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Emerging Giants: decarbonizing ammonia in China, India and the United States

Oliver Hatfield, VP Business Development

Ammonia Energy Association conference


November 2022

Market Reporting

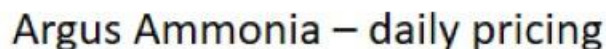
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Crude oil	<p>Argus has a global ecosystem of energy experts to provide an industry-grounded understanding of each aspect of how your firm can better navigate the journey to net zero status.</p> <p>Find out more</p>	
Oil products		
LPG/NGL		
Natural gas/LNG		
Chemicals		
Net zero >		
Power		
Coal		
Bioenergy		
Emissions		
Transportation		
Agriculture		
Fertilizers		
Metals		

Price assessments and news



Hydrogen and FF – news and prices

Argus ammonia

Issue 22-45 • Thursday 10 November 2022

CLEAN AMMONIA

FIT to produce green ammonia in Kenya
Australian hydrogen producer Fortescue Future Industries (FFI) plans to set up a plant for green ammonia and hydrogen production in Kenya and seeks to eventually export up to 1.7m t/yr of renewable hydrogen from the country.

Continued reading →

Egyptian electrolyser tested ahead of 2023 FID

Urea and ammonia producer Fertiglobe has started commissioning the first phase of its renewable hydrogen production project in Egypt; the company said today during an event at the Cop 27 UN climate summit.

Continued reading →

Azoteq, Yara team-up on clean ammonia
Ammonia fuel will drive growth and Norway's Yara Clean ammonia (YCA) will team up on future shipping projects involving the maritime industry.

Continued reading →

Cop 27: H2Global to launch first tender after summit

Germany's H2Global initiative will launch its first tenders for imports of renewable ammonia, a non-fossil and sustainable alternative fuel "right after" the Cop 27 UN climate conference which runs until 18 November. German chancellor Olaf Scholz said today in Sharm el Sheikh.

Continued reading →

'Hydrogen ready' terminals easier sold than alone

Converting so-called "hydrogen ready" LNG terminals to accept hydrogen is far more complex than the label suggests, a study by Germany-based applied research body Fraunhofer has found.

Continued reading →

Cherxon, Jera to explore low-carbon opportunities

Chemical business unit Cherxon New Energies and Japanese utility Jera have agreed to collaborate on low-carbon opportunities including hydrogen and carbon capture utilisation, and storage (CCUS) with a focus on the US and the Asia-Pacific region.

Continued reading →

Green ammonia	\$T mtpa	\$B mtpa	\$A
Middle East CCS-derived DMF Europe	1,271,440	1,208,440	x

FFI ammonia via conventional methanol route, steadily exp. & new	Year 1st	2nd Rate	3rd 19/20/21
DMF directly steady expansion, worldwide, this year, 2027	10,000	1,340,000	1,570,000
DMF green ammonia related units, 1st rate	14,250	1,710,000	1,750,000
DMF direct steam, dedicated	1,000	1,000,000	-
DMF direct steam, different technology	1,000	1,000	-
DMF 2027	-	-	-
USA CCLEP pilot, dedicated	1,000	-	100,000
USA 2027 pilot, different tech	1,000	-	1,000

*needs conversion of DMF output

Jugantar expands role to clean energy

Japan's state-owned energy agency's role is strengthened as it helps expand the country's clean energy projects, along with NHK said to achieve decarbonisation by 2050.

Continued reading →

South Korea outlines hydrogen roadmap to boost industry

South Korea is aiming to boost its hydrogen industry by creating large-scale domestic demand, developing relevant infrastructure and establishing a global supply chain. Domestic companies are collaborating in the development of a clean ammonia supply for use in clean power generation in the country.

Continued reading →

Ammonia production costs

Date	HFO Cost (\$/t)	ITT/LHV Cost (\$/t)
28 Oct 21	~1,500	~1,500
3 Mar 22	~1,500	~1,500
7 Jul 22	~2,500	~2,500
9 Nov 22	~1,500	~1,500

Subscribers can download the latest green ammonia project and vessel tracking data here

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Argus Hydrogen and Future Fuels

Market news, analysis and prices

Issue 22-27 | Sunday 8 November 2020

EDITORIAL *The key to a prosperous hydrogen future to southwest Asia is cross-border co-operation*

South Asia vies for H2 attention

It is easy to overlook southwest Asia. In the global debate over energy and climate, it does not attract the same attention as China, India or the US, and its politics have not captured energy markets in the same way as Russia in the middle East.

But it is a region of more than 650m people, and of vast energy demand and resources, facing the same decarbonisation puzzle as the rest of the planet, and it is coming to some of the same conclusions. Including the idea that low-carbon hydrogen could be one of the solutions.

But progress has been slow. The pace of clean hydrogen progress has varied across Asia, with Japan, South Korea and Taiwan doing the strongest. Southwest Asia has remained more divided, with Saudi Arabia, in part driven by energy security concerns as the Russia-Ukraine conflict has reduced energy trade flows and sent fuel prices soaring, but – as delegates at last month's Singapore International Energy Week conference heard – if clean hydrogen is to be scaled up across the region in a cost-effective way, billions of dollars need to be put on the table, and fast.

The EU, as a comparison, is expected to need 3700bn-5200bn to develop to targeted 10m t/yr of low-carbon hydrogen capacity, according to IEA estimates. Southwest Asia will need to invest much more if not larger sums, and those countries that cannot afford it will have to rely heavily on foreign direct investment, which will in turn mean getting the right policy support and regulation in place.

"Building regulation will attract private-sector investments," said Heng, president for southwest Asia at Asia's green energy development Pioneers For Future Industries, told the conference. "Countries need to champion an example." Heng, he noted, last month became the first southwest Asian country to visit a hydrogen energy, which will involve funding the hydrogen research and co-operation with international partners to establish global supply chains and trade. Cross-border co-operation could in fact be vital for southwest Asia, where no gas. "It is no surprise that major hydrogen policies are being studied by the EU and US – they leverage the power of a federal government to develop policies," notes Shashank Agrawal, acting managing firm CEO. "The Asia-Pacific region is far less homogeneous than the west, but we need to develop more effective policy collaboration too, such as via Asean."

A bigger picture

This is an important point. Southwest Asia sometimes gets overlooked because other countries or regions opt with a single issue when it comes to setting decarbonisation targets and the policy framework to support them. Their governments make a bigger picture, almost every country makes its own decisions on technology, agreements and financing then follow.

But policy co-ordination between southwest Asian governments is far less been spotty. Singapore and Vietnam signed agreