recommissioned mothballed urea plants in Gorakhpur, Sindri and Barauni, including the ammonia units at the sites. The remaining project in Talcher was disrupted by the Covid-19 pandemic to a greater extent, so is now expected to be complete by the second half of 2024.

India's Deepak Fertilizers is nearing completion of its nitrates plant in Taloja, India. The nameplate ammonia capacity at the plant is 518,000 t/yr, and we estimate that nearly 400,000 t/yr of this will be upgraded into nitrates at the site, with the remainder to be sold on the merchant market until a TAN unit is completed in 2025. Pre-commissioning activities began at the site in March 2023, and full production is forecast for July 2023. Deepak has secured a gas supply for two-thirds of its expected requirements.

The final project included in our forecast is BCIC's urea plant in Polash, Bangladesh. The plant is expected to have a urea capacity of 924,000 t/yr, and the project scope includes a new ammonia unit with 552,000 t/yr of capacity. We do not expect any of the ammonia produced to be sold directly. Work at the plant was reportedly at 80pc completion in September 2022, with the company expecting to begin production by December 2023.

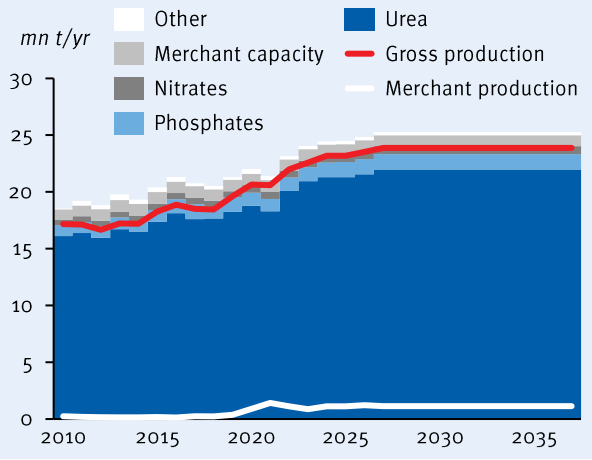
The project timeline was delayed by six months in late 2020 when the EPC contractor, Japanese construction company MHI, declared force majeure on account of the Covid-19 pandemic as it could not ensure the movement of people required to progress the project.

Indian phosphates producer Paradeep Phosphates is progressing the largest project that we are tracking. It includes almost 2.2mn t/yr of gross ammonia capacity that will be used to produce nitrates and phosphates, as well as about 1.16mn t/yr that will be sold directly as ammonia.

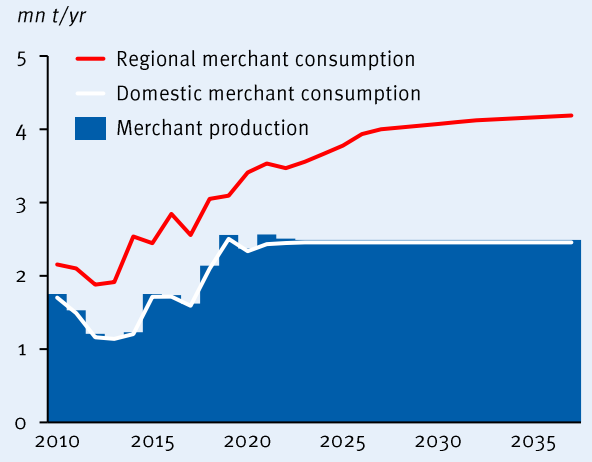
The company has not released its timeline for the project, but the size means we do not expect it to come on line before 2026. Project financing will be the largest hurdle faced by the owner, and it is not clear how it plans to raise the capital requirement for the project.

Until more details are released, we are rating this project as speculative and have excluded it from our forecast.

South Asia ammonia capacity, 2010-37

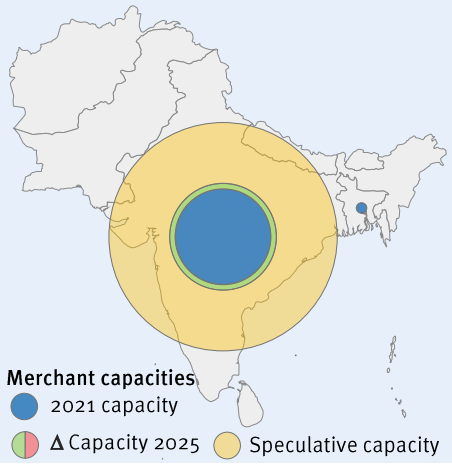


South Asia merchant ammonia, 2010-37



South Asia ammonia supply — mn t/yr

	2015	2022	2023	2027	Δ'22-27
India merch cap	0.9	0.9	0.9	0.9	--
Bangladesh merch cap	0.2	0.2	0.2	0.2	--
Merchant capacity	**1.0**	**1.1**	**1.1**	**1.0**	**(0.1)**
Gross capacity	**21.4**	**25.2**	**26.6**	**28.5**	**3.3**
Merch production	0.2	1.1	0.9	1.1	--
Gross production	18.3	22.0	22.6	23.9	1.9
Merch ops rate	18pc	102pc	83pc	106pc	
Gross ops rate	85pc	87pc	85pc	84pc	



South Asia capacity changes — '000 t/yr

Name	Country	Start	Δ Gross cap	Δ Merch cap
HURL Gorakhpur	India	May-22	759	--
HURL Sindri	India	Nov-22	759	--
HURL Barauni	India	Oct-22	759	--
Deepak Fertz.	India	2H '23	518	120
BCIC	Bangladesh	1H '24	552	--
Total firm + probable			**3,347**	**120**
HURL Talcher	India	2H '24	759	--
BVFCL	India	Post-2028	759	--
Paradeep	India	Post-2028	2,178	1,163
Total project capacity			**7,043**	**1,283**

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AMMONIA SUPPLY: Southeast Asia and Australasia, 2022-37

Incitec Pivot closes Gibson Island facility as interest shifts to low-carbon ammonia projects

Incitec Pivot permanently closed its urea production facility in Gibson Island, Australia, in December 2022, citing an inability to secure an affordable gas supply. We do not forecast any changes to southeast Asian or Australasian capacity before 2028, when the Perdaman urea plant is expected to come on line.

Perdaman in April announced that it had secured financing for its proposed 2mn t/yr urea plant on the Burrup Peninsula, northwest Australia. *Argus* estimates that 1.2mn t/yr of ammonia capacity will have to be included in the project scope to provide a feedstock for the urea operations. No merchant capacity is expected out of this project.

The owner began construction at the site in April this year, but the size of the project means it will take an estimated five years to complete, with initial production anticipated for the second half of 2028.

We are also tracking several grey ammonia projects in Australia and Indonesia that are focused mainly on downstream nitrogen fertilizer production, but these projects are all in their early stages so they are currently categorised as speculative.

Interest has recently emerged in the low-carbon ammonia production sector within the region. Australia will probably become a hub for green ammonia production, but blue ammonia projects are also being proposed as a stepping stone to decarbonising ammonia production.

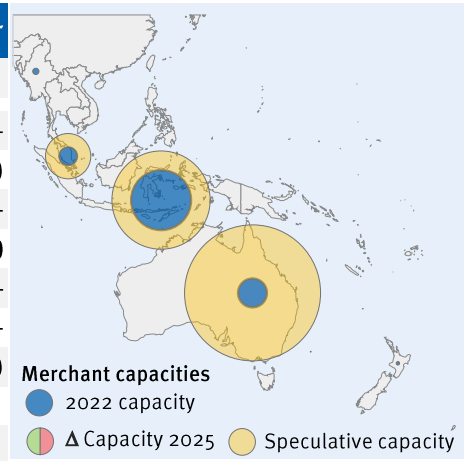
Australia is home to three such projects, all of them seeking to target the merchant market. The projects comprise an 800,000 t/yr merchant plant owned by Hexagon, a 1mn t/yr plant owned by Mitsui and Pilot Energy's 40,000 t/yr proof-of-concept plant.

Indonesia and Malaysia are also attracting interest. State-owned gas company PAU is planning a 700,000 t/yr blue ammonia plant in Luwuk, Indonesia, and Samsung is progressing its H2Biscus project in Sarawak, Malaysia.

The H2Biscus project in Sarawak includes capacity for green ammonia and methanol, as well as 600,000 t/yr of blue ammonia capacity.

SE Asia & Aus. ammonia supply *mn t/yr*

	2015	2022	2023	2027	Δ'22-27
Australia merch cap	0.8	0.8	0.8	0.8	--
Indonesia merch cap	1.7	2.6	2.6	2.4	(0.2)
Malaysia merch cap	0.5	0.5	0.5	0.5	--
Merchant capacity	**3.6**	**3.9**	**3.9**	**3.7**	**(0.2)**
Gross capacity	**12.2**	**15.6**	**15.6**	**15.6**	--
Merch production	3.7	2.5	1.9	2.5	--
Gross production	10.7	13.0	12.5	12.6	(0.4)
Merch ops rate	103pc	64pc	49pc	68pc	
Gross ops rate	87pc	83pc	81pc	82pc	

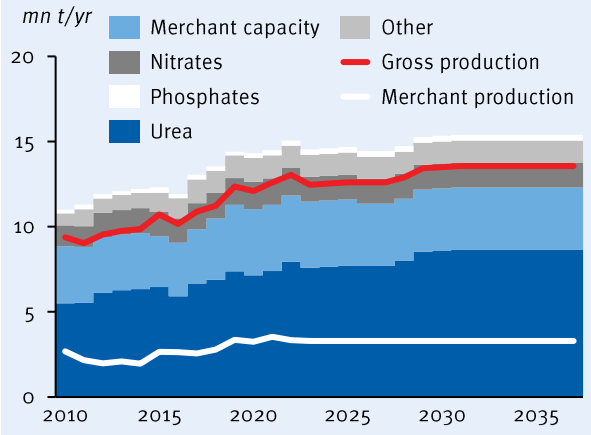


SE Asia & Aus. capacity changes *'ooo t/yr*

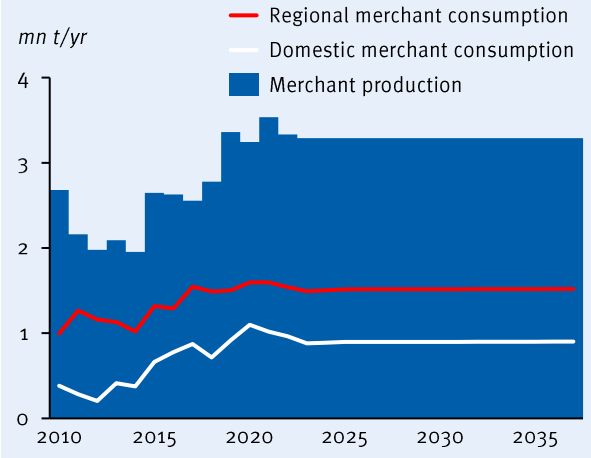
Name	Country	Start	Δ Gross cap	Δ Merch cap
Incitec Pivot	Australia	Dec-22	(280)	--
Perdaman	Australia	2H '28	1,208	--
Total firm + probable			**928**	--
NeuRizer	Australia	Post-2028	574	--
Strike Energy	Australia	Post-2028	792	--
Pupuk Kaltim	Indonesia	Post-2028	825	155
Pusri	Indonesia	Post-2028	(281)	--
PT Bukit Asam	Indonesia	Post-2028	328	--
AFE	Australia	Post-2028	231	231
Derby Fertz.	Australia	Post-2028	1,208	407
Hexagon (B)	Australia	2026	800	800
Mitsui (B)	Australia	2028	1,000	1,000
Pilot Energy (B)	Australia	Post-2028	40	40
PAU (B)	Indonesia	Post-2028	700	700
Samsung (B)	Malaysia	Post-2028	600	600
Total project capacity			**7,745**	**3,933**

(B) denotes 'blue' ammonia projects

SE Asia & Aus. ammonia capacity, 2010-37



SE Asia & Aus. merchant ammonia, 2010-37



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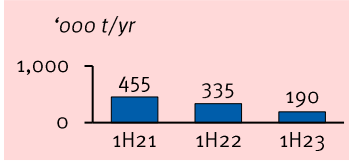
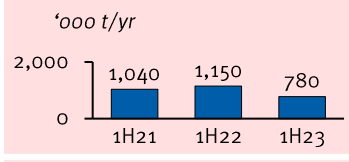
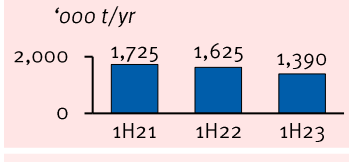
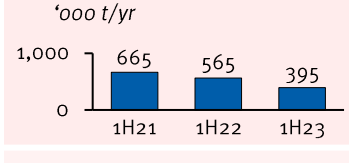
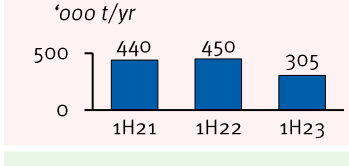
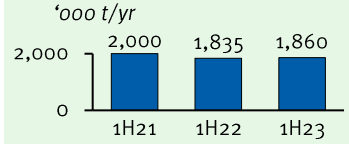
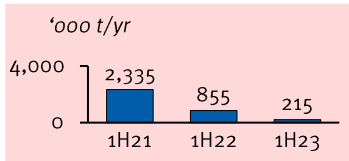
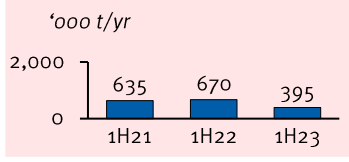
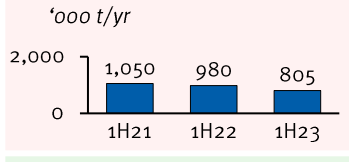
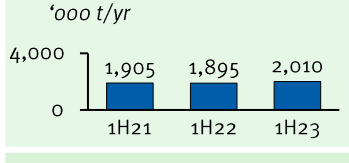
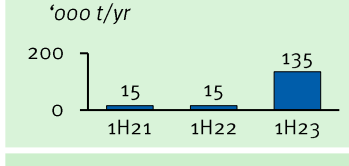
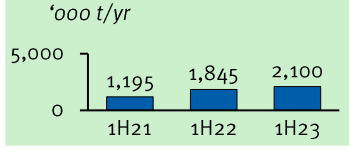
TRADE: Initial data suggests 1H23 trade contracted by 300,000t/yr vs. 1H22…

…lower prices and plentiful supply fail to ignite a demand resurgence

IMPORTS

C&E EU		Czech producers struggled with output on high gas prices, while Eurochem struggles to maintain Lithuanian output given logistical issues. And Ukraine's merchant consumption is sharply reduced on lower output
AFRICA		Morocco's imports have shown the biggest single country contraction, down by 400,000t. High stocks, reduced DAP output and high NH_3 prices minimising requirements. South African imports also struggling
NORTH AM		US import demand down marginally as merchant production increases and demand for industrial products struggles. And the increase in Mexican output has reduced import levels there
MID EAST		Tunisian and Jordanian producers struggle with output, reducing ammonia imports. And Turkish producers maintain demand levels despite reduced nitrates output
LAT AM		Increase in output at Unigel's facilities has reduced Brazilian requirements. Meanwhile, Chilean consumers reduce purchasing as industrial demand contracts
WEST EU		Western Europe presents a mixed picture, industrial demand has ravaged imports in some countries while reduced UK output has resulted in substantially higher import levels

EXPORTS

RUS. & CA		Only viable route to export is now via Eurochem's floating terminal in Ust-Luga. Two shipments loaded so far, delivering to Europe and Turkey though shipments will likely only continue to Turkey in the short-term
WEST EU		Netherlands and Germany trade contracted most significantly on reduced demand for industrial products and lower output
AFRICA		Algerian exports contracted on lower European demand and increased competition following import duty removal
LATAM		Trinidadian exports performing well, gas curtailments have been limited and European demand provided outlet for material
E. ASIA		China continued to export for first few months of the year; falling international ammonia prices halted flows out of China and is likely to do so for the foreseeable
MID EAST		Saudi exports flat y-o-y despite new capacity. Omani and Iranian exports on the other hand have both doubled following new capacity and healthy gas supplies respectively

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TRADE: India

The government's push to build fertilizer stocks boosts 2023 imports, but Deepak's plant will reduce merchant demand

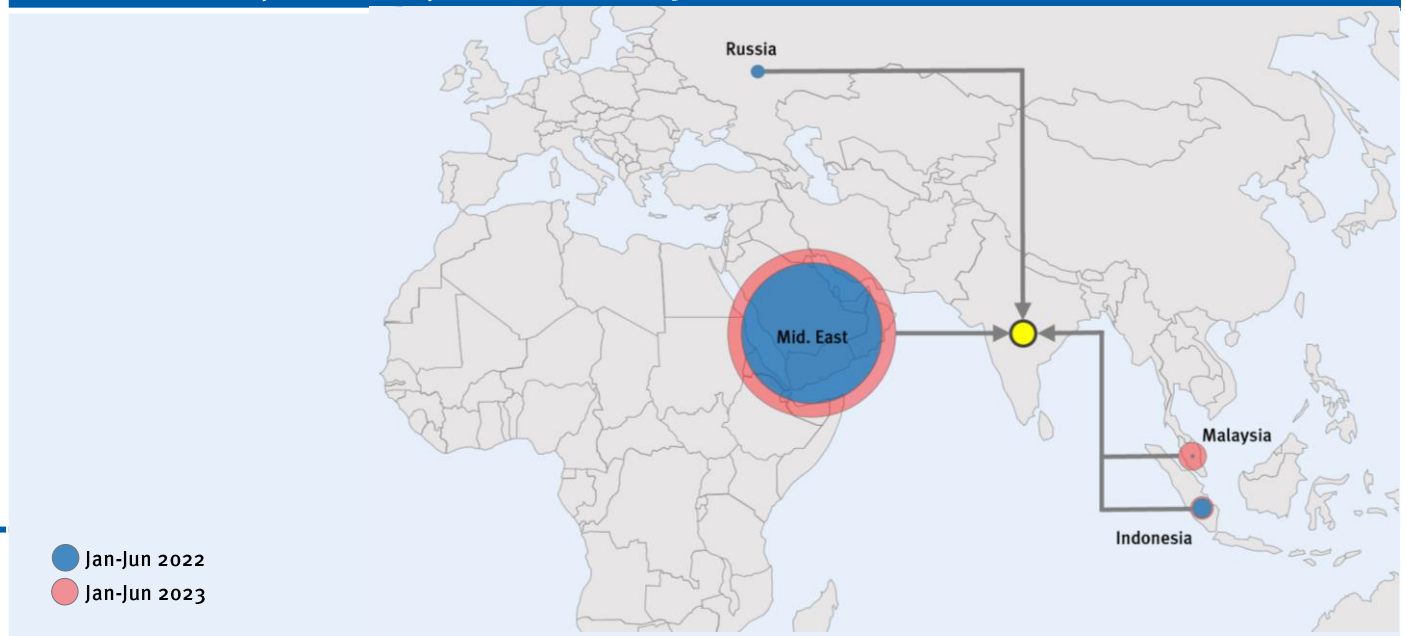
CURRENT

- Since Russia's invasion of Ukraine, Indian importers have had to seek new suppliers or increased volumes from existing partners to replace tonnes lost from Odesa. Almost 80,000t were imported from Russia in the first half of 2022 – January-March before exports were halted – but no shipments have been possible since.
- Indian imports were up by 275,000t in the first half of 2023 compared to 2022, totalling 1.37mn t, a rise of 25pc. The start-up of the Paradeep DAP and NPK facility accounts for some of this rise; capacities of 400,000t/yr DAP and 200,000t/yr NPK came online in the second half of 2022, which require a further 130,000t/yr of ammonia from the merchant market.
- Despite DAP import prices being at a discount to domestic production costs at farm-gate throughout 2023 (see graph), the level of DAP production has risen, boosting the country's ammonia requirement so far this year. A combination of firm phosphates demand and recent new capacity have driven the production rise.

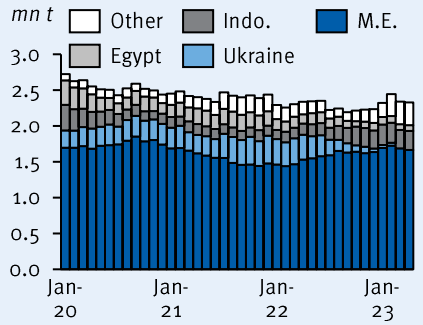
MEDIUM TERM

- Indian producer Deepak Fertilizers is expected to commission the ammonia unit as part of its new nitrates facility in the second half of 2023. A TAN plant is also included in the scope, but this unit will not be ready until late-2025 at the earliest. In the meantime, Deepak will have an estimated merchant capacity of 520,000t/yr, which we expect will be sold to local downstream fertilizer producers as well as meet Deepak's existing requirements, reducing India's overall import requirement. Deepak's merchant demand will then recover, though not to current levels, when then TAN plant is commissioned.
- Indian ammonia imports will increase by 20pc from 2.4mn t in 2022 to 2.9mn t in 2027. The high ammonia price level during 2022 encouraged more domestic production to displace imports, and demand from the industrial and phosphates sectors is expected to grow over the period.

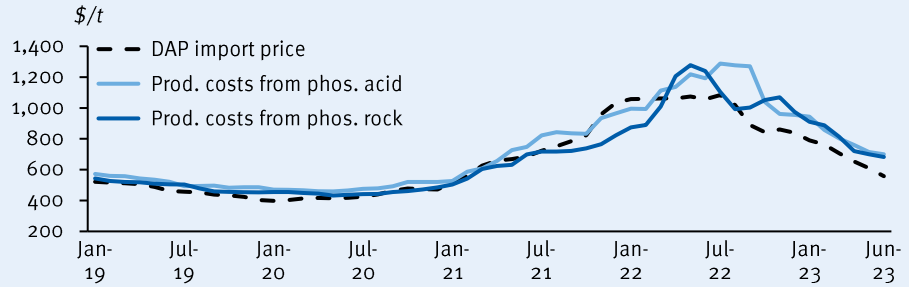
Indian ammonia imports, January-June 2022 vs 2023



Annualised imports, 2020-23



Indian DAP production costs (imported ammonia) vs import price



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TRADE: Russia and FSU

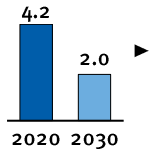
Alternate export terminal projects prioritised to replace lost access to Togliatti-Odesa pipeline and Baltic ports

CURRENT

- Russia's invasion of Ukraine in late February 2022 diminished much of Russia's export capability, both as a result of the closure of the Togliatti-Odesa pipeline and international sanctions that have dissuaded Baltic countries from allowing Russian ammonia to pass through their ports. Railed deliveries were the only remaining route to market for Russian producers, averaging 25,000t/month in January-May 2023.
- The need for an export route accelerated plans to build out export capability in the Russian Baltic Sea port of Ust-Luga. Eurochem began loading ammonia from its Kingisepp plant in Ust-Luga in May. Initial volumes out of the port, around one 23,000t shipment per month, have gone to Europe and Turkey.

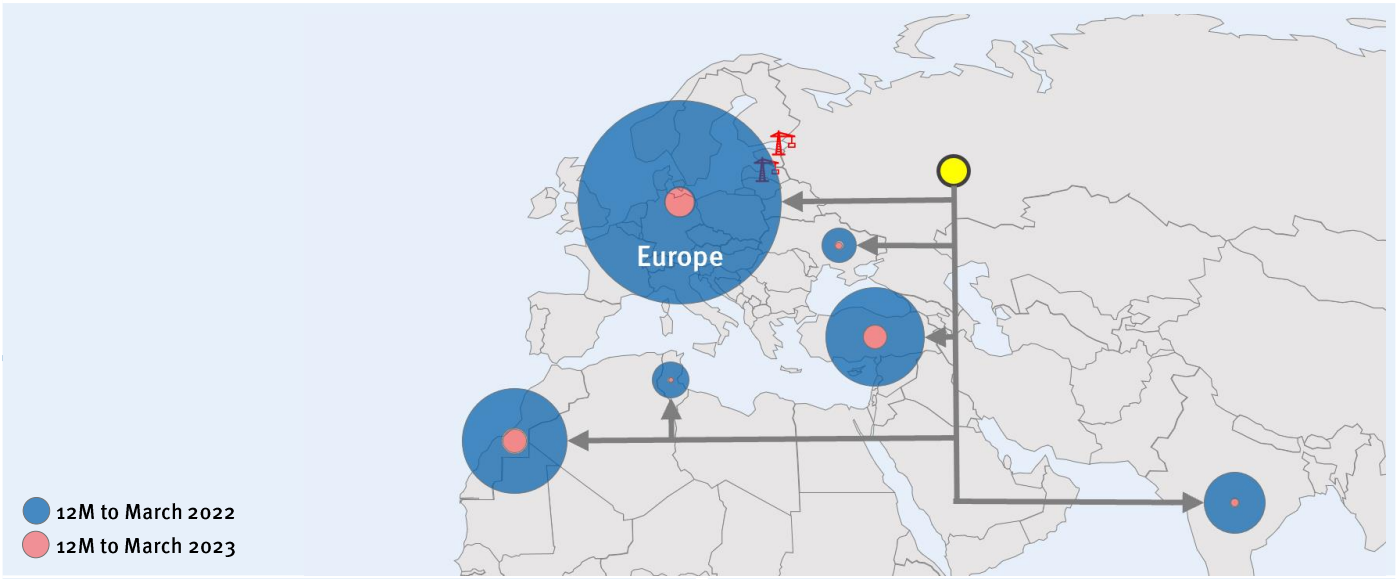
SHORT TO MEDIUM TERM

- We have excluded from our forecast any exports through the Togliatti-Odesa pipeline, and this will remain the case as we are unable to predict when trade could possibly resume, either through an agreement on pipeline terms between Russia and Ukraine or through the end of the war. The pipeline suffered further damage during June, and would require at between one and three months of repair time.
- Efforts to complete an export terminal in the Black Sea port of Taman in southern Russia have been re-energised by the need for alternate export routes. Uralchem is investing $662mn into the project, which it is aiming to have operational by the end of this year.
- We forecast an export recovery from 2023 levels over the next five years as further export routes are opened or expanded, including a terminal at the Black Sea port of Taman, but exports will plateau at about half of the pre-war annual export level.

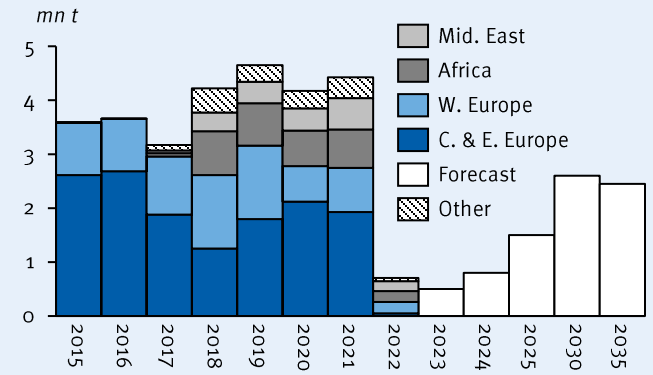


- We would expect to see a permanent shift in global trade flows out of Russia, with trade concentrated to only a few willing regions. Turkey and India are likely destinations for Russian ammonia.

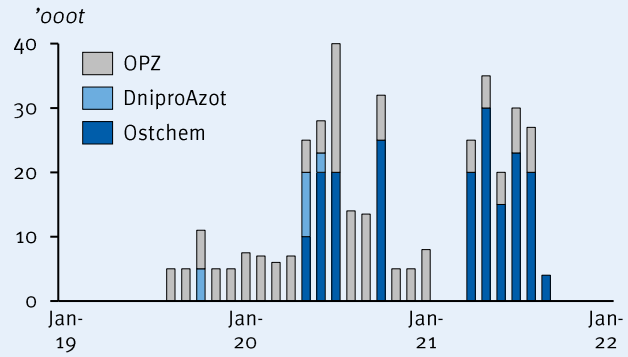
Russia ammonia exports, 2021-23



Russia exports, 2015-35



Ukraine exports through Pivdenny, 2019-22



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TRADE: Americas and Caribbean

US moving closer towards being a net exporter, boosted by the expected start-up of Gulf Coast Ammonia in July

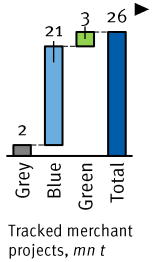
CURRENT

- An ex-Venezuela ammonia shipment was delivered to Turkey during April, marking the first Venezuelan export since 2018, when the country stopped exporting because of feedstock issues. Before the shutdown in 2018, Venezuela exported an average of almost 200,000 t/yr between 2015 and 2018.

SHORT TERM

- The start-up of Gulf Coast Ammonia's (GCA's) 1.3mn t/yr merchant plant is now anticipated to happen in the final quarter of this year. This will reduce US net imports to some extent, but the plant is primarily export-oriented. No other major shift to trade is anticipated in our forecast as we are not tracking any other grey export-oriented projects in the country, or any non-integrated US downstream projects.
- Despite a recent fall in European TTF natural gas prices, which has brought production costs closer to parity with import prices on the continent, there remains an additional demand for ammonia from the Americas, particularly Trinidad and the US. While Trinidad is a typical supplier to Europe, unusually high ammonia exports to the continent from the US will probably continue, as our gas price forecasts suggest European producers will be faced with production costs that exceed international ammonia prices over the next few years.

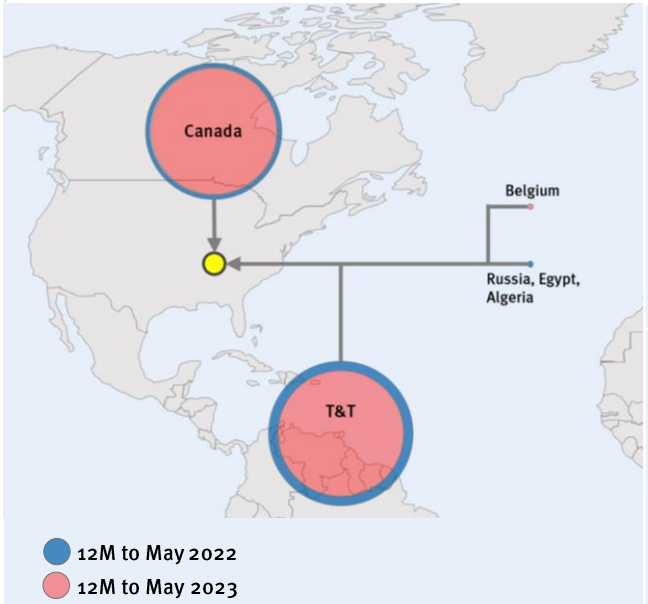
MID-TERM



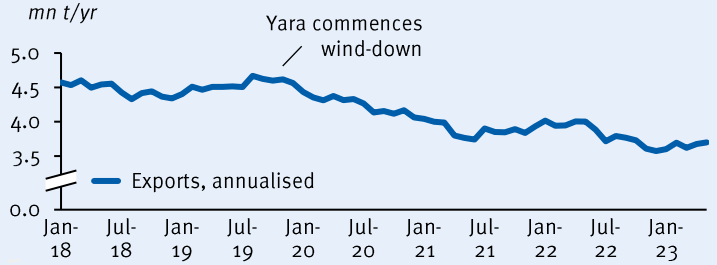
Tracked merchant projects, *mn t*

- We are tracking about 1mn t/yr of merchant grey capacity in the US in addition to the GCA plant, but capacity buildouts are more likely to come from the clean ammonia sector, from the likes of OCI, Nutrien and CF Industries. The favourable investment climate created by the IRA legislation will see substantial blue capacity come on line in the coming years. In regards to green ammonia, we are excluding most projects from our forecast as they are still in their early stages. But the progression of certain projects would mark a substantial shift to our supply forecast.

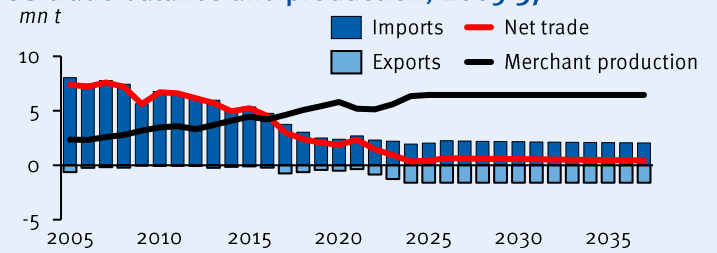
US ammonia imports, 2021-23



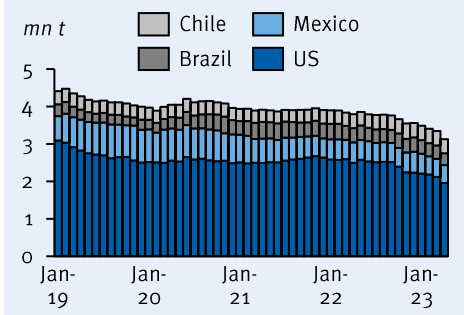
Trinidad exports, 2018-23



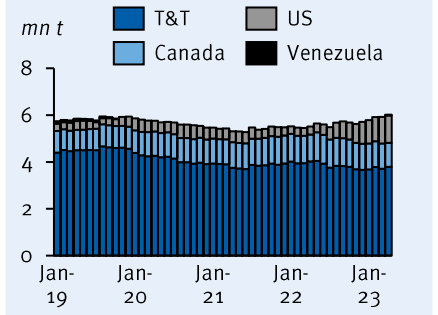
US trade balance and production, 2005-37



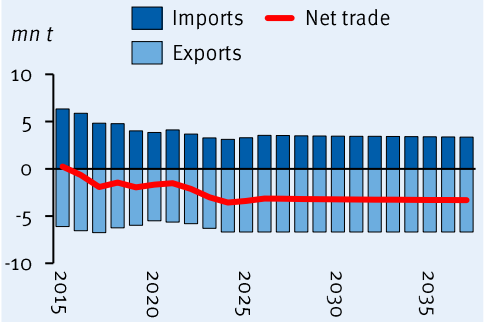
Annualised imports, 2019-23



Annualised exports, 2019-23



Americas trade balance, 2015-37



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TRADE: Middle East

Middle Eastern volumes are making up some of the shortfall resulting from the Russia-Ukraine war

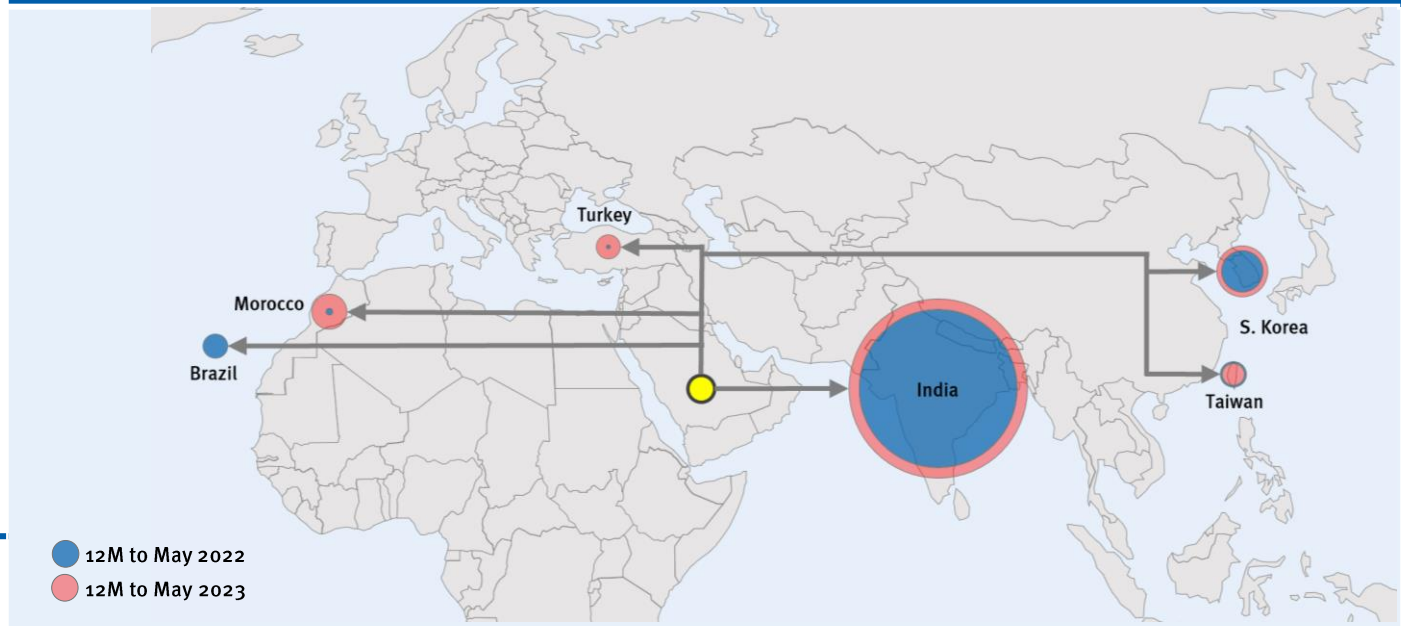
CURRENT

- Export values from the Middle East to India in the first quarter of this year have recovered to the yearly average for 2020 following a drop-off beginning in 2021, as shown in the bottom left chart.
- Shipments from the Middle East to Turkey increased to 265,000t in the 12 months to March 2023, from 43,000t in the 12 months to March 2022. These volumes have been required to replace the Russian ammonia that typically gets shipped to Turkey through Odessa. The Middle East will remain a key supplier of Turkey's ammonia demand while the war continues to restrict Russian output.
- Saudi Arabian producers have started to export blue ammonia cargoes. Ma'aden and Sabic have shipped 40,000t and 37,800t respectively in the first half of 2023 to several markets, including east Asia and Europe. Supply agreements have also been signed with India. Ma'aden has accreditation to produce 140,000t under its current agreement with TUV Rheinland, the accreditor for both producers.

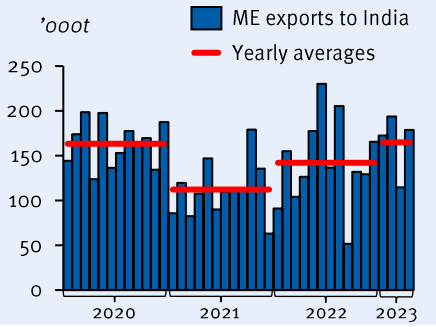
SHORT TO MEDIUM TERM

- Our forecast suggests Moroccan ammonia demand will undergo strong growth over our forecast period, supported mostly by OCP's planned DAP, MAP, NPK and NPS capacity buildouts. While Russian exports are severely reduced, Middle Eastern cargoes will continue to flow west into the medium term to replace the lost volumes.
- Ma'aden is progressing a phosphates project in Saudi Arabia that we have rated as firm and is expected to come on line in 2026. We are expecting this unit to require 670,000 t/yr of ammonia if it runs at capacity, and as there is no ammonia production included in the project, this will lead to a reduction in Saudi Arabian export volumes. This is the main driver behind our forecast reduction in Middle Eastern exports beyond 2025.

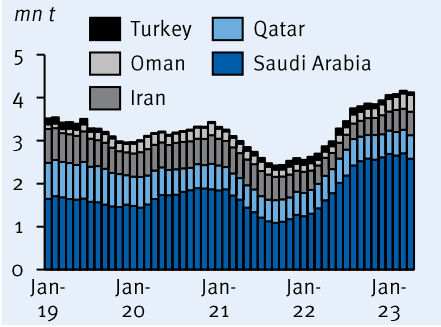
Middle East ammonia exports, 2021-23



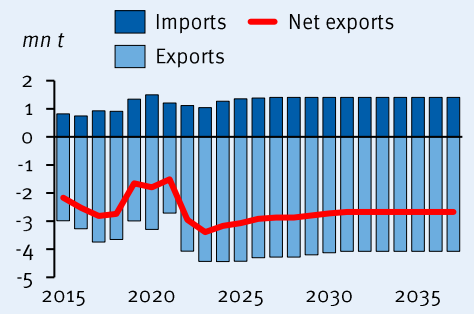
Monthly ME exports to India



Annualised exports, 2019-23



Middle East trade balance, 2015-37



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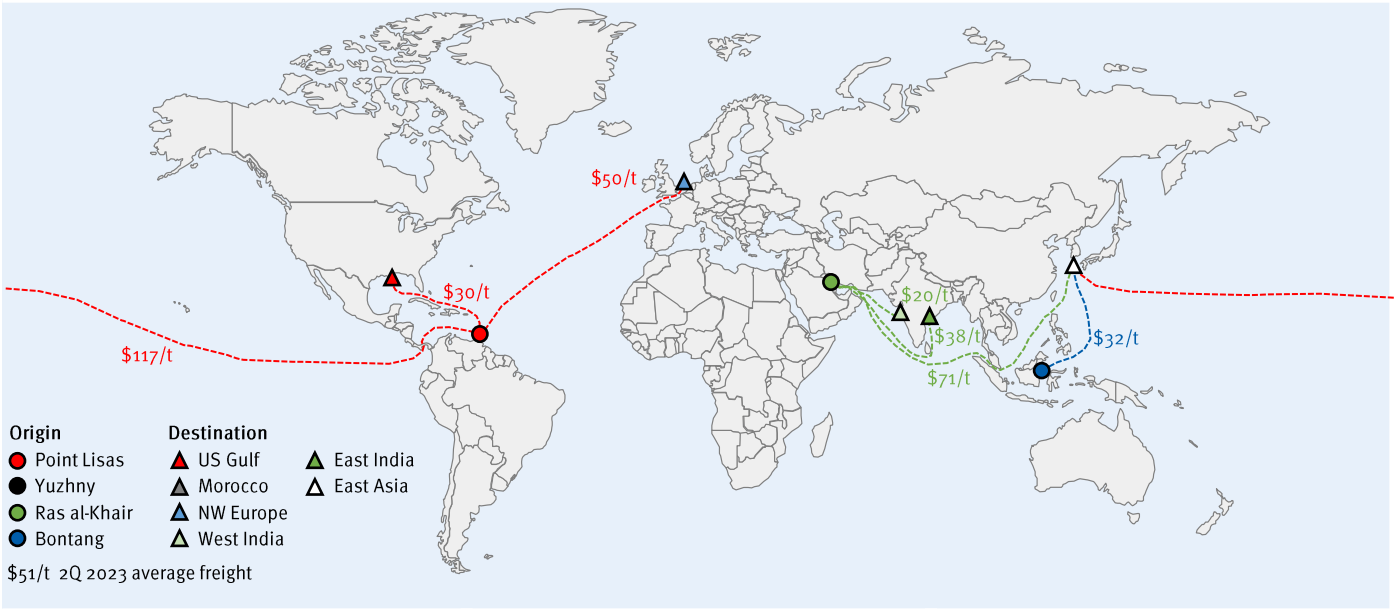
BENCHMARK PLANTS: Softening product prices cause margins to tighten

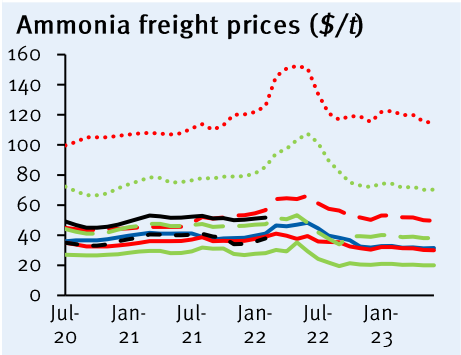
Freight rates remain steady on the quarter, but falling ammonia prices add pressure to marginal producers

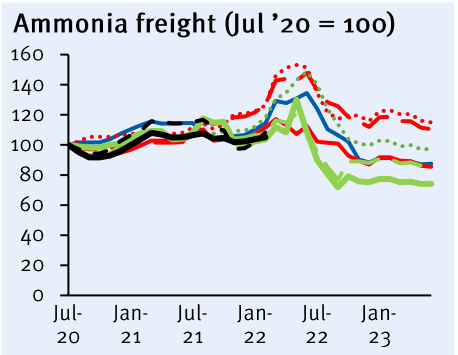
Export costs and margins: Benchmark plants (2Q 2023 basis)

Note: Russian benchmarks have been suspended since February 2022		Saudi Arabia	US	Indonesia	Trinidad
		Ras al-Khair	Donaldsonville	Bontang	N2000
Gas price (HHV)	$/mnBtu	1.25	2.19	6.00	4.15
Gas consumption (HHV)	mnBtu/t	32	37	32	40
Gas cost	**$/t**	40	81	192	166
- Power	$/t	3	4	6	2
- Demin. water	$/t	10	5	4	4
- Catalyst depreciation	$/t	4	4	4	4
Total variable cash costs	**$/t**	**57**	**93**	**206**	**176**
- Labour	$/t	7	13	4	7
- Other overheads	$/t	5	26	18	25
Total fixed costs	**$/t**	**12**	**39**	**22**	**32**
Cost to fob	**$/t**	**2**	**2**	**2**	**2**
Variable cash at fob	**$/t**	**59**	**95**	**208**	**178**
Total cost at fob	**$/t**	**71**	**134**	**230**	**211**
Freight to US Gulf	$/t	--	--	--	30
Freight to NW EU	$/t	--	--	--	50
Freight to east Asia	$/t	71	--	32	117
Cost at US Gulf	$/t	--	--	--	241
Cost at NW EU	$/t	--	--	--	261
Cost at east Asia	$/t	142	--	262	327
Ebitda at US Gulf	$/t	--	--	--	133
Ebitda at NW EU	$/t	--	--	--	128
Ebitda at east Asia	$/t	189	--	69	4

Argus ammonia freight routes (2Q 2023 basis)







Bontang – east Asia
Point Lisas – east Asia
Point Lisas – NW Europe
Point Lisas – US Gulf
Ras al-Khair – east India
Ras al-Khair – east Asia
Ras al-Khair – west India
Yuzhny – Morocco*
Yuzhny – NW Europe*

We stopped publishing freight rates from Yuzhny following the outbreak of war in Ukraine in Feb 2022

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GAS MARKETS: TTF price volatility steps up as supply concerns intensify

But impact is expected to be short-term, and inventories across NWE remain well above 5-year average

CURRENT

- The Dutch TTF, Europe's primary gas hub, is now seeking equilibrium following a spate of supply shocks. A drop in European LNG send out from 439mn m³/d in May to 370mn m³/d across 1-10 June combined with extended Norwegian maintenance has provided some support to European prices. The July contract increased from $7.31/mn Btu on 2 June to almost $12/mn Btu by 21 June. Price volatility is now at its highest level since December 2022. The measure is calculated by finding the standard deviation of daily price assessments on a one-month rolling basis.
- Europe storage inventories stood at 69pc full by the end of May, with injections of 310mn m³/d, in line with our forecast. Despite the European forward curve contango incentivising front loading storage injections, operators have continued to show some restraint in order to retain the flexibility to inject as the summer develops. Injections across 3Q23 are projected in excess of 200mn m³/d. Under this scenario, European inventories are expected to comfortably reach 90pc full by 1 November.

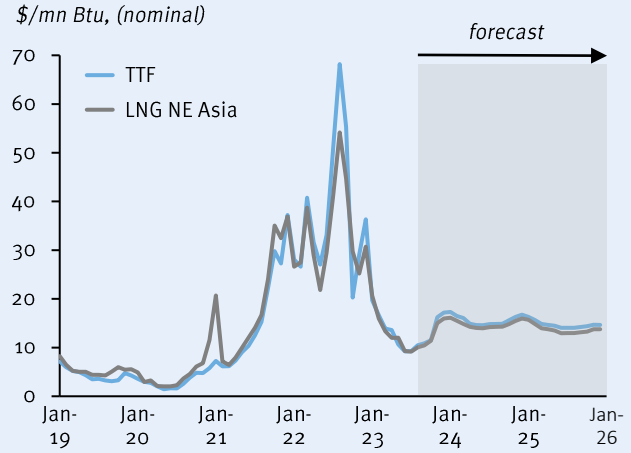
SUMMER '23

- 3Q23 is currently forecast to outturn at $10.20/mn Btu. But a scenario of weaker than anticipated LNG demand from Asia could see prices European prices fall back to below $8/mn Btu over the period. This would provide the necessary incentives to generate increased demand for spot LNG from the northeast Asian power sector. Conversely, if LNG diversions are stronger than we forecast, prices may have to temporarily rise to $14-15/mn Btu to shut off power demand to counter over-incentivised diversions.

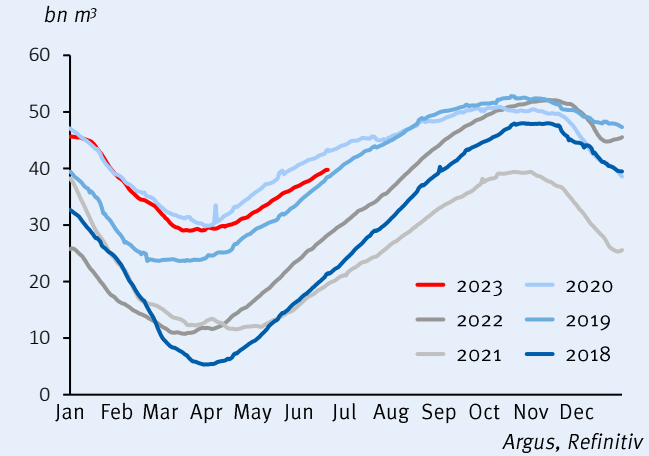
WINTER 23-24

- The fall in prompt prices has also dragged winter 2023-24 lower. While TTF retains a premium to coal switching rates at present, we expect coal prices to increase from current levels as we approach the winter months. TTF and NEA LNG in 4Q23 are currently below the high sulphur fuel oil equivalents and for the entire winter, are below our expectation of the LPG equivalent, all of which support demand for LNG at current market price levels. Continued strong European demand restraint will limit price gains this winter, but our forecast for winter 2023-24 remains at a premium to current market levels.

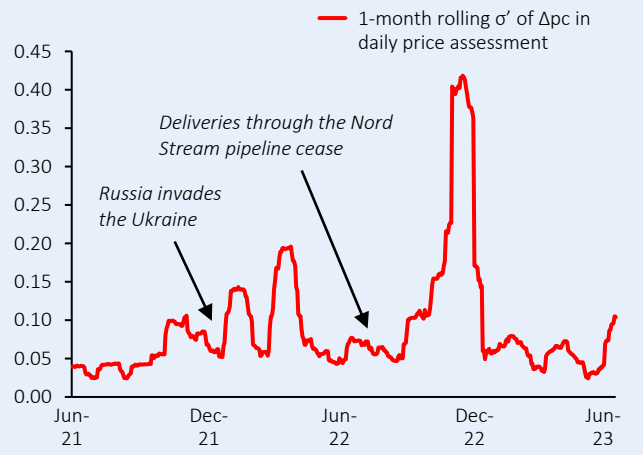
Short-term gas forecasts, 2019-25



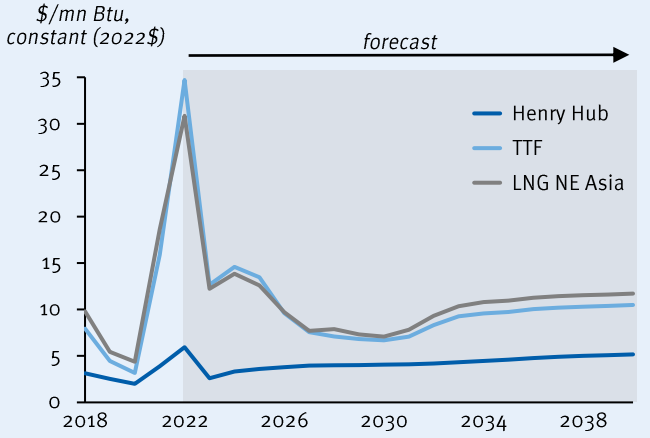
Northwest European gas storage, 2018-23 (ytd)



TTF price volatility, June 2021-23



Long-term gas forecasts, 2018-40



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CRUDE MARKETS: Opec+ cuts of 3.7mn b/d to remain in place until the end of 2024

But stuttering demand growth and rising non-Opec production makes a market deficit in 2H23 unlikely

CURRENT

- North Sea Dated is approaching the $70/bl mark as prices are subjected to sustained downward pressure. Market concerns surrounding recessionary economics continue to impact the balance. Saudi Arabia, the world's second largest oil producer, is expected to sharply cut its output in July. The move comes on top of a broader Opec+ move to limit supply into 2024 as the group seeks to stabilise prices. Under the terms of the agreement, Saudi's energy minister has confirmed that production will be cut by around 10pc. Under similar Opec cuts announced in April 2023, Brent crude surged by around $9/bl, but prices have since retreated.

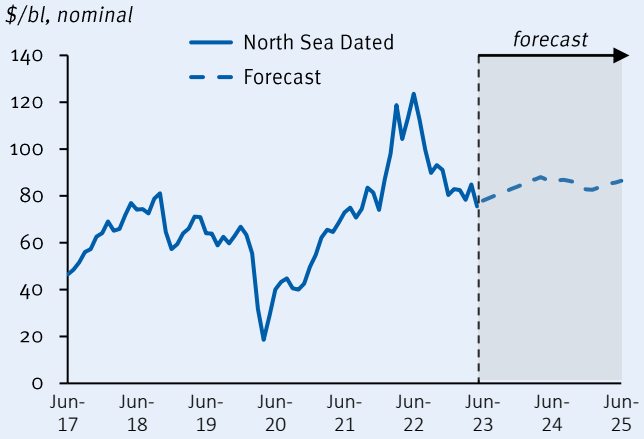
SHORT-TERM

- Faltering demand growth and steadily rising non-Opec production, in our view, makes the development of any significant market deficit unlikely in 2H23. According to the International Energy Agency (IEA), non-Opec+ countries will lead the supply growth over the next year, adding 1.9 mb/d and 1.2 mb/d in 2023 and 2024 respectively. We therefore do not expect any sustained upward price pressure. But if a shortfall in supply were to develop and sentiment turns bullish, the potential for much higher prices could be considerable, given the lack of length in the market. Opec+ can be expected to contain any downside pressure on prices, but there is only a slim chance of the group taking action to halt any sharp move higher following the move by Saudi Arabia to cut production by 1mn b/d in July.

LONG-TERM

- The IEA, in its latest medium-term outlook, forecasts oil demand growing up to 2028 but peaking by 2030. Notably, the peak is set to come five years earlier than slated in the IEA's World Energy Outlook 2022. Opec+ sees things differently. The group's baseline scenario for oil demand forecasts that the peak will come a decade later in 2040, and more than 4mn b/d above the IEA at almost 110mn b/d. The real outcome will depend on many factors that are difficult to predict. Not least the technological advances and policy changes that will determine the pace of energy transition across different parts of an increasingly unequal world. We continue to hold the assumption reduced upstream investment will keep the market balance tight, which will support long-term pricing.

Short-term forecast, North Sea Dated

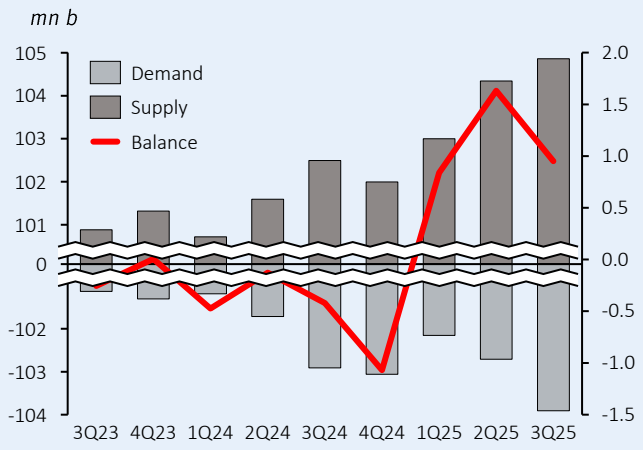


Latest projections for economic growth, 2023-24*

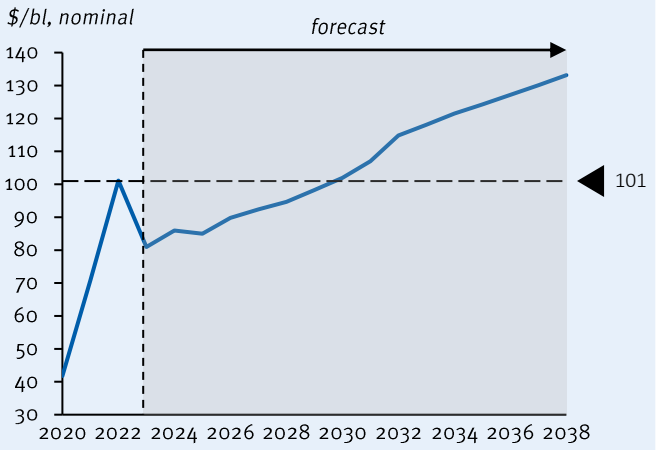
pc	2023			2024		
	IMF	OECD	WB	IMF	OECD	WB
US	1.6	1.6	1.1	1.1	1.0	0.8
Canada	1.5	1.4	1.4	1.5	1.4	1.4
Eurozone	0.8	0.9	0.4	1.4	1.5	1.3
Japan	1.3	1.3	0.8	1.0	1.1	0.7
India	5.9	6.0	6.3	6.3	7.0	6.4
China	5.2	5.4	5.6	4.5	5.1	4.6
Brazil	0.9	1.7	1.2	1.5	1.2	1.4
Russia	0.7	(1.5)	(0.2)	1.3	(0.4)	1.2

*WB = World Bank

Argus crude S/D balance, 2023-25



Long-term forecast, North Sea Dated



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COAL MARKETS: Seaborne market anchored by China as EU demand underwhelms

Newcastle 6,000kcal premiums are still steep, but other price spreads are normalizing

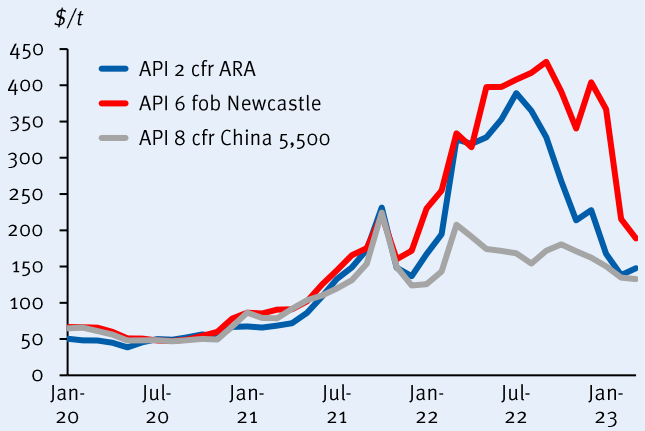
CURRENT

- European coal demand for the summer months remains soft as high levels of natural gas in storage flip economics to favour natural gas in power generation. Chinese and Indian coal consumption growth has been steady, but these countries are absorbing more seaborne supply.
- Fob Newcastle remains at a significant premium to cif ARA prices, although other price differentials are closer to historical averages. Supply growth from Indonesia has been exceptionally strong, but supply from elsewhere has been weak.

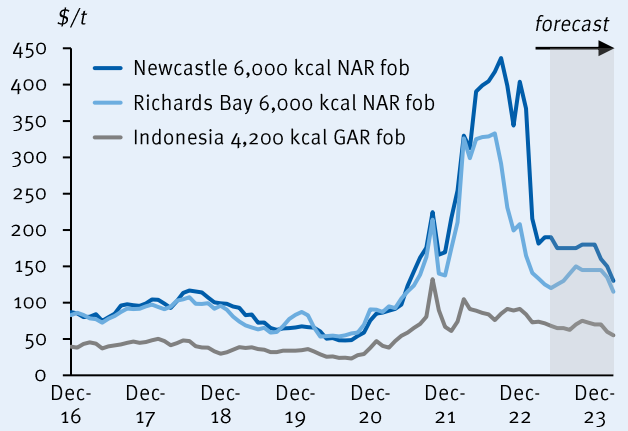
SHORT TO MID-TERM

- Coal supply growth appears adequate to navigate the summer months in key importing countries, assuming average temperatures. There is some uncertainty around the degree to which hydro generation in China may or may not recover.
- The risks for the winter months appear quite different. While achieving adequate natural gas storage in Europe ahead of colder temperatures should be much easier given current levels of storage, its unclear whether supplies will be enough to manage demand after the very mild weather in 2022/23. Chinese stocking demand for coal is also likely to ramp up in September and October, with domestic supply showing signs of strain over the past 9 months.
- Indonesian production is responding to strong margins, but exports elsewhere are struggling. Logistical issues persist at the Richard's Bay coal terminal in South Africa, although lower railings are partly being offset by an expansion in handling capacity at other ports. In the US, exports continue to be hampered by poor rail performance. Australian exports are not bouncing sharply from weather related disruption as productivity deteriorates. Russian exports have been patchy, although avoidance in some markets is starting to erode.
- Price risks are skewed to the upside from current levels towards the end of 2023. In the medium term, prices are set to be elevated compared to previous cycles as rebalancing the Chinese market remains a stretch for domestic producers.

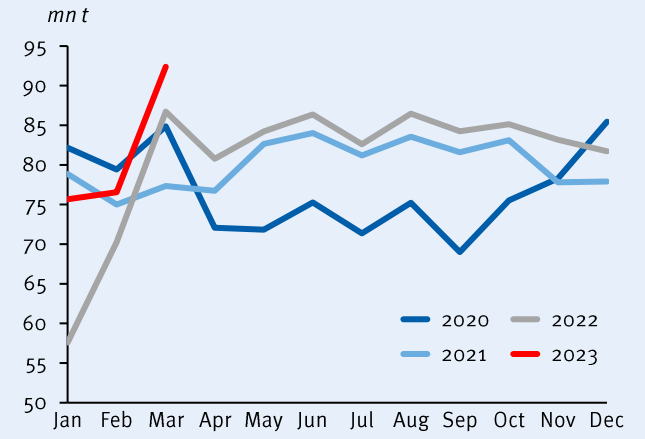
Newcastle fob price premium, 2021-22



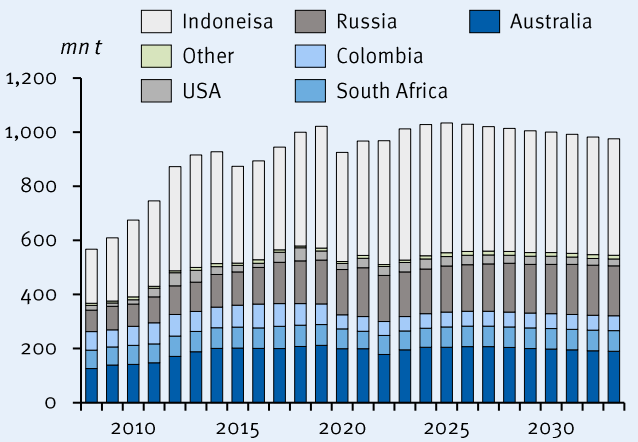
Short-term price forecast, 2016-23



Seaborne thermal coal supply



Thermal coal export availability, 2008-33



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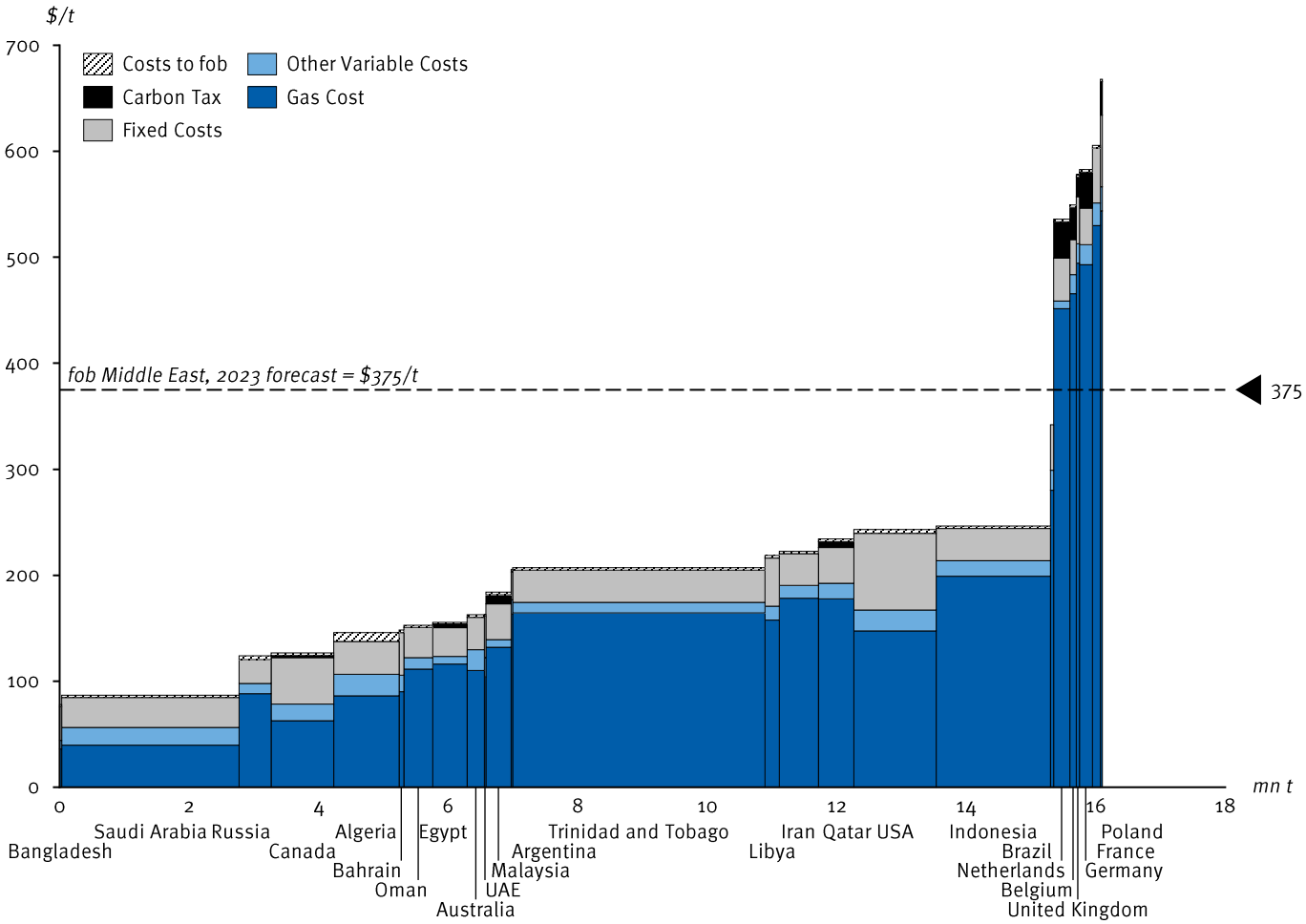
COST CURVE: Argus traded supply curve 2023, fob basis

Swift price correction keeps European producers under pressure despite major reduction in feedstock prices

Export Costs $/t

	Exports, '000 t	Gas Price, $/mn Btu	Gas Cost	OVC	Fixed Costs	Carbon Tax	Cost to fob	Total
Bangladesh	35	1.00	36	8	32	--	2	78
Saudi Arabia	2,735	1.17	40	17	28	--	2	87
Russia	500	2.33	88	10	23	--	4	124
Canada	967	1.77	63	16	44	2	2	127
Algeria	1,006	2.39	86	20	31	--	8	146
Bahrain	75	3.00	90	16	40	--	2	148
Oman	446	3.45	111	11	28	--	2	153
Egypt	534	3.29	116	7	27	3	2	156
Australia	264	3.45	110	19	31	--	2	163
UAE	25	3.00	104	18	38	--	2	163
Malaysia	385	3.80	132	7	34	9	2	184
Argentina	25	4.80	163	14	26	--	2	205
Trinidad and Tobago	3,900	4.67	165	10	30	--	2	207
Libya	218	3.50	158	13	45	--	2	218
Iran	604	5.24	178	12	30	--	2	222
Qatar	546	4.69	178	14	34	6	2	234
USA	1,275	4.24	147	20	72	--	4	243
Indonesia	1,762	6.00	199	15	30	--	2	246
Brazil	50	7.00	280	19	43	--	--	342
Netherlands	250	13.29	452	7	41	34	2	536
Belgium	100	13.69	465	18	33	30	2	549
United Kingdom	50	14.32	494	18	44	19	2	578
Germany	200	13.69	493	19	35	34	2	583
France	125	13.94	530	22	52	--	2	605
Poland	30	14.69	544	23	67	32	2	668

Export cost curve, 2023 (fob/fca/daf basis)



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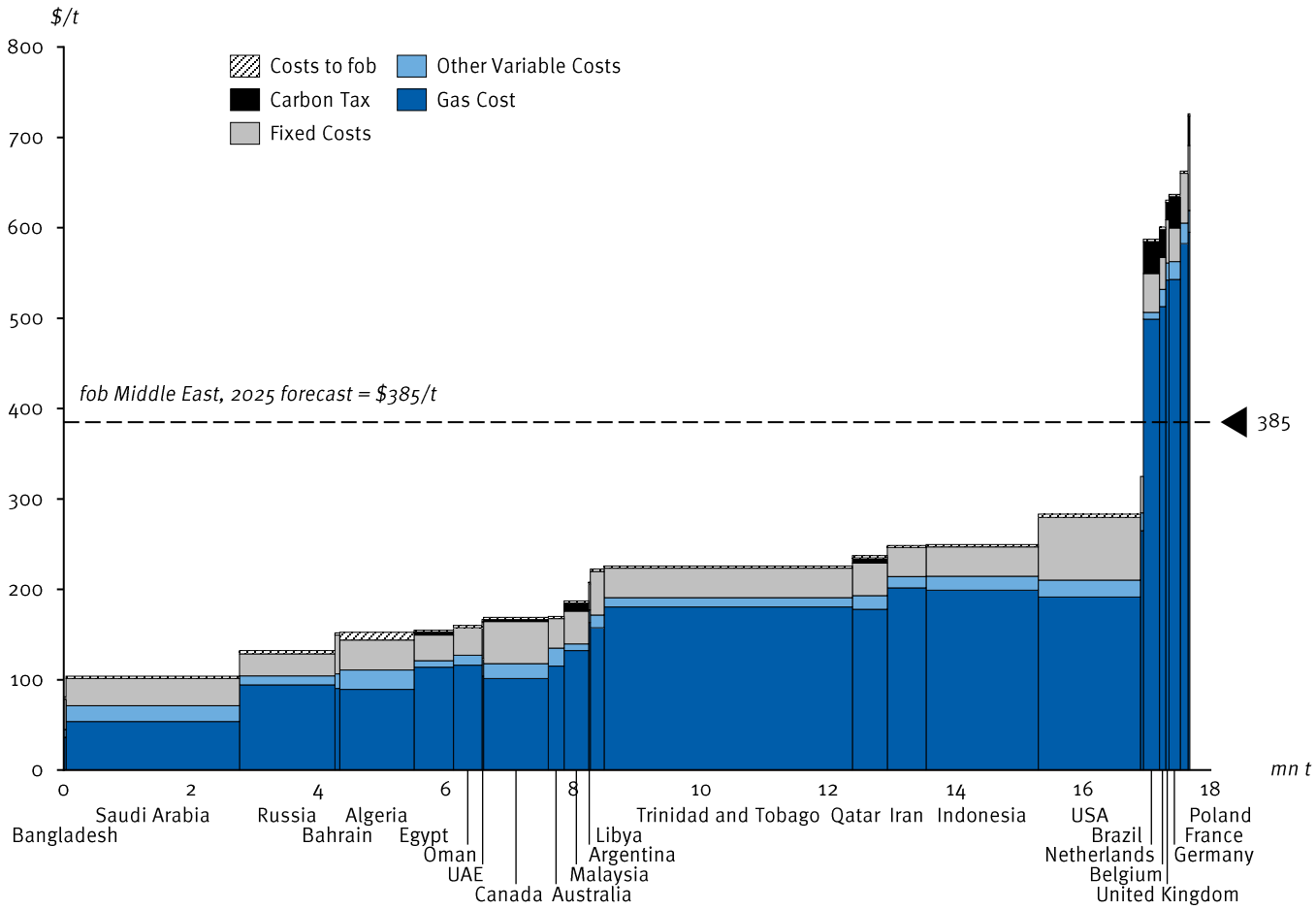
COST CURVE: Argus traded supply curve 2025, fob basis

Pressure on European producers remains as uptick in supply keeps a lid on ammonia prices

Export Costs $/t

	Exports, '000 t	Gas Price, $/mn Btu	Gas Cost	OVC	Fixed Costs	Carbon Tax	Cost to fob	Total
Bangladesh	35	1.00	36	9	34	--	2	81
Saudi Arabia	2,725	1.58	54	17	30	--	2	104
Russia	1,500	2.49	94	10	24	--	4	132
Bahrain	75	3.00	90	16	43	--	2	152
Algeria	1,164	2.48	89	21	33	--	8	152
Egypt	623	3.22	114	7	28	4	2	155
Oman	446	3.59	116	11	30	--	2	160
UAE	25	3.00	104	19	41	--	2	166
Canada	1,016	2.86	101	16	46	2	2	169
Australia	247	3.59	115	20	33	--	2	170
Malaysia	385	3.80	132	8	36	9	2	187
Argentina	25	4.80	163	14	28	--	2	208
Libya	218	3.50	158	14	48	--	2	222
Trinidad and Tobago	3,900	5.12	180	10	32	--	2	226
Qatar	546	4.69	178	15	36	6	2	237
Iran	611	5.93	201	13	32	--	2	248
Indonesia	1,762	6.00	199	15	33	--	2	249
USA	1,600	5.51	191	19	70	--	3	283
Brazil	50	7.00	265	20	40	--	--	325
Netherlands	250	14.68	499	7	43	35	2	587
Belgium	100	15.08	513	19	35	31	2	601
United Kingdom	50	15.71	542	19	47	19	2	630
Germany	175	15.08	543	20	37	35	2	637
France	125	15.33	583	22	55	--	2	663
Poland	30	16.08	595	24	72	33	2	726

Export cost curve, 2025 (fob/fca/daf basis)



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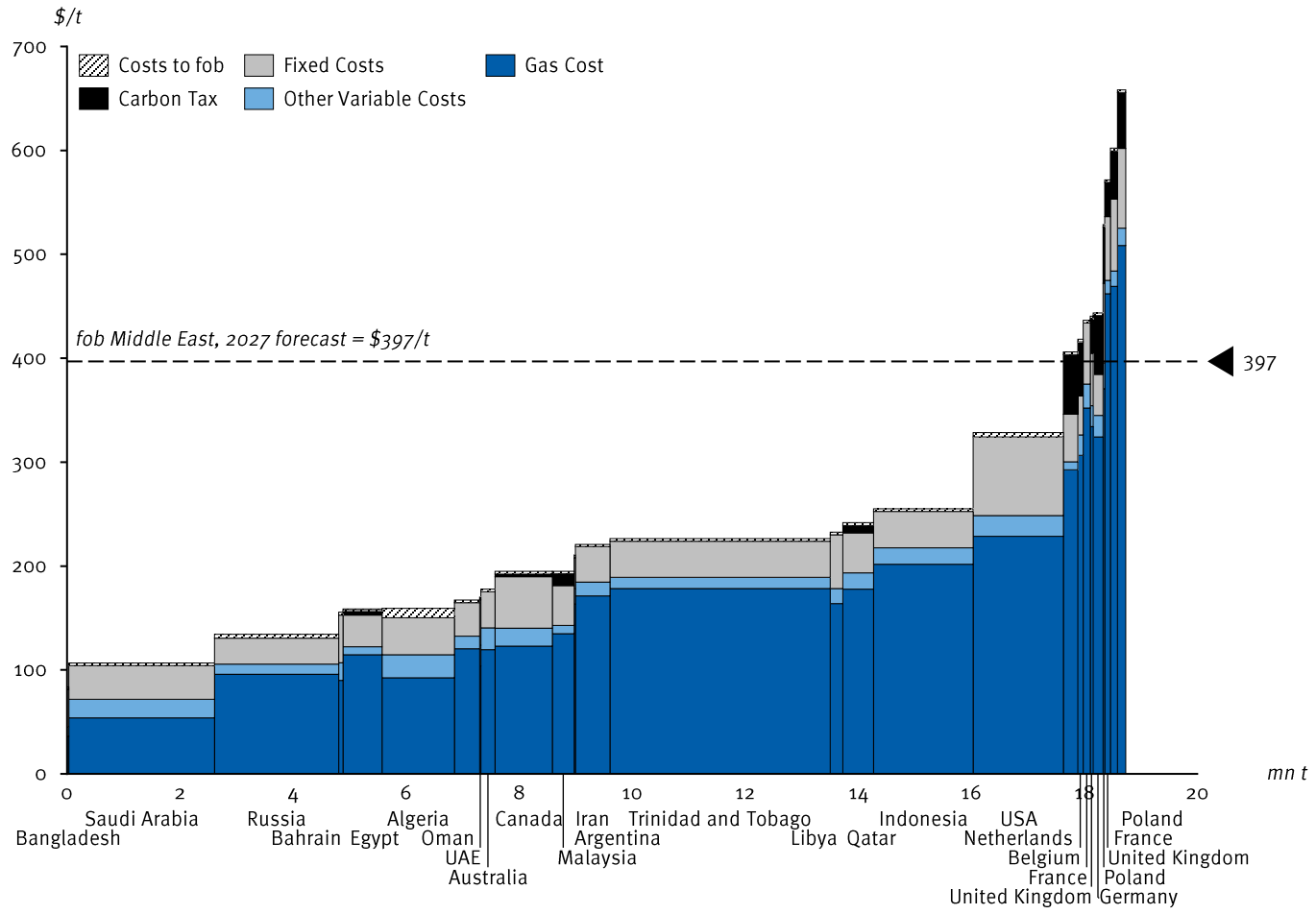
COST CURVE: Argus traded supply curve 2027, fob basis

European production regains some viability, for select countries, as feedstock prices become workable once more

Export Costs $/t

	Exports, '000 t	Gas Price, $/mn Btu	Gas Cost	OVC	Fixed Costs	Carbon Tax	Cost to fob	Total
Bangladesh	35	1.00	36	9	36	--	3	84
Saudi Arabia	2575	1.58	54	18	32	--	3	107
Russia	2200	2.53	96	10	25	--	4	134
Bahrain	75	3.00	90	17	46	--	3	155
Egypt	691	3.24	115	8	31	4	2	159
Algeria	1282	2.57	92	22	36	--	9	159
Oman	446	3.73	120	12	32	--	3	167
UAE	25	3.00	104	20	44	--	3	170
Australia	247	3.73	119	21	35	--	3	178
Canada	1013	3.47	123	17	49	3	3	195
Malaysia	385	3.88	135	8	38	11	3	195
Argentina	25	4.80	163	15	30	--	3	211
Iran	611	5.04	171	13	34	--	2	221
Trinidad and Tobago	3900	5.06	178	11	35	--	3	226
Libya	218	3.64	164	14	52	--	3	233
Qatar	546	4.69	178	16	38	7	3	242
Indonesia	1762	6.08	202	16	35	--	3	255
USA	1600	6.60	229	20	76	--	4	328
Netherlands	250	8.61	293	8	46	57	3	406
Belgium	100	9.01	306	20	38	52	3	418
France	125	9.26	352	23	59	--	3	437
United Kingdom	50	9.64	334	20	51	33	3	440
Germany	175	9.01	324	20	39	57	3	444
Poland	30	10.01	370	25	77	54	3	528

Export cost curve, 2027 (fob/fca/daf basis)



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0	Executive Summary
1	Demand
2	Supply
3	Trade
4	Costs and Inputs
5	Balance and Prices
6	Green Ammonia
7	CF Industries, USA

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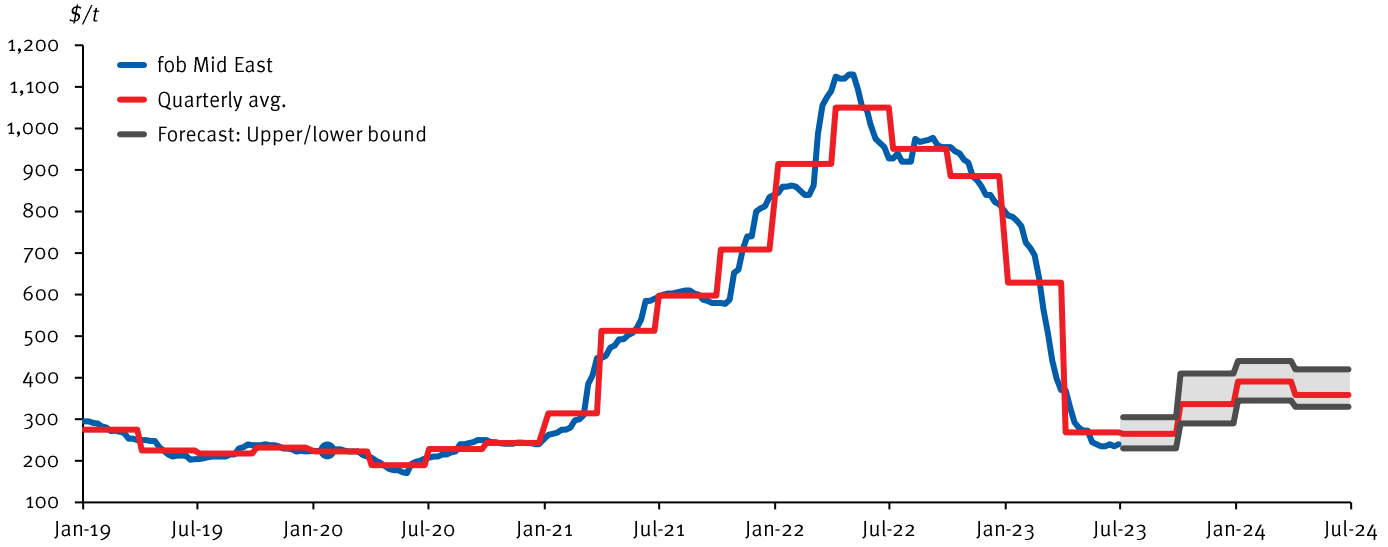
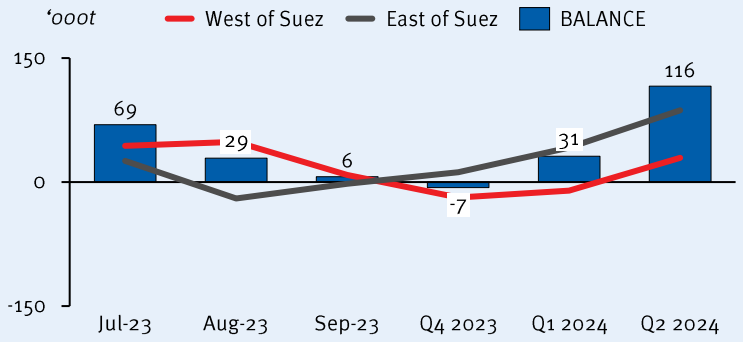
OUTLOOK: Ammonia prices find a floor in the east, pressuring marginal producers...

...price-, energy- and macro-driven demand destruction, and high inventories allowed for the swift price correction

RUSSIA	Eurochem has shipped its first cargoes from its new seaborne terminal in Ust-Luga. Currently one 23,000t cargo a month appears to be on offer from the terminal. We expect this to increase to two from 2024.
MID EAST	New capacity and secure gas supplies have allowed for significant growth in Omani and Iranian trade, respectively, in 2023. Plentiful Mid East supply to continue to weigh on east of Suez benchmarks.
USA	Exports from the Gulf Coast Ammonia 1.3mn t/yr plant are now not expected until the fourth quarter at the earliest. New supply will see east and west benchmarks closer aligned as in previous years.
TRINIDAD	Trinidad's export position looks set to recover on 2022 levels following less significant gas curtailments to producers, and despite reduced America's demand. Exports still to come in under 4mn t.
EAST ASIA	East Asian demand picture is fragmented. Severe lack of industrial demand in Taiwan and South Korea is offsetting China's return following ammonia's price retreat to below $500/t cfr.
EUROPE	Macro pressures are subduing industrial demand, and the sharp fall in TTF prices has improved output on the continent. Prices still favour imports over production, and producers still face winter pressure.
INDIA	DAP production improves on lower raw material costs, higher demand and new capacity from PPL, Greenstar, et al, reducing domestic merchant availability and boosting imports.
MOROCCO	High prices and inventories, and ammoniated phosphate production contraction saw import demand fall significantly in 1H23 versus a year prior. Full year trade to be down on 2022 by 0.4mn t.



Short-term S/D balance



2023 Ammonia price drivers

Indicator	Value	Δ	Signal
New capacity	1.0mn t/yr	-0.1mn t/yr	Concern
Closures (excl. China)	0.8mn t/yr	-0.1mn t/yr	Supportive
Demand growth	-0.3mn t/yr	+4.0mn t/yr	Concern
Chinese imports	0.7mn t/yr	+0.5mn t/yr	Supportive
TTF gas price	$13.3	-$24.3	Concern
Newcastle fob	$178	-$181	Concern
EM GDP growth	3.9pc	-0.1pc	Concern

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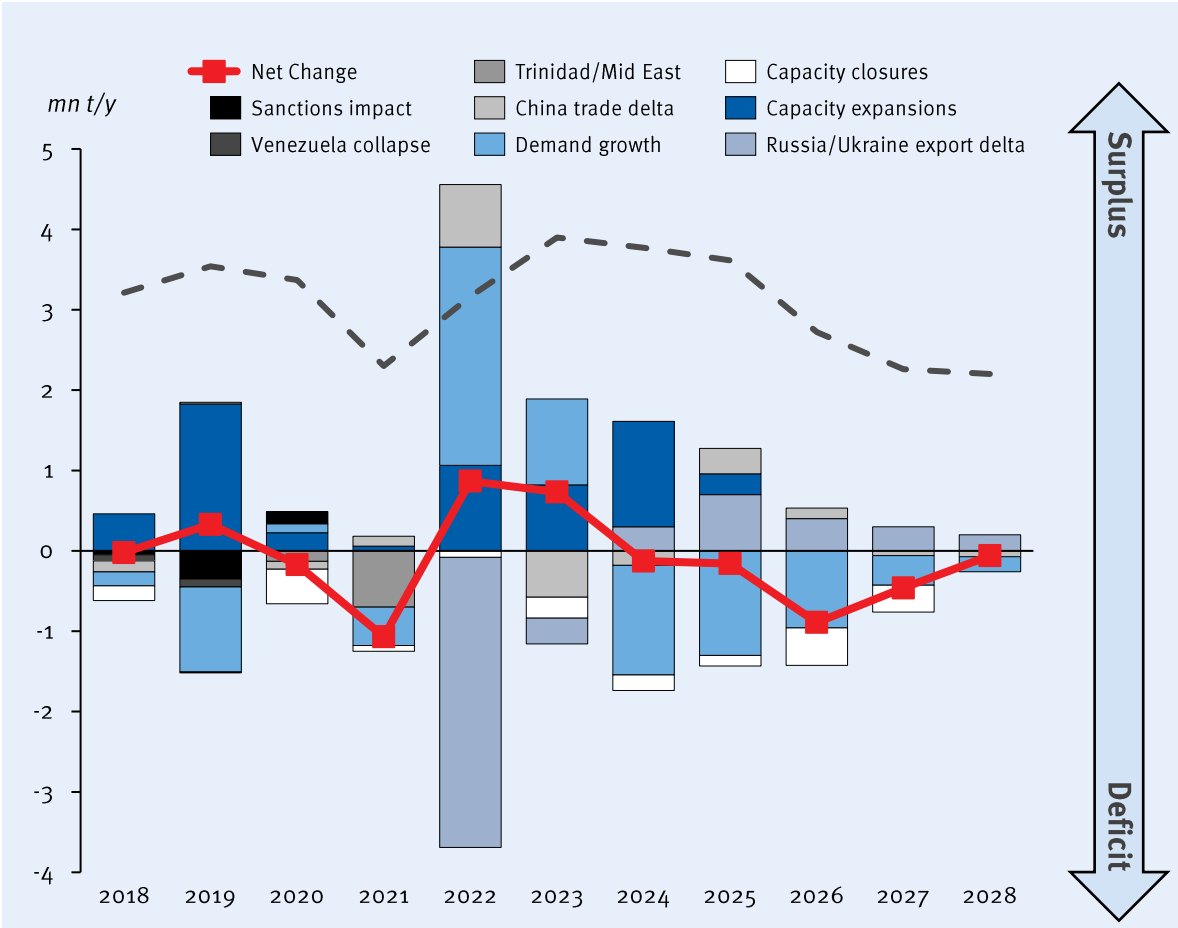
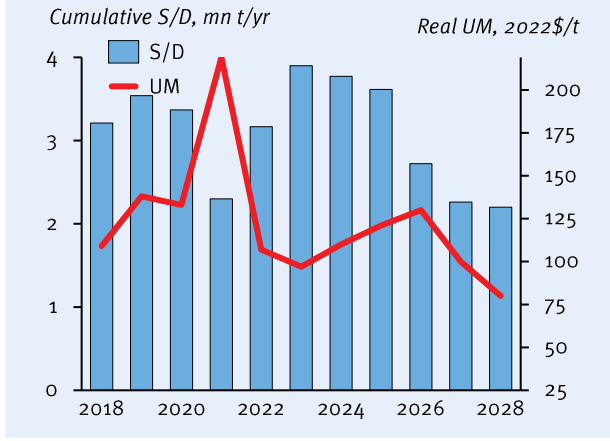
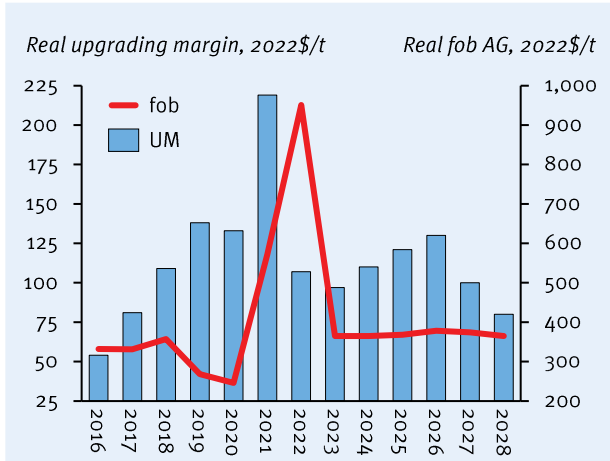
S/D BALANCE: Major ind. and phos. demand retraction keeps market in oversupply...

...lower prices, downstream projects and limited merchant projects will provide market stability in the coming years

2022/23	**RUSSIA-UKRAINE CONFLICT**
▼	Ramp up at SMC, Ma'aden online
▼	Heavy China, EU & Africa demand retraction
▲	Sanctions hit Russia exports
▲	Gas prices trade at +$60/mn Btu
2024/25	**DEMAND RECOVERY OFFSETS NEW SUPPLY**
▲	Indian and Moroccan phos. expansions
▲	Ind. demand recovery in EU and Asia
▼	Russia exports through new dom. terminals
▼	GCA's 1.3mn t/yr plant ramps up
2026/27	**SHIFT TO SURPLUS**
▼	Gradual increase in Russian exports
▲	Ma'aden ramps up phos expansions
▲	Continued industrial demand recovery
▲	Demand returns to pre-war levels
✖	**RISKS TO FORECAST**
▲	Delay to Russian exp. projects
▲	Delays to new supply projects
▼	Higher Russian exp. than forecast
▼	Ind. demand recovers at slower rate







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AMMONIA LRMC: The urea LRMC is the basis of all of our long-term N price forecasts

The inflationary period the market has been through lifted costs in the base-year creating a deflationary forecast

UREA SETS THE NITROGEN LRMC

We do not think it is correct to model distinct LRMCs for different nitrogen products. There is a real danger that in producing one LRMC for urea, and one LRMC for ammonia, we could create a divergent set of real cost increases. These could either model an arbitrage of convergence, or divergence, in perpetuity, which if extended to 2050, could create spurious outcomes that the market does not allow. Should the LRMC of ammonia and urea converge too closely and ultimately cross, it would suggest that standalone ammonia plants would always invest in upgrading production into urea, rather than producing and selling ammonia as standalone units. Alternatively, should the LRMC of ammonia and urea diverge in the long run, then it would suggest all investment capital should flow to ammonia and that all urea plants would close in favour of a nitrogen market supplied entirely by ammonia. Clearly this has never happened, and these are most unlikely outcomes in the long run. Instead, flexible nitrogen plants throttle urea production in favour of ammonia sales when urea and ammonia prices converge, until the two prices revert towards their long-run equilibrium allowing urea production to increase again.

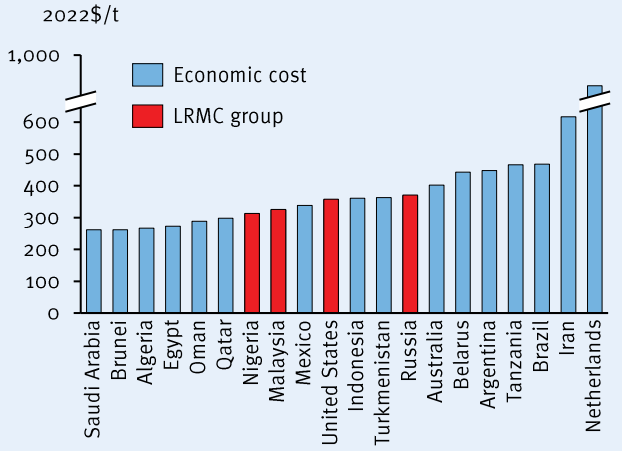
UREA & AMMONIA

It is this market response to divergent price signals that keeps the prices of urea and ammonia range bound and negates the possibility of separate LRMCs for ammonia and its other straight nitrogen derivatives. We take the position that there can logically be only one LRMC for nitrogen. And since urea is the largest and most liquid market for nitrogen, we can say with some certainty that across the business cycle, nitrogen finds its value in urea, with value of other nitrogen products like ammonia following the pricing direction of the urea market. Consequently, urea is used to model the LRMC of nitrogen, and therefore, the LRMC of ammonia.

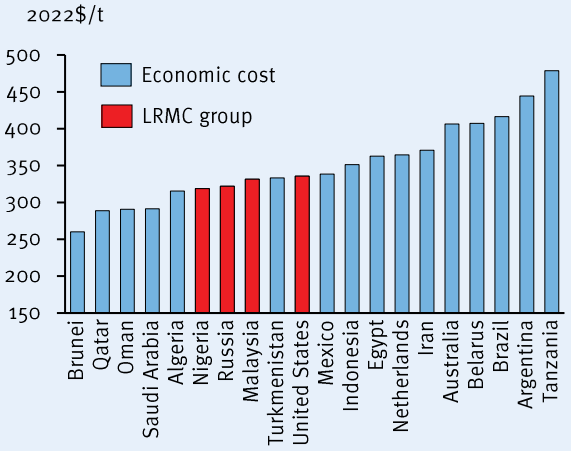
ECONOMIC COSTS

To estimate the LRMC, the full economic costs of urea production must be modelled. This prices in a new production asset's access to raw materials, to markets and to capital. It is our belief that every successful commodity investment needs to have access to raw material, markets, and capital at reasonable rates, and that our calculated economic cost models the cost or rate at which this is achieved. Economic costs are equal to the sum of operating costs, value-in-use realisations, and the capitalised investment costs and returns. We assume that the LRMC of new production in each country is equivalent to the economic cost. We select a group of these country-level economic costs and take their arithmetic mean to calculate the industry's LRMC.

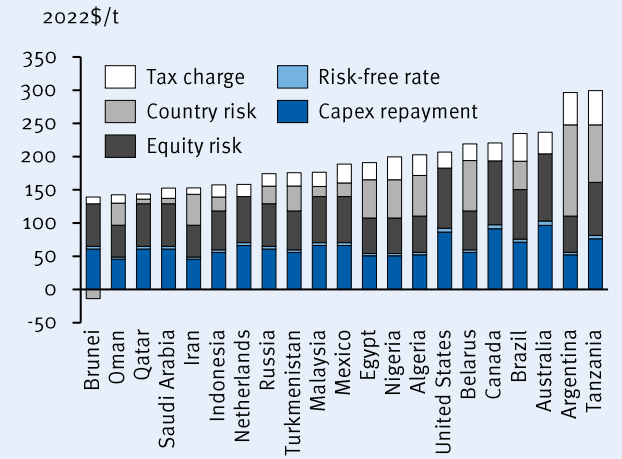
Economic cost of urea production in 2022



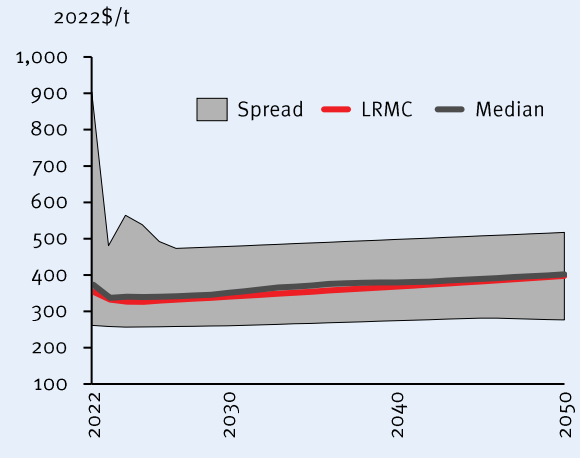
Economic cost of urea production in 2030



Economic cost breakdown in 2030



Urea LRMC forecast and country spread



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AMMONIA LRMC: Our urea LRMC models economic costs from OPEX, VIU and WACC

We select a sample group from countries' economic costs and use the arithmetic mean as a proxy for urea's LRMC

OPERATING EXPENSES

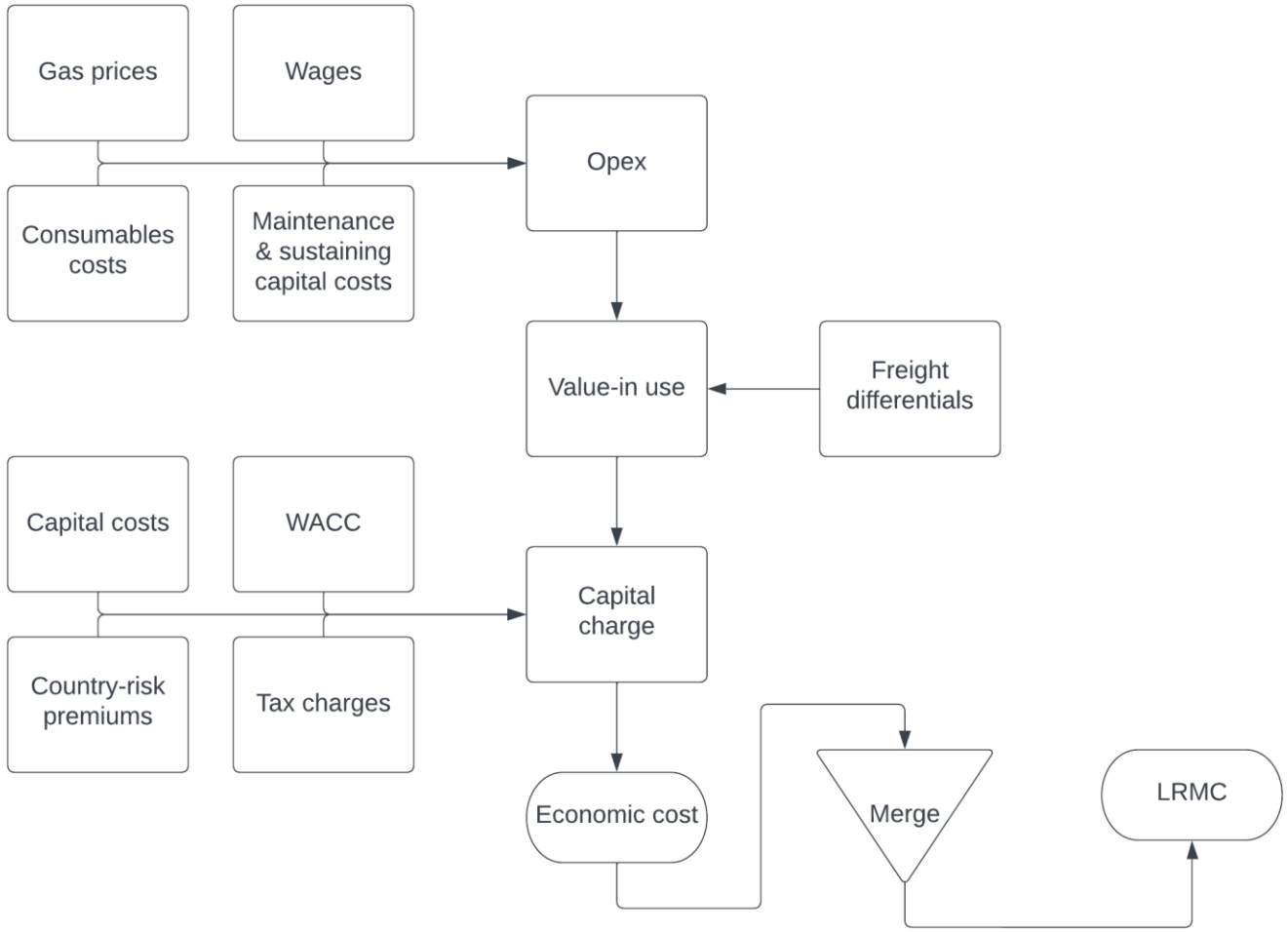
When calculating the operating costs of our generic, future urea plants, we first need to ascertain the cost of incremental gas or coal supplies to the urea industry in each country. To do this, we begin by estimating current, state-of-the-art energy requirements of a new, greenfield, single-train ammonia-urea plant. The process we model for our new capacity is assumed to be steam-methane reforming (SMR). We assume a 3,800t/d urea plant downstream of a 2,200tpd ammonia plant operating for 340 days. (While 340 days of annual operation may seem conservative for a new plant, especially in its early years, we are aiming to average its operating days over 25 years.)

VIU NETBACK ADJUSTMENT

To calculate our base-year LRMC we need to adjust all our generic urea projects' operating costs for each project's access to markets. To do this we have conducted a normalising exercise to mark each project's costs to an fob Middle East (granular) basis. There are two main methods to do this, depending on whether the project is selling into its own domestic market or exporting into the seaborne, traded urea market. A project selling into its own market will generally create a cost discount equivalent to the higher (relative to fob Middle East) factory gate netbacks typically available to producers in countries with large, domestic urea markets. Whereas producers in exporting countries, especially those located inland and not at an export port, typically generate a cost penalty equivalent to the lower netbacks on offer to them.

CAPITAL CHARGES

Capital charges are equivalent to the minimum amount of margin each tonne of urea will need to generate to recover the principal equity investment, cover the project's debt service (loan principal repayment and compound interest charges) as well as provide returns to equity investors at a level that offsets all the systematic and particular risks associated with investing in this new urea capacity. Our calculated capital charge is based on three main inputs: capital intensity; risk adjusted WACC; and the marginal corporate tax rate.



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AMMONIA LRMC: The urea LRMC is converted by setting a long-run upgrading margin

The upgrading margin is set at the ten year average of $100/t (constant 2022$) and inflated over the forecast

PREMIUM PRICING

Historically ammonia has priced at a discount to urea on a tonne nitrogen (tN) basis. Part of this discount is driven by the ammonia molecule's unfavourable qualities—it is a toxic gas at room temperature. Transport requires refrigeration and careful handling; freight is considerably more costly as specialized gas carriers also used to ship LNG are required. This discount comes despite ammonia's higher per tonne nitrogen content. The discount is also because urea is a value-adding derivative of ammonia. It is therefore essential that urea provide a higher return per unit N than ammonia, otherwise there would be no incentive to develop urea plants and upgrade ammonia. The level of the discount has varied over time and has averaged 59pc over the last 17 years we have data for at fob Middle East.

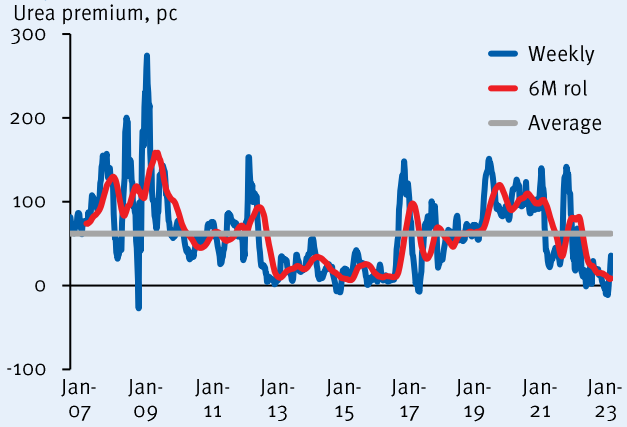
UPGRADING MARGIN

An alternative method to fixing urea's premium relative to ammonia over the long run is to use urea's upgrading margin over ammonia. This method uses a real number—the upgrading margin—rather than the abstraction of percentages. The benefit of using a real number here is that it can be inflated with the same basket of effective inflation generated by our urea LRMC model, thus avoiding this issue where an arbitrage develops from a fixed percentage premium over the long term. The upgrading margin is the simple residual value when the market value of urea's ammonia content is subtracted from the market value of urea. Essentially urea's value-added. This is the value required to incentivise the production of urea at the industry's margin, and would need to cover all the energy, consumable and labour costs to upgrade ammonia into urea. It would also need to provide an incentivising margin to offset the opportunity cost on the current and future capital tied up in the urea plant (future because regular sustaining capital investments will be needed to keep the asset operational).

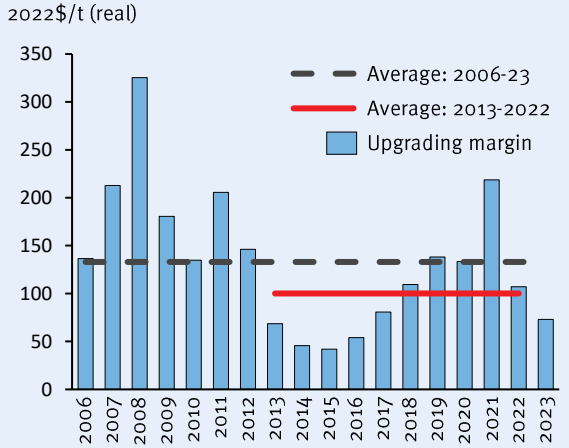
GREY AMMONIA LRMC

We have opted for a 10-year average of the real upgrading margin to be used to calculate our long-run ammonia value. A value that equates to $100/t (2013-22). The upgrading margin is subtracted from the LRMC of urea in each year with the product of the subtraction then divided by 0.58 (the amount of ammonia in a tonne of urea). This provides our proxy for the ammonia LRMC. We use the effective basket of urea inflation from our urea LRMC to inflate the real long-run upgrading margin. This creates a gradual increase in the cost of producing ammonia and holds urea's nitrogen premium over ammonia constant on a percent nitrogen basis. We believe that this provides a more nuanced equilibrium than the more arbitrary fixed percent premium or fixed real upgrading margins.

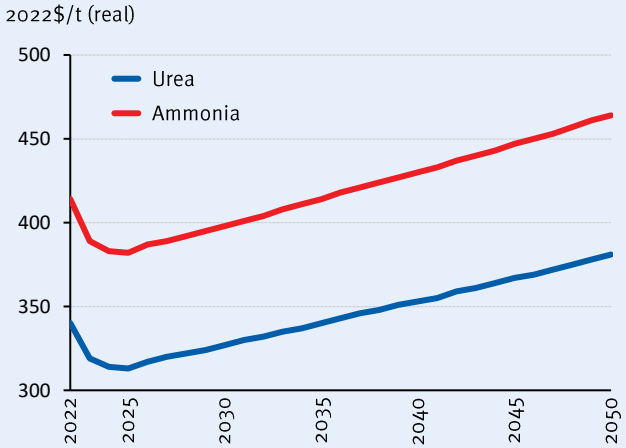
Urea's N premium over ammonia averages 62pc



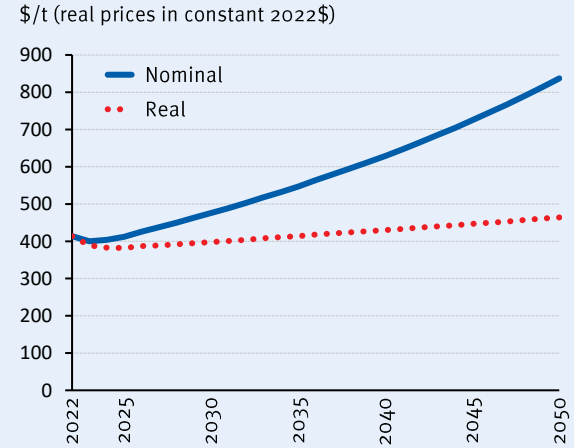
Urea's upgrading margin at fob ME is $100/t



Real LRMC comparison: Urea vs. ammonia



Ammonia LRMC forecast at fob Middle East



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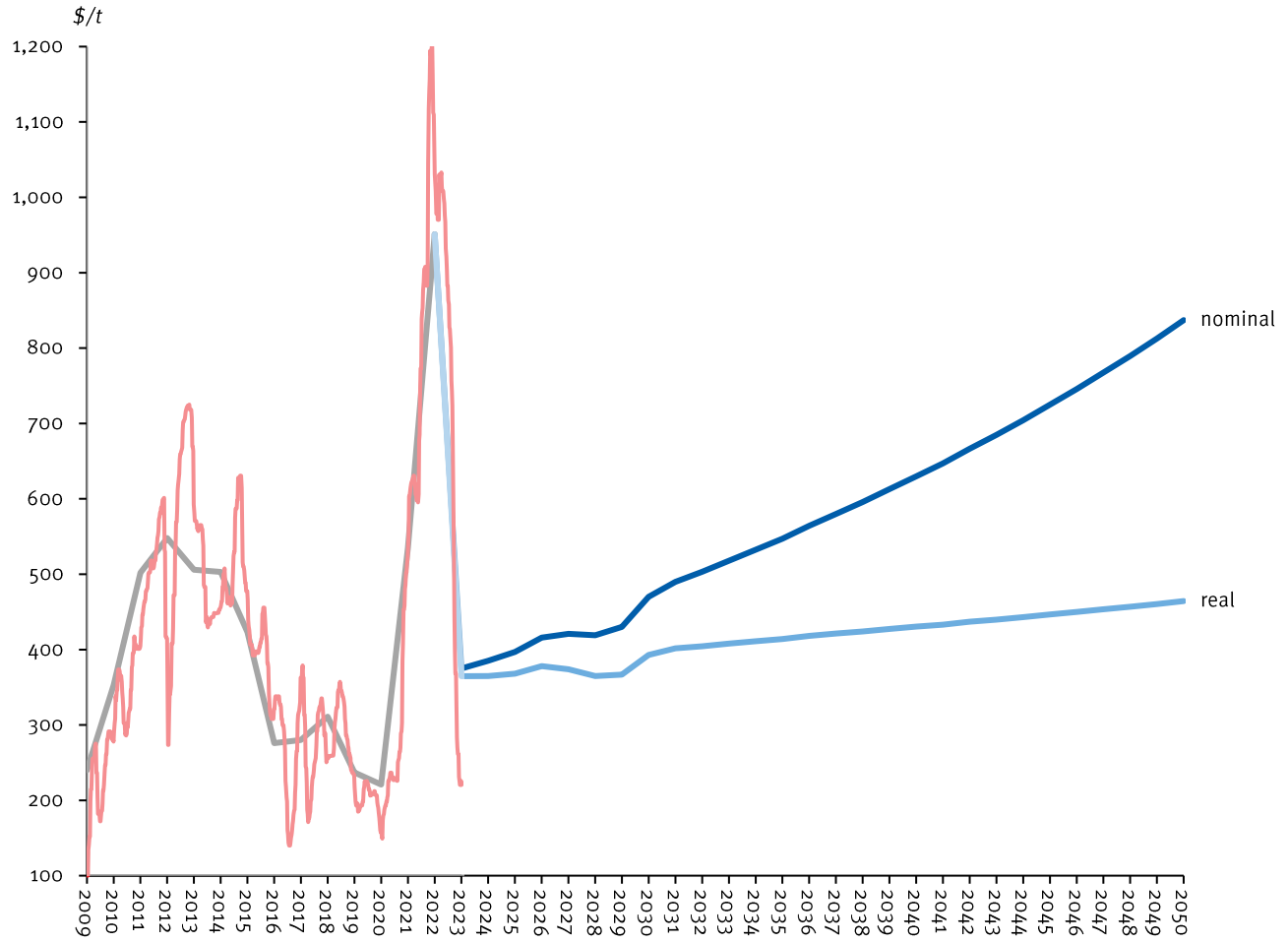
PRICES: Benchmark prices, 25-year outlook

Prices correct on widespread demand destruction and easing of TTF; gas to still provide medium-term price support

Ammonia benchmark prices, 2022-2047 *$/t, nom.*

	Mid. East	Pivdenny	Baltic	USG/ Caribbean	Tampa	Far East	India	N. Africa	NW Europe	NW Europe
	fob	fob	fob	fob	cfr	cfr ex. Taiwan	cfr	cfr	cfr Excl. duty	cfr Incl. duty
2022	951	1,109	1,283	1,115	1,162	961	934	1,110	1,182	1,248
2023	375	n/a	n/a	396	458	413	399	413	443	452
2024	385	n/a	n/a	417	464	429	412	412	455	480
2025	397	n/a	n/a	412	456	444	423	429	468	494
2026	425	n/a	n/a	440	485	476	452	458	498	526
2027	421	n/a	n/a	436	482	472	448	455	495	523
2028	409	n/a	n/a	425	472	462	437	444	485	512
2029	430	n/a	n/a	446	494	484	458	465	508	535
2030	467	n/a	n/a	483	532	521	495	503	546	576
2031	490	n/a	n/a	506	556	546	519	526	571	602
2032	503	n/a	n/a	520	571	560	533	540	586	618
2033	518	n/a	n/a	535	587	576	548	556	602	635
2034	532	n/a	n/a	550	603	592	563	571	618	652
2035	547	n/a	n/a	565	619	607	579	587	635	669
2036	564	n/a	n/a	582	638	626	596	605	653	689
2037	580	n/a	n/a	598	655	643	613	621	671	708
2038	596	n/a	n/a	614	672	660	629	638	689	727
2039	613	n/a	n/a	632	691	678	647	656	708	747
2040	630	n/a	n/a	649	710	697	665	674	727	767
2041	647	n/a	n/a	667	728	715	683	692	746	787
2042	667	n/a	n/a	687	750	736	703	712	767	810
2043	685	n/a	n/a	705	770	756	722	731	788	831
2044	704	n/a	n/a	725	791	777	742	752	809	854
2045	725	n/a	n/a	747	813	799	764	774	832	878
2046	746	n/a	n/a	768	836	821	785	795	855	902
2047	768	n/a	n/a	790	860	845	808	818	880	928

Ammonia price forecast, 2021-50



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0	Executive Summary
1	Demand
2	Supply
3	Trade
4	Costs and Inputs
5	Balance and Prices
6	Green Ammonia
7	CF Industries, USA

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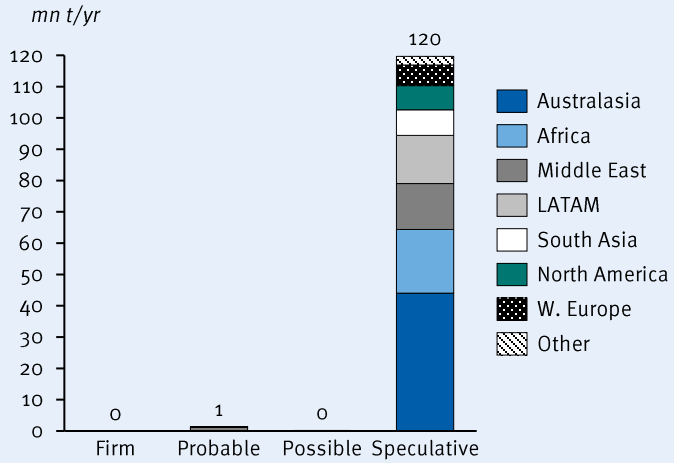
Global green ammonia capacity forecast, 2022-37

African planned capacity exceeds Middle Eastern; Australia remains top of capacity list

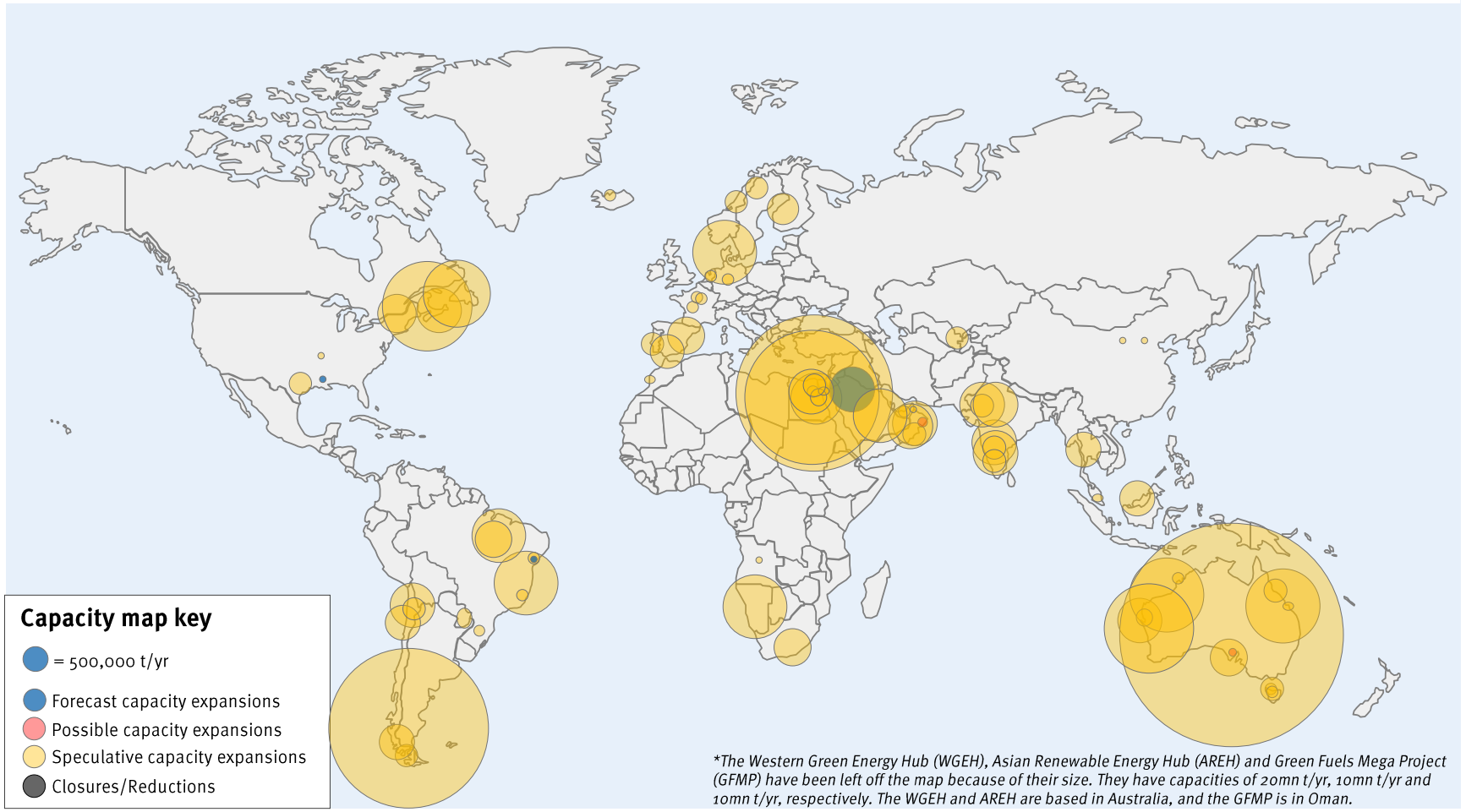
Capacity additions shown here are those that will affect the merchant ammonia market. Closures, therefore, indicate either the permanent shutdown of a plant, a reduction in gross capacity or a reduction in merchant ammonia capacity as downstream capacity is increased. The closures included in our forecast represent net reductions in merchant ammonia capacity as companies look to increase downstream processing capacity. As upgrading margins swing out of favour of the merchant ammonia market, producers look to decrease their exposure to the merchant ammonia market.

The timeline below shows the potential capacity that would come on line if all of the projects that we are tracking continue to progress. These are not all included in our forecast.

Green ammonia capacity by rating



Merchant ammonia capacity expansions



**The Western Green Energy Hub (WGEH), Asian Renewable Energy Hub (AREH) and Green Fuels Mega Project (GFMP) have been left off the map because of their size. They have capacities of 20mn t/yr, 10mn t/yr and 10mn t/yr, respectively. The WGEH and AREH are based in Australia, and the GFMP is in Oman.*

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Green ammonia capacity tracker

Pilot projects, unless in our forecast, and those with unknown capacities have not been included in the following slides

Project specifications									Forecast	Project milestones							Start-up	
	Project location			Gross capacity		Merchant	Grey impact	Major product	Renewable source	Rating	Contracts			Progress indicators				Project completion date	
Company	Project/site	Stage	Country	t/d	'000 t/yr	'000 t/yr	Y/N				EPC	Renewables	Electrolyser	Financing	Groundwork	Construction	Commissioning	Original target	Argus forecast
Fertiberia	Puertollano	Pilot	Spain	60	20	-	N	Nitrates	S	Firm	In place	In place	In place	In place	Complete	Complete	Complete	2021	2022
Total FIRM CAPACITY					**20**	**-**													
Unigel	Bahia	Phase 1	Brazil	174	60	60	N	Merchant	W	Probable	In place	In place	In place	In place	Under way	Under way	Not started	2023	2024
Skovgaard Invest	Western Jutland	Pilot	Denmark	14	5	5	N	Merchant	S, W	Probable	In place	In place	In place	In place	Under way	Under way	Not started	2023	2024
ACWA, NEOM, AP	Neom	Full scale	Saudi Arabia	3,500	1,208	1,208	N	Merchant	S, W	Probable	In place	No supply	In place	In place	Under way	Under way	Not started	2023	2024
CF Industries	Donaldsonville	Pilot	US	58	20	20	Y	Merchant	G	Probable	In place	In place	Agreed	In place	Under way	Under way	Not started	2023	2024
Total PROBABLE CAPACITY					**1,293**	**1,293**													
Total capacity forecast (FIRM + PROBABLE)					**1,313**	**1,293**													
H2U, Casale	Port Bonython	Phase 1	Australia	120	40	40	N	Merchant	S, W	Possible	In place	In place	No supply	In place	Not started	Not started	Not started	4Q22	2024
YURI	Dampier	Phase 0	Australia	11	4	4	Y	Merchant	S	Possible	In place	In place	No supply	In place	Not started	Not started	Not started	1H23	2024
ACME, Scatec	Duqm	Phase 1	Oman	290	100	100	N	Merchant	S	Possible	In place	In place	No supply	No finance	Not started	Not started	Not started	2025	2025
Total POSSIBLE CAPACITY					**444**	**444**													
Minbos	Minbos Angola	Full scale	Angola	320	110	110	N	LDAN/CAN	H	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Amp Energy	AmpX	Full scale	Australia	14,493	5,000	5,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028
bp Australia	GERI	Full scale	Australia	2,900	1,000	1,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2029	Post 2028
CIP	Murchison	Full scale	Australia	5,797	2,000	2,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Clean Holdings,CAC-H2	Bundaberg	Full scale	Australia	87	30	30	N	Merchant	B	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Q4 2023	2025
Fortescue Future Ind.	FFI	Full scale	Australia	725	250	250	N	Merchant	n/k	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
H2U	Gladstone	Full scale	Australia	4,800	1,656	1,656	N	Merchant	S,W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
H2U, Casale	Eyre Peninsula	Full scale	Australia	2,400	800	800	N	Merchant	S, W	Specul.	In place	In place	No supply	In place	Not started	Not started	Not started	Post 2028	Post 2028
Idemitsu et al.	HyNQ	Full scale	Australia	1,449	500	500	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Incitec Pivot	Gibson Island	Full scale	Australia	800	280	280	N	Merchant	n/k	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	2025
AREH	AREH	Full scale	Australia	28,986	10,000	10,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
WGEH	WGEH	Full scale	Australia	57,971	20,000	20,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Kinara Power	Project Astra	Full scale	Australia	1,739	600	600	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028
Origin Energy	Bell Bay	Full scale	Australia	1,220	420	420	N	Merchant	G	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	mid-2020s	Post 2028
Province Resources	HyEnergy	Full scale	Australia	870	300	300	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Queensland Nitrates	QNP	Full scale	Australia	10	20	-	N	Nitrates	G	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Woodside Energy	Bell bay	Full scale	Australia	580	200	200	N	Merchant	H, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Yara	YURI	Full scale	Australia	4,707	1,624	1,624	N	Merchant		Specul.	In place	In place	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
AmmPower	AmmPower	Full scale	Brazil	4,000	1,380	690	N	Merchant/nitrates	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Casa dos Ventos	Casa dos Ventos	Full scale	Brazil	5,797	2,000	2,000	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	Post 2028
En.lt	En.lt Rio Grande	Full scale	Brazil	696	240	240	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Jan-27	Post 2028
FFI	Port of Acu	Full scale	Brazil	725	250	250	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Porto Central, CEI	Porto Centro, CEI	Full scale	Brazil	5	2	2	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Solatio	Solatio Large	Full scale	Brazil	3,478	1,200	-	N	Downstream	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	Post 2028
Solatio	Solatio Small	Full scale	Brazil	2,377	820	-	N	Downstream	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	Post 2028
Unigel	Unigel Camacari	Full scale	Brazil	1,739	600	600	N	Merchant	W	Specul.	No EPC	No supply	In place	No finance	Not started	Not started	Not started	2025	2025
Bear Head Energy	Point Tupper	Full scale	Canada	5,797	2,000	2,000	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028
EverWind Fuels	Point Tupper	Full scale	Canada	330	1,000	1,000	N	Merchant	G, W	Specul.	No EPC	In place	Signed	No finance	Not started	Not started	Not started	2025	Post 2028

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Green ammonia capacity tracker

The full list, including all pilot projects, can be found in the Data & Downloads file associated with this report

Project specifications										Forecast	Project milestones							Start-up	
	Project location			Gross capacity		Merchant	Grey impact	Major product	Renewable source		Contracts			Progress indicators				Project completion date	
Company	Project/site	Stage	Country	t/d	'000 t/yr	'000 t/yr	Y/N			Rating	EPC	Renewables	Electrolyser	Financing	Groundwork	Construction	Commissioning	Original target	Argus forecast
Teal	Teal	Full scale	Canada	2,200	800	800	N	Merchant	H	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	Post 2028
World Energy GH2	GH2 Nujio'qonik	Full scale	Canada	4,348	1,500	1,500	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
AES Andes	AES Andes	Full scale	Chile	725	250	250	N	Merchant	G, S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	2025
ACH-MRP	ACH-MRP	Full scale	Chile	2,899	1,000	1,000	N	Merchant	G, S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2027	Post 2028
Albatros & Co.	SELKNAM	Full scale	Chile	1,450	500	500	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	2026
AustriaEnergy, CIP	HNH Energy	Full scale	Chile	2,450	850	850	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	2026
CWP Global	H2 Magallanes	Full scale	Chile	12,754	4,400	4,400	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028
ENGIE & ENAEX	HyEx	Full scale	Chile	2,081	718	350	N	Merchant	G,S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	Post 2028
Glenfarne, Samsung	Green Pegasus	Full scale	Chile	1,330	459	459	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Statkraft	Pauna Greener	Full scale	Chile	464	160	160	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
TCI GECOMP	HOASIS	Full scale	Chile	725	250	-	N	Merchant	G, S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2024	2025
CEEC China	CEEC China	Full scale	China	290	100	100	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
SPIC & Co.	Inner Mongolia	Full scale	China	290	100	100	N	Merchant	S, W	Specul.	No EPC	In place	No supply	In place	Not started	Not started	Not started	2025	Post 2028
CIP	Power-to-X	Full scale	Denmark	2,600	900	900	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028
Alcazar UAE	Alcazar	Full scale	Egypt	725	250	250	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	Post 2028
Alfanar	SCZone	Full scale	Egypt	1,449	500	500	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2027	Post 2028
AMEA Power	Ain Sokhna	Full scale	Egypt	2,319	800	800	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
EDF, ZeroWaste	SCZone	Full scale	Egypt	1,014	350	350	N	Bunkering	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Fertiglobe	Fertiglobe	Full scale	Egypt	260	90	90	Y	Merchant	S,W	Specul.	Agreed	In place	In place	No finance	Not started	Not started	Not started	2025	2026
MEP	MEP	Full scale	Egypt	348	120	120	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
ReNew Power	Ain Sokhna	Full scale	Egypt	3,768	1,300	1,300	N	Merchant	S,W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025-2029	2025
Scatec , SCZONE & Co.	Ain Sokhna	Full scale	Egypt	8,700	3,000	3,000	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Plug Power	Plug Kokkola	Full scale	Finland	2,029	700	700	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Aquamarine	HydrGEN	Full scale	Germany	300	104	104	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2024	2026
H2Carrier	H2Carrier	Full scale	Greenland	2,609	900	900	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028
Atome Energy	Atome Iceland	Full scale	Iceland	304	105	105	N	Merchant	G	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
ABC Cleantech	ABC Cleantech	Full scale	India	2,899	1,000	1,000	N	Merchant	S,W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
ACME Group	Mangalore	Full scale	India	3,478	1,200	1,200	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2027	Post 2028
ACME Group	Tamil Nadu	Full scale	India	3,188	1,100	1,100	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Avaada	Rajasthan	Full scale	India	2,899	1,000	1,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Jakson Group	Jakson Green	Full scale	India	1,058	365	365	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Keppel, Greenko	Karnataka	Full scale	India	2,899	1,000	1,000	N	Merchant	S, W, H	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Ocior Energy	Ocior Odisha	Full scale	India	2,899	1,000	1,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
ONGC, Greenko	Rajasthan	Full scale	India	2,899	1,000	1,000	N	Merchant	S,W, H	Specul.	No EPC	In place	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Petronas	Karnataka	Full scale	India	1,449	500	500	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
JGC, Asahi Kasei	Fukushima	Full scale	Japan	4	1	1	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	2025
Maire Tecnimont	Power-to-Fertz	Full scale	Kenya	149	51	-	N	Nitrates	GT, S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	Post 2028
IHI, Gentari Hydrogen	IHI Johor	Full scale	Malaysia	580	200	200	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	Post 2028
Samsung Engineering	H2biscus	Full scale	Malaysia	1,830	630	630	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Conjuncta & Co.	Mauritania	Full scale	Mauritania	23,188	8,000	8,000	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Hy2gen	Hy2gen Mexico	Full scale	Mexico	406	140	140	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028

Continued on next slide...

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Green ammonia capacity tracker

Global gross green ammonia project tracked capacity now exceeds 124mn t, and 118mn t on a merchant basis

C									Forecast	Project milestones							Start-up	
Project location				Gross capacity		Merchant	Grey impact	Major product	Renewable source	Rating	Contracts		Progress indicators				Project completion date	
Company/project	Project/site	Stage	Country	t/d	'000 t/yr	'000 t/yr	Y/N				EPC	Renewables	Electrolyser	Financing	Groundwork	Construction	Commissioning	Original target	Argus forecast
HEVO Ammonia	Agadir	Full scale	Morocco	530	183	183	N	Merchant	S, W	Specul.	No EPC	No supply	Signed	No finance	Not started	Not started	Not started	2026	Post 2028
Hyphen Hydrogen En.	Namibia	Full scale	Namibia	4928	1,700	1,700	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Proton Ventures	Rotterdam	Full scale	Netherlands	300	99	99	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Yara	Sluiskil	Full scale	Netherlands	215	75	75	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	Post 2028
Balance-Agri	Kapuni Green Hydro.	Full scale	New Zealand	12	4	-	N	Urea	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	Post 2028
Aker, Varanger Kraft	Berlevag	Full scale	Norway	245	85	85	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026-2028	Post 2028
CIP	Iverson eFuels	Full scale	Norway	600	207	207	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2027	Post 2028
North Ammonia	Arendal	Full scale	Norway	290	100	100	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Yara	HEGRA	Full scale	Norway	1520	525	-	N	Nitrates	H	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026-2028	Post 2028
Yara, Nel	Porsgrunn	Full scale	Norway	59	21	-	N	Nitrates	G	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2023	2025
ACME	Duqm	Full scale	Oman	3,500	1,200	1,200	N	Merchant		Specul.	In place	In place	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
ENGIE, POSCO	Duqm	Full scale	Oman	3,478	1,200	1,200	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
OQ, ACWA, AP	Salalah	Full scale	Oman	2,899	1,000	1,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
OQ, Intercontinental	Green Fuels	Full scale	Oman	28,986	10,000	10,000	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028-2038	Post 2028
OQ & Co.	SalalaH2	Full scale	Oman	1,000	345	345	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Atome Energy	Villeta	Full scale	Paraguay	322	111	111	N	Merchant	H	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	2026
Atome Energy	Yguazu	Full scale	Paraguay	797	275	275	N	Merchant	H	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2027	Post 2028
MadoquaPower2X	Sines	Full scale	Portugal	1,500	500	500	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	2026
Kepco Saudi	Kepco Saudi	Full scale	Saudi Arabia	3,478	1,200	1,200	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Hive Energy	Coega SEZ	Full scale	South Africa	2,250	780	780	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	2026
Omnia	Omnia SA green	Full scale	South Africa	290	100	100	N	Merchant	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Cepsa	Algeciras	Full scale	Spain	2,174	750	750	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2027	Post 2028
Fertiberia	Puertollano	Full scale	Spain	520	179	-	N	Nitrates	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2024-2027	2026
Fertiberia & Co.	HyDeal España	Full scale	Spain	870	300	-	N	Nitrates	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	2026
Fertiberia, Cepsa	Palos de la Frontera	Full scale	Spain	1,100	380	-	N	Nitrates	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2024-2027	Post 2028
Fertiberia & Co.	Catalina	Phase 1	Spain	716	247	-	N	Nitrates	S, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2027	Post 2028
Ignis	Castellon	Full scale	Spain	2,464	850	850	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2031	Post 2028
Fertiberia	Green Wolverine	Full scale	Sweden	1,501	518	518	N	Merchant	H, W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2026	2026
ACWA Thailand	Thailand	Full scale	Thailand	3,478	1,200	1,200	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
BRE, Siemens Energy	BRE UAE Green	Full scale	UAE	1,739	600	600	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Helios Industry	Kizad	Full scale	UAE	638	220	220	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
IHI, Enoc	IHI	Full scale	UAE	580	200	200	N	Merchant	S	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2028	Post 2028
Eneus Energy	Orkney	Full scale	UK	11	4	4	N	Merchant	W	Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
AmmPower	Port of Louisiana	Full scale	USA	4,000	1,380	1,380	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Avina	AvinaH2	Full scale	USA	2,029	700	700	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	2025	Post 2028
CF, NextEra Energy	Verdigris	Full scale	USA	290	100	100	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Greenfield Nitrogen	Iowa	Full scale	USA	240	83	83	N	Merchant		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
JWC Gburg	Nebraska	Full scale	USA	377	130	-	N	UAN, ATS		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
LSB Ind.	Pryor Green	Full scale	USA	87	30	30	N	Nitrates	S, W	Specul.	No EPC	No supply	Signed	No finance	Not started	Not started	Not started	2024	2025
ReMo	ReMo Illinois	Full scale	USA	43	15	15	N	Merchant		Specul.	No EPC	No supply	MoU	No finance	Not started	Not started	Not started	2024	2024
ACWA	Chirchiq	Full scale	Uzbekistan	1,458	503	515	N	Urea		Specul.	No EPC	No supply	No supply	No finance	Not started	Not started	Not started	Post 2028	Post 2028
Total capacity forecast					**124,008**	**118,815**													

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Green ammonia project updates

A flurry of new project announcements was seen in H1 2023 as green ammonia interest grows

1. World Energy GH2 – Nujio'qonik, Canada

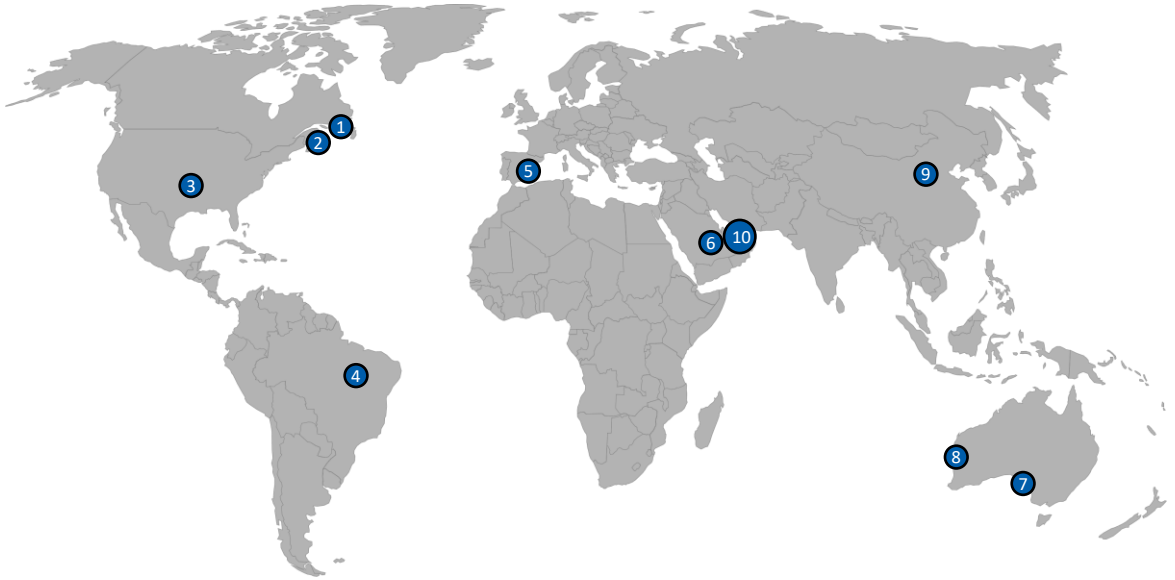
Canada has attracted significant investment interest for green ammonia capacity thanks to its abundant access to wind power resources, and World Energy GH2 has announced that it plans to build a two-phase project totalling 1.5mn t/yr capacity in Nujio'qonik, Canada. An initial 360,000t/yr phase is aimed for 2026, followed by the remaining 1.14mn t/yr, but an ETC is not available.

2. Bear Head – Point Tupper, Canada

Energy developer Bear Head Energy has received environmental approvals for its proposed 2mn t/yr green ammonia project in Point Tupper, on the eastern coast of Canada. Substantial wind power resources already exist at the site, and the company is planning to use these to power 2GW of electrolysis capacity. An initial export target of 2028 has been announced.

3. CF, NextEra Energy – Verdigris, US

US fertilizer producer CF Industries has announced that it will partner with renewable energy developer NextEra Energy to build a 100,000t/yr green ammonia unit at CF Verdigris site in Oklahoma. The partnership has not released its expected timeline for the project, nor the intended end-use of the green ammonia produced. CF is also progressing a separate project in Donaldsonville.



10. IHI, Enoc – Dubai, UAE

Japanese energy producer IHI will partner with Emirati state-owned energy company Enoc to develop a 200,000t/yr project new Dubai, UAE. The partners plan to launch a first phase before commercial operation begin in 2028, but capacity details for this stage have not been announced. The product will be mainly distributed to Asian markets for power generation and bunkering.

9. CEEC – Inner Mongolia, China

State-owned China Energy Engineering Company (CEEC) has plans to invest 5bn yuan ($723mn) in a project with a capacity of 100,000t/yr green ammonia in Inner Mongolia, China. An MoU has been signed with an engineering company for the design of the project, but no official timeline details have been announced.

8. CIP – Murchison, Australia

Danish investor Copenhagen Infrastructure Partners (CIP) is planning a 2mn t/yr plant in Geraldton, Western Australia including 3.7GW wind, 1.5GW solar and 3GW electrolysis capacity. It is separately planning to invest $30bn in a 7GW project on the Eyre Peninsula, but the capacity has not been announced. A similar sized project in Chile expects to produce 4.4mn t/yr.

4. Solatio – Piaui, Brazil

Spanish solar energy company Solatio is planning two green ammonia projects in Piaui state, northeast Brazil. The first will use 1.4GW of electrolysis to produce up to 1.2mn t/yr of ammonia, while the second will have an electrolysis capacity of 945MW for 820,000t/yr ammonia capacity. The renewable power will be purchased through PPAs, and both plants are targeting operation in 2026.

5. Ignis – Castellón de la Plana, Spain

Spanish energy developer Ignis wants to invest EUR 1bn in an 850,000t/yr green ammonia project in Castellón de la Plana, Spain. It has applied for the project to be designated as a 'Strategic Territorial Project', which will help to streamline administration. The company currently plans to begin operations at the site in 2031. No details were given about how the project will be financed.

6. Kepco – Saudi Arabia

Five Korean companies – Kepco, KSP, KNOC, Samsung C&T and Posco – will partner with Saudi Arabia's PIF to develop a 1.2mn t/yr green ammonia project in the Kingdom. Timeline details have not yet been released, but PIF's involvement suggests that it will aid with some of the project financing elements. The heavy Korean involvement also implies an export project to East Asia.

7. Amp Energy – Cape Hardy, Australia

Canadian developer Amp Energy wants to construct a 5mn t/yr green ammonia plant in Cape Hardy, southern Australia using 5GW of electrolysis capacity. The developer announced a nine-month window starting in April 2023 to develop the project schedule and scope. It is hoping to begin construction at the site in 2026, for first production in the third quarter of 2028.

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DEMAND: Initial modelling suggests 247mn t/yr of clean ammonia demand by 2050

But projections are clouded with uncertainty; more regulations and subsidies will be required to grow demand

Progressive regulations in large, modern economies coupled with progress in carbon capture and electrolyser technologies are now beginning to generate demand potential for low carbon forms of ammonia.

The demand itself has subdivisions depending on the end-use, the immediate of which is the distinction between direct and indirect consumption. In its direct form, the ammonia is being consumed either for its use as a low carbon fuel in mobile and stationary combustion processes, as a low-carbon nitrogen carrier for agriculture, or as a feedstock for downstream industrial nitrogen processes. The major indirect consumption use is the potential role ammonia can play as hydrogen carrier. Ammonia is not the only carrier and faces competition from other molecules. But as a more energy dense molecule and requiring less cryogenic processing, ammonia has the potential to link areas of high renewable potential and low energy consumption with the world's major energy consumers, where it can be cracked back into H_2.

We have identified four future demand segments for low-carbon ammonia consumption which are explored in detail in this section: direct combustion of ammonia as a marine fuel, co-firing for power generation, ammonia as a hydrogen carrier and traditional ammonia demand. Our initial modelling suggests that global demand for clean ammonia could reach as high as 247mn t/yr by 2050. This is of course couched with significant caveats given that current clean ammonia demand is near zero, and the market has yet to settle on ammonia as a major contributor as future combustion fuel or hydrogen carrier.

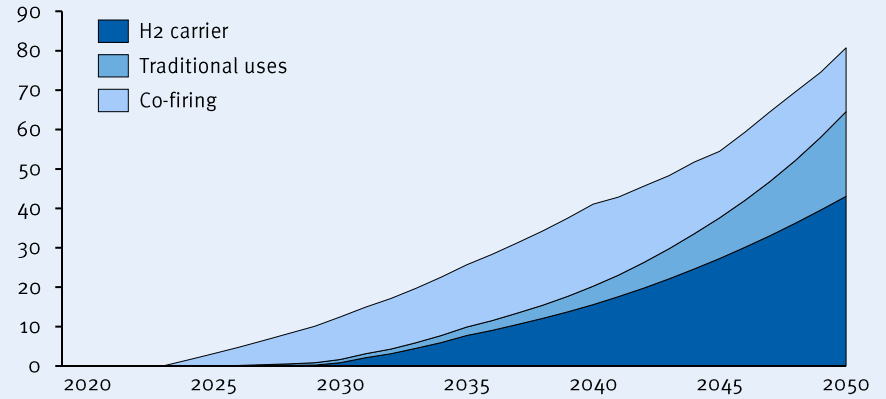
Our view is that clean ammonia demand will primarily emerge as demand for ammonia itself rather than as indirect demand for H_2 molecules. This means that it is more likely clean ammonia molecules will be valued as carbon-free nitrogen for agriculture or industry, or as a carbon-free fuel for use in the marine freight and power generation sectors, than as a vector for trans-regional hydrogen supply.

In the early development of the clean ammonia market (the 2020's & 2030's) the power sectors of South Korea and Japan are forecast to emerge as the main driver for ammonia demand. Co-firing ammonia with coal offers an immediate, low investment cost solution for lowering CO_2 emissions from operational power generators in a region that has very limited renewable wind and solar resources. Clean ammonia demand in the traditional segment (agriculture & industrial) is also emerging early, but the challenging economics around switching to green & blue ammonia limits long-term growth prospects.

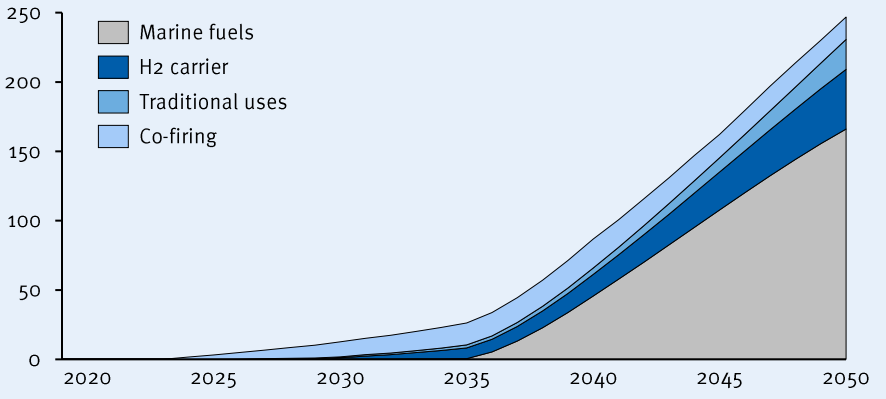
Our central forecast is that without further plans to develop new co-fired ammonia/coal plants, demand from this segment is likely to start falling in the 2040's. The gradual closure of legacy coal generators will gradually depress regional ammonia requirements in northeast Asia. But large OEM's are investing in research for 100pc ammonia-fired turbines that could provide a longer-term demand prospect for ammonia as a generation fuel. Instead, ammonia as a H_2 carrier could become increasingly important. In the early 2030's, we are expecting an new H_2 carrier segment to emerge, driven by ambitious hydrogen development plans in Europe and northeast Asia.

By far, the greatest potential for clean ammonia's future use is in the marine fuel industry. Even its moderation penetration into the future marine-fuel mix would create the largest nascent demand sector for clean ammonia. Increasingly ambitious decarbonisation goals in the marine sector are driving low-carbon fuel demand, in which ammonia could play a major role. We are assuming that ammonia meets around 20pc of the global marine fleet's energy requirements by 2050. It's use at this level creates over 150mn t of new ammonia demand.

Clean ammonia demand excluding the marine fuel segment, 2020-50



Clean ammonia demand from all segments, base-case, 2020-50



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DEMAND: Marine fuel sector offers greatest potential for clean ammonia's future use

Assuming that technology develops at such a pace that NH_3-fired engines become widely available by mid 2030s

Estimated emissions from the marine fuels sector exceeded 1bn t of CO2e in 2019. And increasing scrutiny of its emissions profile over the last few years has put the industry under renewed pressure to address its environmental impact.

Limiting GHG emissions from the combustion of fossil fuels in marine engines remains a major challenge for the industry. The International Maritime Organisation (IMO) has proposed the following non-binding goals: reduce the average GHG intensity (CO2e emission per tonne-mile) by 40pc in 2030 and 70pc by 2050 compared to 2008, reduce GHG emissions by 50pc in absolute terms by 2050 compared to 2008.

The IMO's 2030 target is able to be achieved solely via increasing the energy efficiency of the existing vessel fleet. But to reach the 2050 target, fuel switching will be necessary. Different marine fuels have a different carbon intensity. Of the alternative fuels being assessed as options for large-scale fuel switching, clean ammonia and green methanol have emerged as the most likely contenders to displace diesel and fuel oil in the long term. Today, carbon intensity from the marine fuel sector is averaging around 93-95tCO2/GJ, but to achieve IMO targets, this figure will have to fall to around 50tCO2/GJ by 2050.

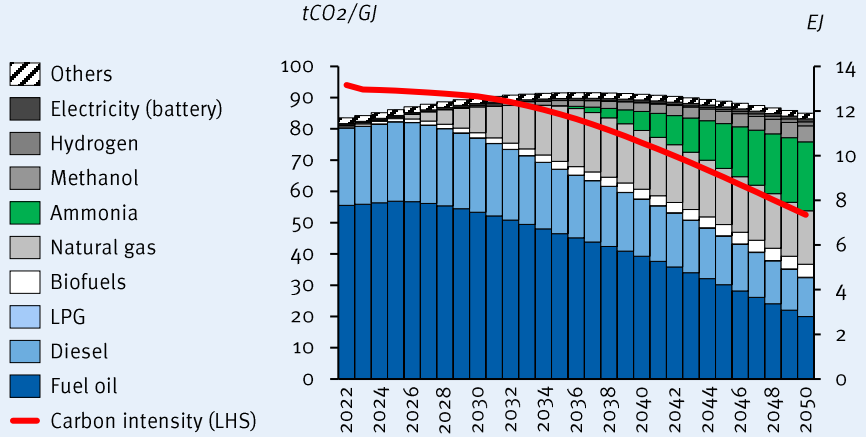
- In the short-term (to 2027), the marine industry has little leeway to adapt low carbon fuels and the underlying vessel fleet determines fuel usability. Even though exponential growth in alternative vessel orders can be observed, they have little impact on the overall fuel structure in the short term. Biofuels are thus the only viable option to achieve short term decarbonisation goals.
- In the medium-term (2027-2037), LNG becomes the preferred option due to greater availability and significant vessel build. We estimate that LNG can provide a carbon saving of up to 20pc over traditional fuel oils. But its transition fuel character as well as the vessel life cycle of 20-25 years leads to stagnating demand by 2037.
- In the long-term (2037-2050), we assume that zero carbon becomes available under a scenario where we need to cut greenhouse gas emissions by up to 50pc. Vessel operators look for fuels with the lowest abatement costs and ammonia becomes the most viable zero-carbon fuel for international voyages. Clean ammonia consumption only shows significant growth in this period.

Our short-term forecasts are built around assumptions made regarding the number of vessels available for each fuel type and their respective shipping capacities. The *Argus* marine fleet database forms the foundations on which to base our analysis, while IMO targets and objectives guide our view on future fuel blends. The medium-to-long-term forecast is a little more nuanced and assumption heavy. For more information, please visit the *Argus Ammonia Analytics – Annual Long-Term Outlook* publication, now available on Argus Direct.

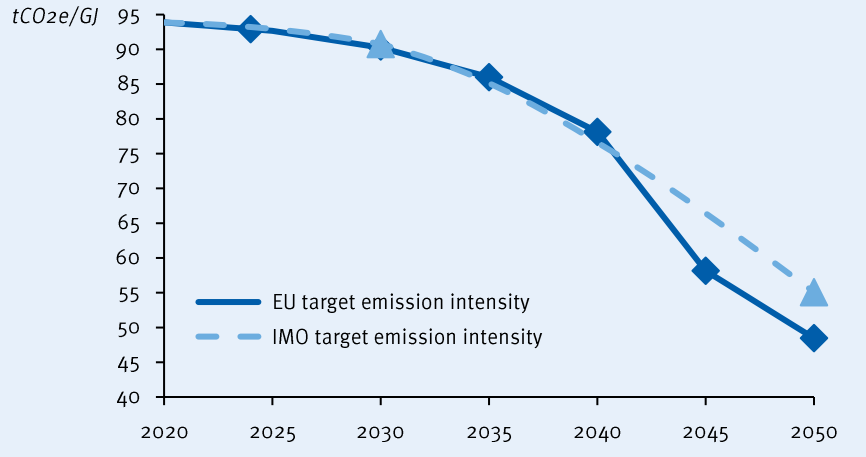
Marine fuel demand forecast, 2023-50 *mn t/yr*

	2023	2027	2030	2035	2040	2045	2050
Total	282	293	298	303	329	360	381
Fuel-oil	191	192	182	159	134	103	68
Diesel	82	82	78	68	60	51	41
Biofuels	2	4	6	9	11	13	15
Natural gas	1	8	23	50	53	50	48
Clean NH3	--	--	--	--	46	108	166
Methanol	--	1	3	11	19	28	36
Hydrogen	--	--	--	--	--	1	1
Others	6	6	6	6	6	6	6

Argus marine fuel demand forecast by fuel type, 2022-50



FuelEU maritime fuel intensity targets vs IMO targets, 2020-50



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DEMAND: Other segments have the potential to add 81mn t/yr of demand by 2050

Ammonia's use as a hydrogen carrier could account for over half of this total by the end of the forecast

TRADITIONAL SEGMENT

Decarbonising the agricultural and industrial sectors will be integral in achieving deep decarbonisation in the long term. More than 78.0mn t of grey ammonia was consumed by these sectors in 2022. This figure excludes urea-based demand. Urea, the major nitrogen fertilizer product traded and consumed in the world today, requires a carbon input for production. We have modelled clean ammonia demand growth in the traditional segment based on government announcements, decarbonisation policies and underlying fundamentals across a range of fertilizer and non-fertilizer products. As such, we have combined product and country-specific low-carbon ammonia penetration rates alongside *Argus'* existing ammonia demand outlook. According to base-case estimates, low carbon demand could grow to 21.5mn t/yr by 2050. This figure includes blue ammonia in the US, where CO2 generally re-injected into exhumed petroleum reservoirs or is used in enhanced oil recovery (EOR).

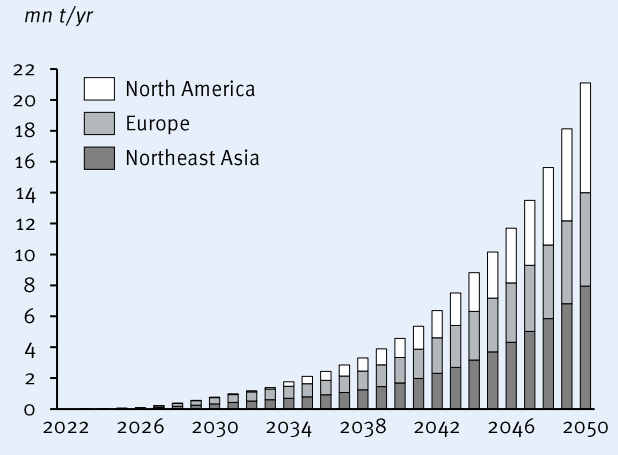
H2 CARRIER

Public initiatives via national and supranational hydrogen strategies are assumed to be the key drivers for the development of low-carbon hydrogen industries. Europe is likely to be the dominant consumer of ammonia as a hydrogen carrier, due to its size and hydrogen ambition. Europe shows the greatest growth in the forecast, reaching 9.7mn t by 2040 and potentially 29.1mn t by 2050. We expect ammonia demand in South Korea to fail to keep pace with Japan in the first 5 years after Japan begins to import commercial-scale volumes. We attribute this to legislative differences between countries. Our base case forecasts total ammonia use as a hydrogen carrier at 43.1mn t/yr by 2050.

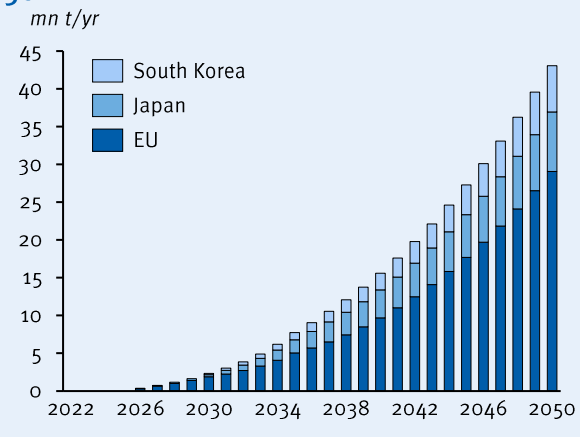
CO-FIRING

In the early development of the clean ammonia market (the 2020s & 2030s) the power sectors of South Korea and Japan are forecast to emerge as the main driver for ammonia demand. Ammonia demand for South Korea could be higher in the earlier years, projected at 7.5mn t/yr in 2030 and 11.3mn t/yr in 2040. But it then decreases significantly to 5.7mn t/yr in 2050 without an increase in co-firing rates. The projected decline in ammonia demand in South Korea from 2040 onwards is attributed to an ageing coal-fired fleet. A similar trend is observed in Japanese data, but reverse around 2045 as the ammonia consumption in co-firing rate is assumed to increase from 20pc to 50pc.

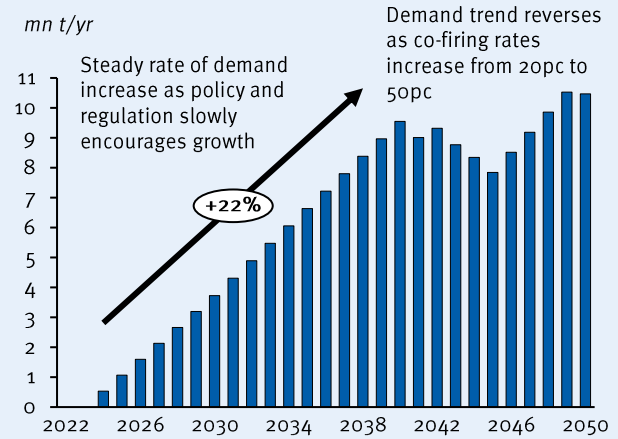
Clean NH_3 demand from traditional sources



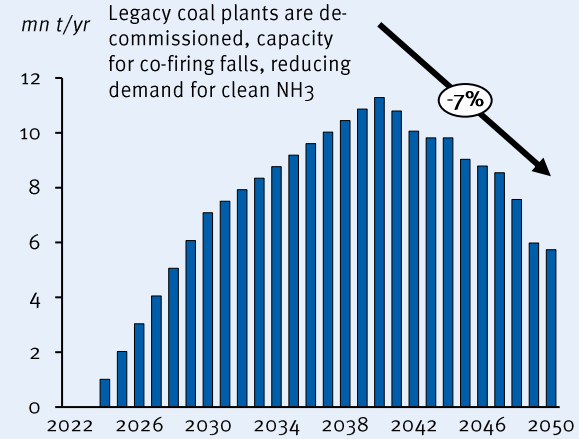
Clean NH_3 adaptation as a H_2 carrier, 2022-50



Japanese clean NH3 demand for co-firing



South Korea clean NH3 demand for co-firing



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Green ammonia LRMC model: Production setups, optimisation, and learning curves

Tailored forecasts accounting for green hydrogen regulations, minimum energy usage, and uncertainty

PRODUCTION SETUPS

While clean hydrogen regulatory frameworks are still in their early stages, we are already seeing important differences around the world. For example, Oman is allowing producers to grid bank- electrolysers can draw power from the grid during low power generation periods with withdrawals capped by the excess power exported to it. In contrast, the EU has stricter rules where producers must ensure temporal correlation-hydrogen production must match hourly renewable power generation. This makes grid banking infeasible, only permitting grid-based and island setups where power is secured using a PPA or a direct connection to a renewable generator. Different rules across countries imply that production methods for green ammonia will vary based on regional guidelines. And each method will result in a different cost structure as some involve purchasing power externally while others generate it in-house. Our brand new green ammonia LRMC model estimates levelised costs for countries based on what production setups are feasible while accounting for the heterogeneity in costs across them.

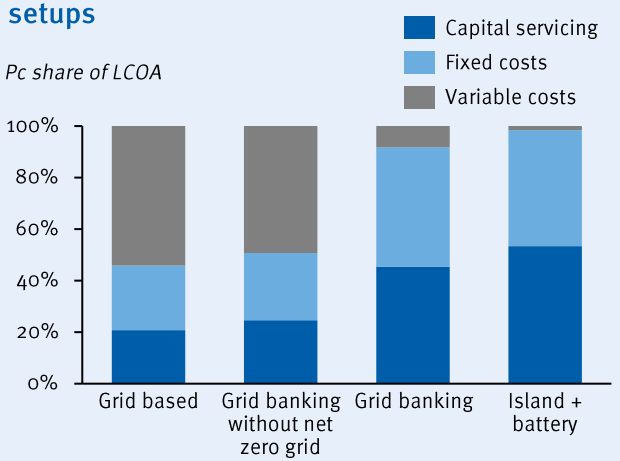
OPTIMISATION

While estimating the LRMC under different production setups, we apply a unifying notion of minimal power usage.* Our model ensures that each setup purchases or generates no more power than what is required to produce at the target scale - representing the production capacity (t/yr) of a typical ammonia facility. This approach allows us to compare the LRMC from a capex-heavy setup like the island plus battery model, to a low capex and high variable cost setup like the grid-based model. We also integrate a country's renewable power potential while calculating costs. Using renewable power data from green ammonia project locations, we produce a daily power curve representing the average hourly power generation in a country. We use this to calculate renewable power costs and the minimum required generator and electrolyser capacities for different production setups to produce at the target scale.

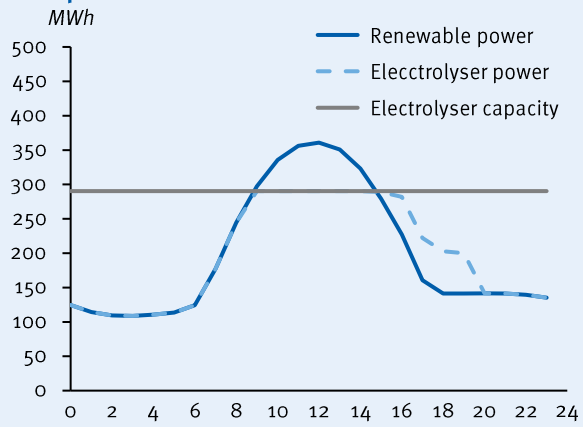
LEARNING CURVES

Obtaining the renewable power costs and optimal built capacities under different production setups allow us to calculate the LRMC for each country. But this LRMC estimate is surrounded with uncertainty. Renewable costs have fallen considerably in the past decade thanks to technical improvements in power capture, reduction in solar PV panel and wind turbine costs, and economies of scale. A similar trend is expected for electrolysers, particularly the PEM type, which have not been built at scale before. As a result, we model three learning curve scenarios: Advanced, Base and Conservative which represent varying rates of cost reductions for electrolysers and renewables. We estimate the LRMC for all three scenarios including varying assumptions on electrolyser type, production setups, and borrowing costs.

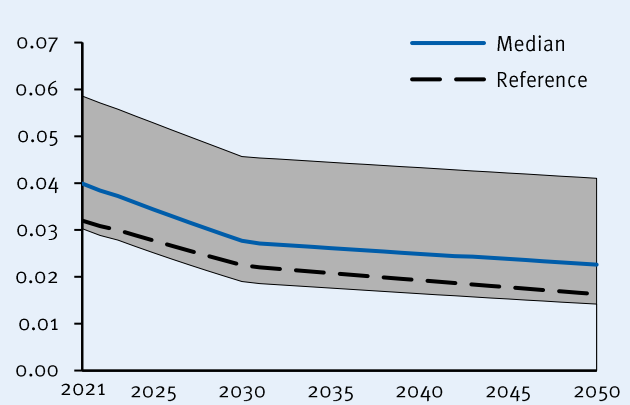
Heterogeneity in costs across production setups



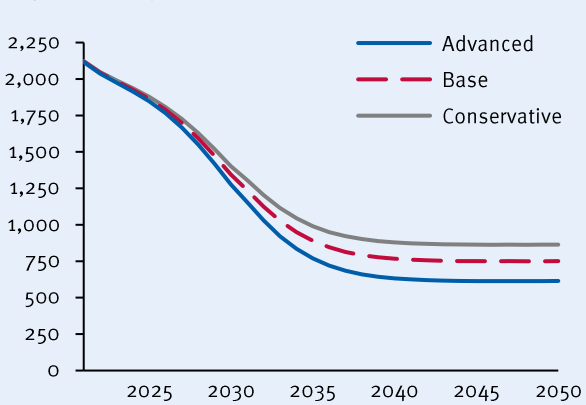
Daily power curve for the island + battery setup



Variance in renewable costs for Chile 2021-2050



Learning curves for PEM electrolyser 2021-2050



*Complete methodology of the green ammonia LRMC model is presented in the *Ammonia Analytics: Long-term Outlook to 2050*

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Green ammonia LRMC model: Forecast bands, results, and the long run price trend

Saudi Arabia and the US emerge as cheapest producers; Europe sets the long run price despite high costs

FORECAST BANDS

Changing assumptions related to production setups, learning curves, electrolyser type, renewable costs, and borrowing costs gives us over 400 LRMC forecasts for each country. We present these using a forecast band, indicating a range for the future LRMC and partially mitigating the current uncertainty in production costs. For example, we forecast that the LRMC in Chile in 2040 can vary from $257/t (2021$) to close to $1000/t (2021$). To get better point estimates, we look at the median and base case forecasts, where the latter refers to the LRMC of a country based on underlying baseline assumptions. These baseline assumptions represent country specific borrowing costs based on regional risk premiums, industry risk, and project gearings, and a production setup that is feasible and aligned with regional green ammonia regulations. For Chile, we estimate a real WACC of 6.8pc and use the island plus battery setup, representing the absence of grid infrastructure in remote regions where renewable power is abundant and most of the upcoming green ammonia projects are located. Our model forecasts the median and base case LRMC in Chile in 2040 as $479/t (2021$) and $381/t (2021$) respectively.

LRMC RESULTS

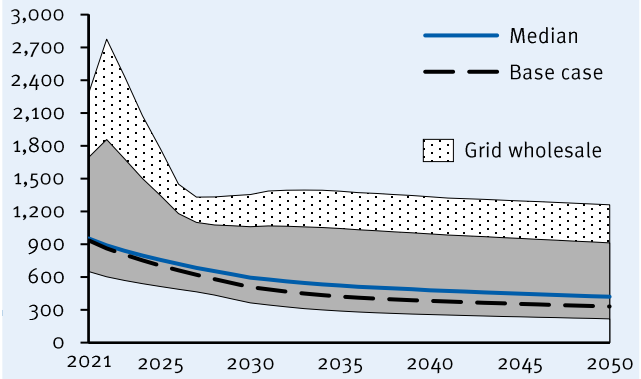
While comparing base case costs across countries, our model suggests that Saudi Arabia is forecast to be the cheapest producer of green ammonia with an LRMC of $348/t (2021$) in 2035. We attribute this to the country's large renewable potential derived from intense solar radiations and high wind speeds. Although, if we account for government subsidies like the IRA tax credits, the US emerges as the cheapest producer with a real LRMC of $148/t (2021$) in the same year. The most expensive locations for green ammonia production in our forecast group are European. While Europe has strong renewable power potential, higher renewable plant costs because of offshore wind farms, and stricter regulations that disallow grid banking make green ammonia production extremely costly.

LONG RUN PRICE

Although Europe would benefit from importing green ammonia from cheaper producing countries like Oman and Saudi Arabia, production targets set by the EU and energy security goals will induce domestic production. The carbon border adjustment mechanism will also deter imports of carbon intensive grey ammonia by imposing carbon tariffs. Accordingly, we choose Europe as our marginal cost producer that forms the industry LRMC. We can see that this is higher than the median cost of our forecast group, reflecting the higher average cost in Europe. By changing underlying assumptions for European countries, we can also build a forecast band for the industry LRMC. As our industry LRMC sets the long run price trend of green ammonia, this forecast band also indicates the uncertainty in future prices.

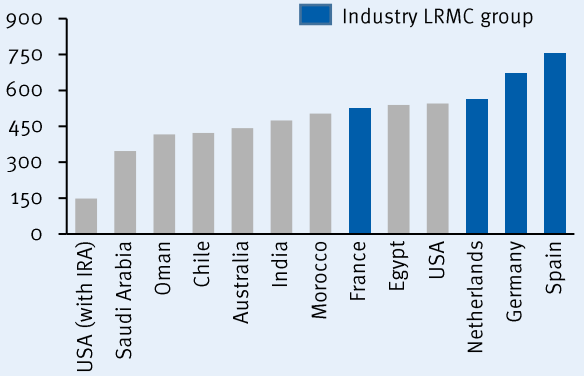
LRMC forecast band for Chile 2021-2050

2021$/t fob Middle East



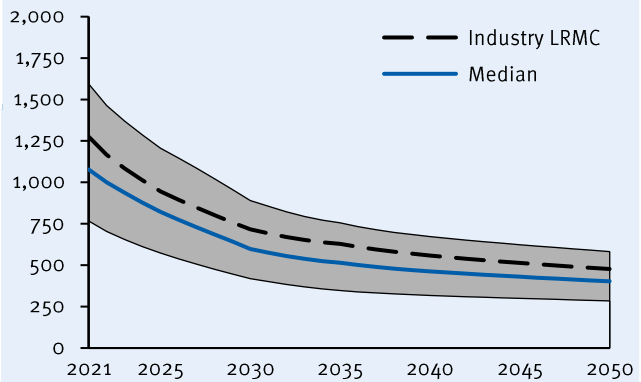
Green ammonia industry LRMC in 2035

2021$/t *fob Middle East*



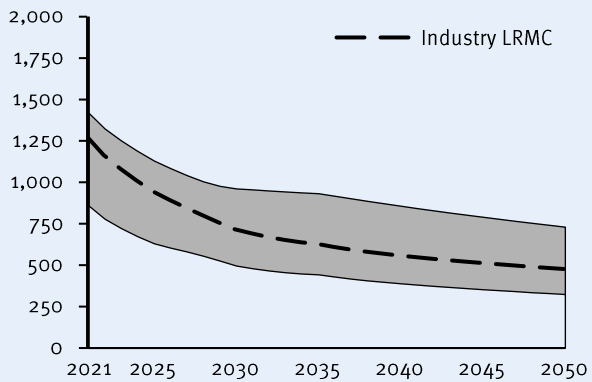
Green ammonia LRMC range 2021-2050

2021$/t fob Middle East



Industry LRMC uncertainty range 2021-2050

2021$/t fob Middle East



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AMMONIA LRMC: The grey and green ammonia LRMCs do not converge before 2050

An effective global carbon price would bring this forward to 2035-2040 if set at $100/t (real, 2022$)

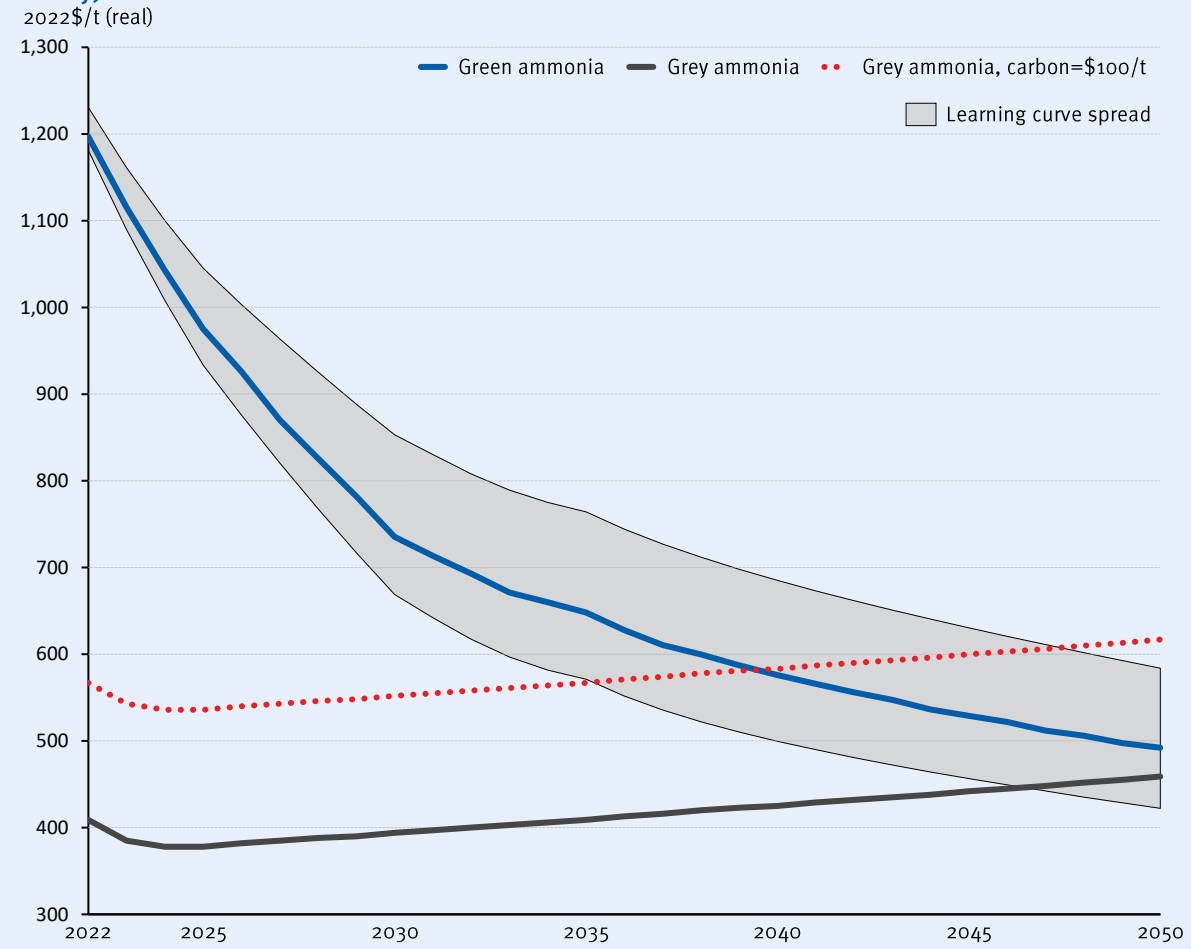
While we believe nitrogen should have a single LRMC, it is possible to create a world where separate LRMCs for grey and green ammonia can coexist. If ammonia is being valued for its carbon-free energy content and or its carbon-free hydrogen content, it is possible to accept that its value may substantially differ from one based purely on its nitrogen. This is logical given the significant disparity in their production costs; if green ammonia is simply priced at the same level as grey ammonia, then shareholders would face huge write downs on their capital and the risks of investment would be too high. The first wave of green ammonia investments will likely need to be made with 80-100pc offtake agreements in place on fixed-price contracts (that would be priced sufficiently high to recover the invested capital and provide some level of return on electrolysers, wind turbines, and solar PV systems) to be bankable. This indicates that a value for green ammonia far-in excess of the real LRMC of SMR-based grey ammonia will be agreed, though not on a transparent, liquid spot market basis that can be tracked.

The scale of the real cost differentials between the grey, SMR-based LRMC, and the potential green ammonia LRMC in 2022 is huge; almost $800/t. This differential falls substantially to around $300/t (real, constant 2022$) by 2030 as the electrolyser technology rollout lowers manufacturing costs and our aggregate experience of the technology improves system efficiency. But the rates at which the grey LRMC increases and the green LRMC falls in our base case scenario suggests that there will not, organically, be an inflection point where the prices equalise or cross until beyond 2050 (except for in our advanced learning curve scenario).

If the climate-changing externalities of SMR-based ammonia's carbon emissions are more widely priced around the world, then this inflection point can be brought forward. If we were to assume a real $100/t price for carbon in perpetuity, then we can reach this inflection point in the base case forecast at around 2038-40. Obviously, a higher carbon price will bring this further forward.

Of course, a carbon price is not the only method to close this gap between the LRMCs. Subsidies would play a similar role by lowering the marginal cost of green ammonia production in the long run. These subsidy payments would indirectly lower the WACC by providing either an upfront reduction in the capital cost of green ammonia facilities with a direct capital injection or would create an additional revenue stream with a payment per unit of carbon abated (like the IRA scheme in the US).

Green ammonia won't be competitive with grey unless there is some form of carbon pricing (or subsidy)



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1	Demand
2	Supply
3	Trade
4	Costs and Inputs
5	Balance and Prices
6	Green Ammonia
7	CF Industries, USA

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PROJECT REVIEW: CF Ind. plans to build two blue ammonia projects — new-build and retrofit

CF's projects provide an opportunity to directly compare the economics of new-build versus retrofit blue ammonia

US fertilizer producer CF Industries has announced plans to further decarbonise its ammonia portfolio using carbon capture and storage (CCS) technologies. In this section we review and compare two of its projects, the first being a new 1mn t/yr ammonia unit with a CCS unit included, and the second being a CCS retrofit to 1.7mn t/yr of its existing grey ammonia capacity. Both projects are located at CF's Donaldsonville industrial complex, where it currently operates 3.8mn t/yr of ammonia capacity.

Both projects will aim to capitalise on the US government's passing of the Inflation Reduction Act (IRA) into law, which contains tax credits of up to $85/t of CO_2 captured and sequestered. This credit greatly increases the feasibility of low-carbon ammonia projects in the US, and has prompted a swathe of project announcements over the past year.

CF has entered into a joint-venture with Mitsui, with a 52-48pc ownership split, respectively, for the newly built blue ammonia project, which the partners are hoping to complete by 2027.

Access to resources: For the retrofit project, minimal extra resources are required as the only addition will be the CCS unit. CF will partner with ExxonMobil, which will be responsible for the carbon management process once the CO_2 has been captured.

ExxonMobil plans to develop a 125,000 acre CO_2 storage facility in Vermilion Parish, Louisiana. The CO_2 will be permanently stored underground at the site, which is already owned the oil major. An agreement has been signed with gas pipeline company EnLink Midstream to transport the CO_2 from Donaldsonville to Vermilion.

As CF already operates a substantial ammonia capacity in Donaldsonville, increasing its requirement for natural gas, water and power for the production plant should not be a problem.

Access to markets: Both of CF's projects will likely target the export market. Early demand for clean ammonia is most likely to emerge in Japan and Korea for cofiring with coal in power generation. The partially-decarbonised ammonia would also have an advantageous export position in Europe following the introduction of CBAM by the EU's CEC. The Donaldsonville site has an existing ammonia export terminal on the Mississippi river, around 120km from the Port of New Orleans. As an established ammonia producer, CF will already have the logistical capabilities and expertise to export ammonia.

Minority partner Mitsui will be responsible for the marketing and distribution elements of the new production plant and is primarily targeting sales into Northeast Asia.

The existing ammonia plants that are receiving the CCS retrofit are currently supplying the merchant market, so our assumption is that the blue ammonia produced will continue to be sold as anhydrous ammonia rather than upgraded. CF has not stated whether it plans to alter its target markets for this product once it has a lower carbon footprint, but as volumes are already shipped to Europe, another emerging demand centre for low-carbon ammonia, we have assumed that this could be a destination for the CF's blue ammonia as well.

Access to capital: The $199mn expected capital requirement for the retrofit CCS project will be sourced from CF's annual growth capital budget, so we are therefore assuming that the project has already secured financing. As the capital is coming internally from CF's balance sheet, our project WACC is assumed to be equal to CF's cost of equity, which we have estimated at 10.49pc.

The more substantial $2bn capital expenditure requirement for the new worldscale export project would likely be raised on the capital markets. CF has not described its capital budgeting for the project, so we have used our standard project-finance assumption of a 70/30 debt/equity split in favour of debt.

Project details and assumptions

General details			New build	Retrofit
Country	US	Est. start year	2027	2026
Location	Donaldsonville, LA	Start year gas price	$4.74/mmBtu	N/A
Corporate WACC	9.06pc	Capex	$2bn	$199mn
Target market	Export	Blue capacity (t/yr)	1.0mn t/yr	1.7mn t/yr
		Project gearing	70 pc	0 pc
		Project WACC (nominal)	6.05 pc	10.49 pc
		CO_2 capture rate	60 pc	60 pc



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PROJECT REVIEW: Economic evaluation of CF's new-build blue ammonia plant

The project is forecast to return shareholder value even if selling without a premium to the grey market price

US-based blue ammonia project owners received a boost when the IRA was signed into US law in August. The legislation includes tax credits for domestic low-carbon ammonia production, to increase the feasibility of projects and aid industrial decarbonisation by mitigating against one of the biggest challenges — the increased cost of new technology.

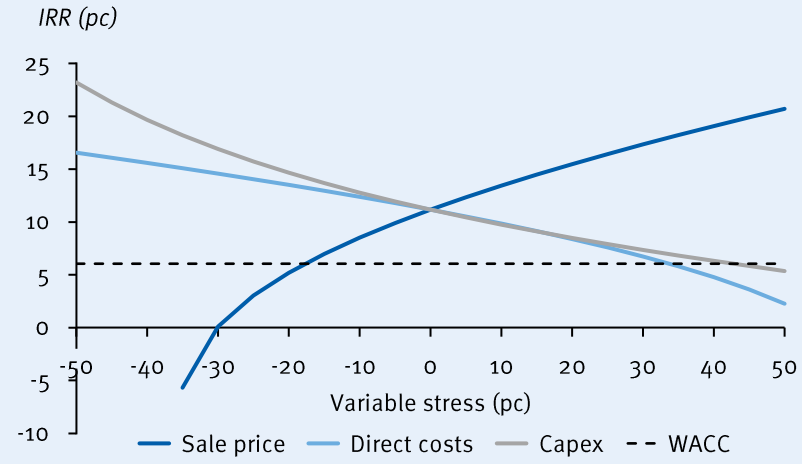
Assuming the plant qualifies for the full IRA tax credit throughout its lifetime, our analysis suggests that CF's new-build project would generate a net present value (NPV) of $996mn over its 25-year economic lifetime, implying that the project will be profitable. The $85/t CO_2 ($81.60/t NH_3 based on our assumed efficiency of 1.6t CO_2/t NH_3 and a 60pc capture rate) tax credit provided by the government significantly improves the project's viability, as our analysis suggests that it will cost CF $40/t NH_3 to capture the CO_2 produced by this plant.

Our forecast for CF's feedstock gas price is calculated as a 5pc premium to our Henry Hub forecast throughout the analysis. This equates to a delivered gas price of $4.74/mmBtu in 2027, the first year of operation.

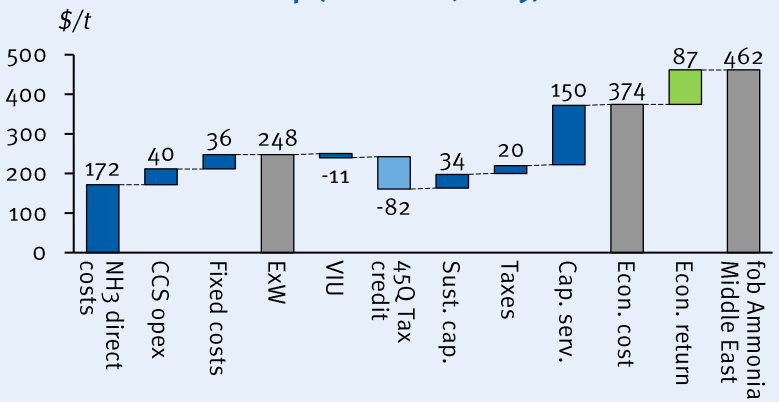
To calculate the cost of capital for this project, we have used our base-case assumption of the debt/equity ratio for a project of this size, 70:30pc. The low risk associated with investments in the US helps to drive down the cost of debt, which we have calculated as 4.1pc. Overall, the weighted average cost of capital (WACC) that was used as a baseline for this analysis was 6.05pc, and as the IRR is in line with this, the project looks to be feasible.

Mitsui's role in this project will be to handle the marketing and distribution elements, and to bring its expertise in Asian markets to help place the product in the continent. To calculate this base case financial analysis, we have assessed the ammonia's value on a US Gulf fob basis. This assumes there is no premium captured by the plants blue ammonia, and that it is all sold on at US gulf. In reality, 100% of the product will be shipped at significant cost to Northeast Asia, implying a lower netback than that achieved by selling at US Gulf.

IRR sensitivity analysis, FCFF (pre-tax) – base case



Economic cost build-up (base case, 2029)



Cash-flow analysis

	Pre-tax FCFF (Base case)	Post-tax FCFE (Base case)
Present value	$ 2,822 mn	$ 599 mn
Terminal value (PV)	$ 1,497 mn	$ 165 mn
Enterprise value	$ 2,750 mn	N/A
Equity value	N/A	$ 342 mn
NPV	**$ 1,253 mn**	**$ 176 mn**
IRR	**12pc**	**13pc**
Profit index	1.5	1.1

NPV heatmap – FCFF (pre-tax) basis – base case

NH3 price sensitivity (pc)

WACC (pc) \ NH3 price sensitivity (pc)	-50	-40	-30	-20	-10	--	10	20	30	40	50
3	-2221	-1333	-444	445	1334	2222	3111	4000	4889	5777	6666
3.8	-2100	-1311	-522	267	1056	1845	2634	3423	4212	5001	5790
4.5	-1994	-1291	-588	115	818	1520	2223	2926	3629	4331	5034
5.3	-1901	-1273	-645	-17	611	1239	1867	2495	3124	3752	4380
6	-1820	-1257	-693	-130	433	**996**	1559	2122	2685	3248	3812
6.8	-1748	-1241	-735	-228	278	785	1291	1798	2304	2811	3317
7.6	-1684	-1227	-770	-313	144	601	1058	1515	1972	2429	2885
8.3	-1626	-1213	-800	-386	27	441	854	1268	1681	2094	2508
9.1	-1575	-1200	-824	-449	-74	301	676	1051	1426	1801	2177

Base case NPV

WACC = 6.05pc

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PROJECT REVIEW: Economic evaluation of CF's new-build blue ammonia plant cont.

CF can sell at a discount of 3.3pc on the grey ammonia price and still breakeven, but need an 8.4pc premium for a 10pc IRR

The nascency of the blue ammonia market means that we do not currently have a price forecast for the product. To counter this, we have conducted analyses for the prices required by the CF project to reach three key financial indicators; a 10pc IRR case which we assume would be CF's minimum targeted returns for the project, an upside 15pc IRR case and a breakeven case where the NPV equals zero (IRR=the discount rate) over the project's life.

This, in effect, is our attempt to model the likely basis under which CF/Mitsui are looking to sell the blue ammonia. That is a long-term contract with buyers on a Henry Hub plus basis (plus conversion costs and capital servicing), similar to agreements already in place with Mosaic for ammonia shipments to tampa.

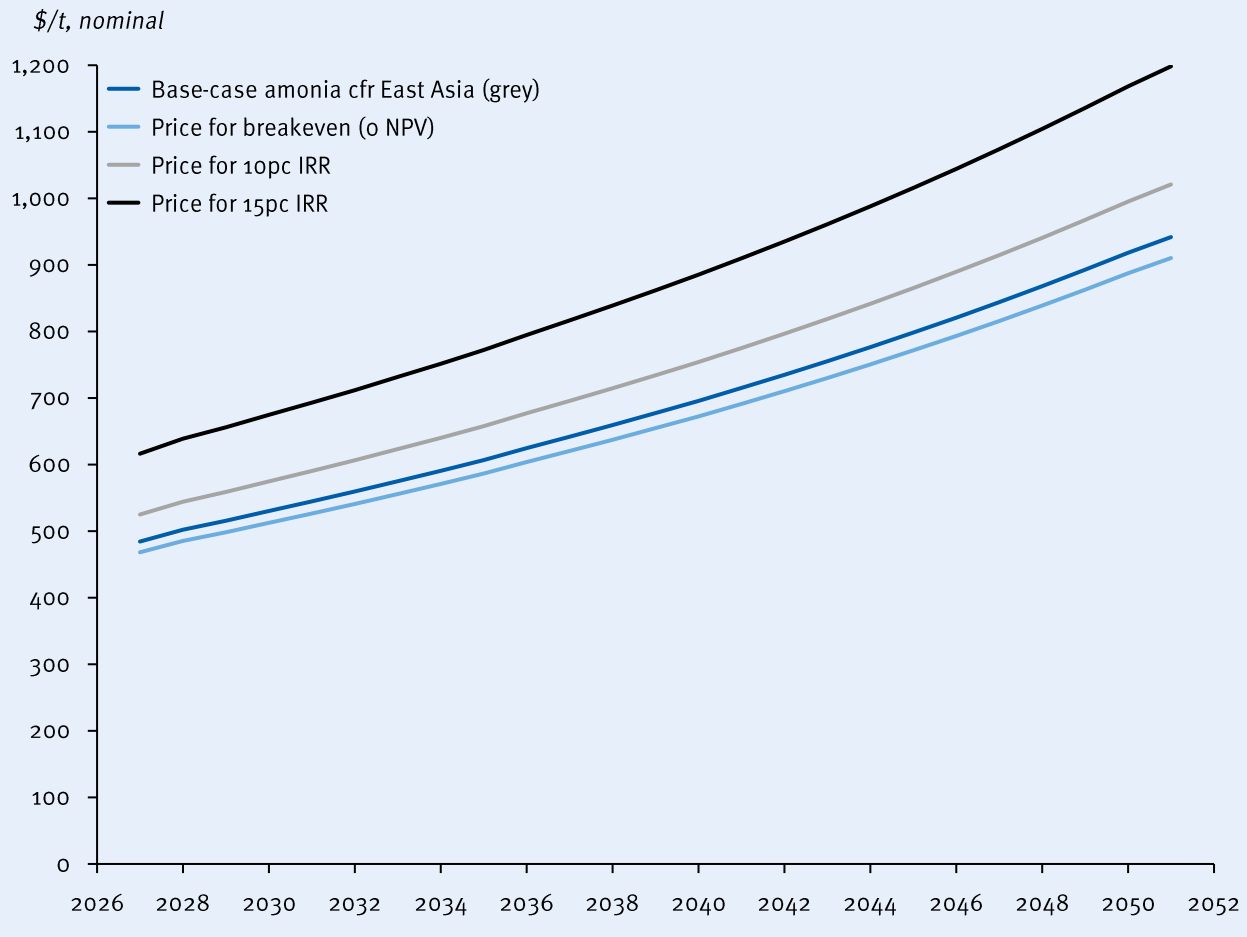
To run these scenarios we have estimated the cost to CF of shipping its product to the East Asian market that it is targeting, and calculated the price required to make returns at this benchmark. We have used a freight cost of $115/t in 2027 from the US Gulf to Ulsan, South Korea. This represents 29pc of the total economic cost per tonne in our base case, which decreases returns at the cfr East Asia benchmark. The graph shows that CF can afford to sell at a small discount to our grey ammonia price forecast and still breakeven; a discount of 3.3pc.To reach an IRR of 10pc, a price premium of 8.4pc must be achieved by CF, and to reach the 15pc IRR target a 27.2pc premium is needed.

Fundamentally, this analysis indicates that buyers of blue ammonia in East Asia will have to pay a premium over grey prices to secure supplies, as producers like CF will likely be looking for an IRR closer to 10pc. It is clear that the project would succeed on the basis of selling at the forecast grey ammonia price—meaning that should blue premiums not emerge, the asset will still create value.

It is important to note that this analysis excludes the impact which could be felt if a significant volume of blue ammonia comes online during the forecast. We are tracking over 40mn t/yr of potential capacity, much if it concentrated in the US following the passing of the IRA last year.

The addition of extra supply could lead to an oversupplied market, especially as the blue ammonia market is yet to develop an independent pricing mechanism from grey. There is even a situation in which the grey ammonia price could be pressured downwards by too many new blue ammonia projects built in advance of sufficient clean ammonia demand. This presents a risk to blue ammonia projects, as even small percentage changes to the grey ammonia price have a vast impact on the NPV over a project's lifetime. (Although this pricing risk is will likely offset by the long-term contracting early movers may pursue.)

Price scenarios at East Asia cfr benchmark



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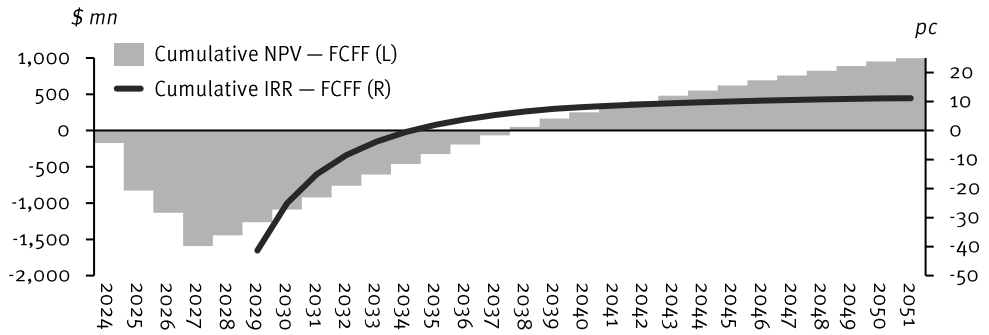
PROJECT REVIEW: CF new-build blue ammonia project cash flow

Our base-case scenario forecasts a $996mn profit on a pre-tax FCFF basis, at an IRR of 11pc

Cash flow: CF Donaldsonville new-build blue ammonia project (base case)[1] *$ mn*

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Revenue	-	-	-	52	541	554	567	581	595	609	624	639	656	672	689	706	641	660	678	697	717	738	759	781	804	827	851	873
Operating costs	-	-	-	-50	-256	-263	-270	-276	-286	-297	-309	-320	-336	-349	-361	-370	-381	-391	-402	-412	-422	-433	-445	-456	-466	-479	-490	-612
EBITDA	-	-	-	3	285	291	298	305	309	313	315	319	320	323	328	336	260	268	276	286	295	305	314	325	337	348	361	261
Sustaining Capital	-	-	-	-32	-33	-33	-34	-35	-35	-36	-37	-38	-38	-39	-40	-41	-42	-42	-43	-44	-45	-46	-47	-48	-49	-50	-51	-52
ΔNWC	-	-	-	-1	-52	-1	-1	-1	-1	-1	-0	-1	-0	-1	-1	-1	14	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	18
Capital Investment	-184	-734	-367	-551	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCFF (pre-tax)	-184	-734	-367	-581	200	256	263	269	273	276	278	281	282	284	287	293	233	224	232	240	248	257	266	275	286	296	307	227
EBITDA	-	-	-	3	285	291	298	305	309	313	315	319	320	323	328	336	260	268	276	286	295	305	314	325	337	348	361	261
Depreciation[2]	-	-	-	135	142	149	155	162	163	164	164	165	166	167	167	168	169	170	42	42	43	44	45	46	47	48	49	50
EBIT	-	-	-	-133	143	142	142	142	146	149	151	154	154	157	160	167	91	98	235	243	252	261	269	279	290	300	312	211
Interest	-	-	-	-80	-77	-73	-69	-65	-61	-56	-51	-46	-40	-35	-28	-22	-15	-8	-	-	-	-	-	-	-	-	-	-
Tax payment	-	-	-	-	-19	-20	-21	-22	-24	-27	-28	-31	-33	-35	-38	-41	-22	-26	-67	-69	-72	-74	-77	-80	-83	-85	-89	-60
Net income	-	-	-	-213	47	49	52	55	61	67	71	77	82	87	94	104	55	65	168	174	180	187	192	200	208	214	223	151
ΔNWC	-	-	-	-1	-52	-1	-1	-1	-1	-1	-0	-1	-0	-1	-1	-1	14	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	18
Sustaining capital	-	-	-	-32	-33	-33	-34	-35	-35	-36	-37	-38	-38	-39	-40	-41	-42	-42	-43	-44	-45	-46	-47	-48	-49	-50	-51	-52
Depreciation	-	-	-	135	142	149	155	162	163	164	164	165	166	167	167	168	169	170	42	42	43	44	45	46	47	48	49	50
Equity investment	-55	-220	-110	-165	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repayment of principal	-	-	-	-60	-64	-68	-72	-76	-80	-85	-90	-95	-100	-106	-112	-119	-126	-133	-	-	-	-	-	-	-	-	-	-
FCFE (post-tax)	-55	-220	-110	-336	40	96	101	106	108	109	109	109	109	108	109	111	70	58	165	170	177	183	189	196	203	210	219	167



Free cash-flow to firm (FCFF)

Our calculation of free cash-flow to firm is an estimation of the cash generated by the project that will be contributed to a parent company. Returns are measured before tax, interest payments or repayments of principal are made. This is close to an Ebitda analysis and ignores regional disparities on tax.

Free cash-flow to equity (FCFE)

Free cash-flow to equity measures the cash-flows accruing to equity holders after taxes are paid to the local government, and interest and principal are repaid to debt holders. Rather than setting the discount rate to the project's WACC, we discount the cash flows with the project's cost of equity.

FCFF or FCFE?

The FCFF values are necessarily larger than those calculated on an FCFE basis as fewer cost items have been incurred. Both measures are valid, but the FCFE method assumes that the project is a standalone company and that all of its liabilities are attributable to the asset in question.

[1]Cash flows forecasted on a nominal basis for first 25 years of full production

[2]Initial capex depreciated on SL basis over 10yrs

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PROJECT REVIEW: Economic evaluation of CF's retrofit blue ammonia plant

Help from the IRA's 45Q tax credit makes this project profitable, boosting the appeal of US CCS retrofits

Given the IRA's influence on the cost of production for blue ammonia in the US, the biggest question faced by many existing grey producers is whether it is economically feasible to convert their capacity to blue by adding a CCS unit retrospectively. The capital costs associated with this type of project are far lower than building new capacity – the capital expenditure per tonne ammonia for CF's retrofit project is $117/t, compared to $2,000/t for the newly-built ammonia capacity.

To perform the analysis of the retrofitted plant, we have isolated the CCS operations to perform a cash flow for the duration that CF will receive the 45Q credits – 12 years from the start of production. This has been done by assuming that the revenue generated by the project is equal to the tax credits received from the government, and the costs associated are the CCS operating expenditure, increased fixed costs from the need for more workers, sustaining capital and capital servicing.

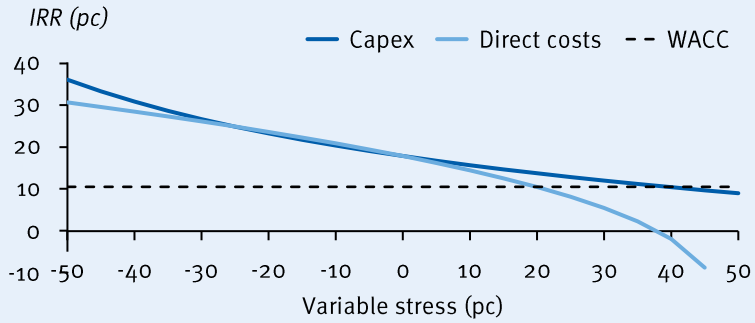
We estimate that the tax credit received by blue ammonia producers would equate to $100/t ammonia produced, as they will capture 1.17t CO_2/t NH_3, as long as the company qualifies for the full credit by adhering to apprenticeship clauses. The assumption with the highest sensitivity associated with it is the CCS opex figure, as very few plants globally are operating CCS units to draw data from. We have therefore included a sensitivity analysis which varies the direct costs (primarily driven by CCS opex) to explore its impact on NPV as the WACC varies.

The heatmap shows that the plant would produce positive returns would be generated by the project as long as the direct costs are kept below 20pc of our base CCS opex assumption. We have assumed an operating cost of $40/t of CO_2 captured, which equates to $49/t of NH_3, using a carbon dioxide capture rate of 60pc, calculated from CF's expected CO_2 reductions of 2mn t/yr.

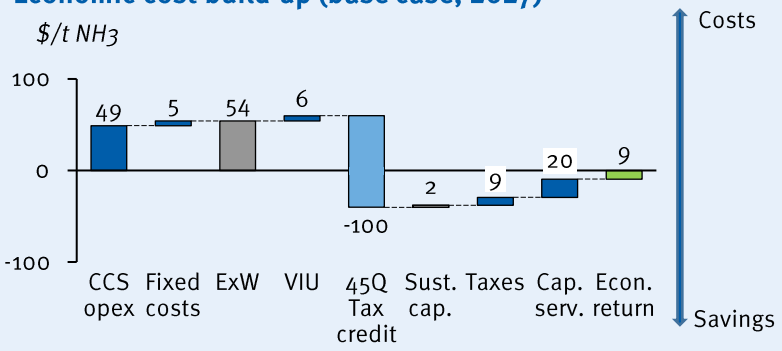
As the financing for this project is being sourced from CF's annual growth capital expenditure budget, we have used our calculated WACC for the company as a whole to estimate the cost of capital of this project. Using CF's financial data, we estimate that its cost of equity is 10.49pc, which was used at the project WACC and the benchmark IRR for a project to be worthy of investment.

The key outcome here is that the IRA tax credits look to be of sufficient magnitude to layoff most of the capital and operating costs of the CCS retrofit. (In our analysis 100pc, but there is a margin of error hear given the uncertainty around CCS costs). This means any upside from premiums achieved on sales of decarbonised ammonia over the grey market price in the future will likely accrue—perhaps in their entirety—to shareholders.

IRR sensitivity analysis, FCFF (pre-tax) – base case



Economic cost build-up (base case, 2027)



Cash-flow analysis

	Pre-tax FCFF (Base case)	Post-tax FCFE (Base case)
Present value	$ 242 mn	$ 193 mn
Terminal value (PV)	$ 3 mn	$ 2 mn
Enterprise value	$ 59 mn	N/A
Equity value	N/A	$ 9 mn
NPV	**$ 56 mn**	**$ 7 mn**
IRR	**15.0 pc**	**11.0 pc**
Profit index	1.1	0.9

NPV heatmap – FCFF (pre-tax) basis – base case

Direct cost sensitivity (pc)

WACC (pc)	-50	-40	-30	-20	-10	--	10	20	30	40	50
5.2	564	494	424	354	283	213	143	73	3	-67	-137
6.6	489	426	364	301	238	176	113	51	-12	-75	-137
7.9	424	368	311	255	199	143	87	31	-25	-81	-137
9.2	367	317	266	216	165	115	65	14	-36	-86	-137
10.5	317	272	227	181	136	90	45	0	-46	-91	-137
11.8	274	233	192	151	110	69	28	-13	-54	-95	-136
13.1	236	199	162	124	87	50	13	-24	-61	-99	-136
14.4	203	169	135	101	67	34	0	-34	-68	-101	-135
15.7	173	142	112	81	50	19	-12	-42	-73	-104	-135

Base case NPV

WACC = 10.49pc

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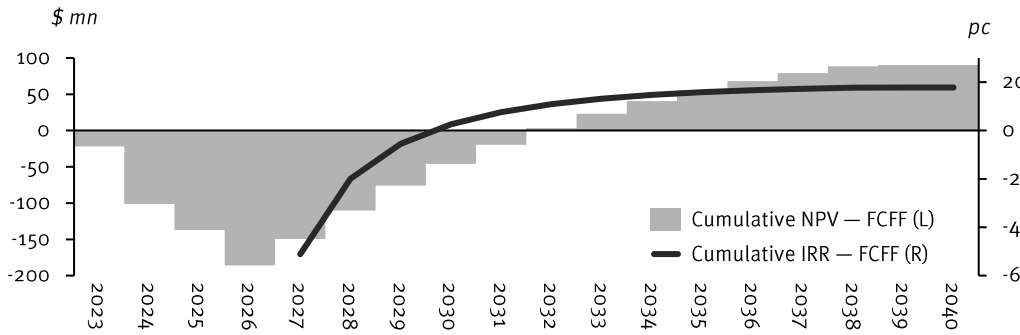
PROJECT REVIEW: CF retrofit blue ammonia project cash flow

Our base-case scenario forecasts a $90mn profit on a pre-tax FCFF basis, at an IRR of 18pc

Cash Flow: CF Donaldsonville retrofit blue ammonia project (base case)[1] — *$ mn*

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Revenue	-	-	-	16	160	160	160	160	160	159	159	159	159	159	158	158	-	-
Operating costs	-	-	-	-12	-90	-92	-94	-96	-98	-99	-101	-103	-105	-107	-110	-112	-	-
EBITDA	-	-	-	4	70	68	66	64	62	60	58	56	53	51	49	46	-	-
Sustaining Capital	-	-	-	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-5	-5	-5	-	-
ΔNWC	-	-	-	-1	-12	0	0	0	0	0	0	0	0	0	0	0	9	-
Capital Investment	-22	-88	-44	-66	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCFF (pre-tax)	-22	-88	-44	-66	54	65	63	60	58	56	54	52	49	47	45	42	9	-
EBITDA	-	-	-	4	70	68	66	64	62	60	58	56	53	51	49	46	-	-
Depreciation[2]	-	-	-	15	16	17	18	18	19	19	19	19	19	19	19	19	15	15
EBIT	-	-	-	-11	54	51	48	46	44	41	39	37	35	32	30	27	-15	-15
Interest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tax payment	-	-	-	-	-15	-15	-14	-13	-12	-12	-11	-10	-10	-9	-8	-8	-	-
Net income	-	-	-	-11	39	37	35	33	31	30	28	26	25	23	21	19	-15	-15
ΔNWC	-	-	-	-1	-12	0	0	0	0	0	0	0	0	0	0	0	9	-
Sustaining capital	-	-	-	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-5	-5	-5	-	-
Depreciation	-	-	-	15	16	17	18	18	19	19	19	19	19	19	19	19	15	15
Equity investment	-22	-88	-44	-66	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repayment of principal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FCFE (post-tax)	-22	-88	-44	-66	39	50	49	47	46	44	43	41	40	38	36	34	9	-



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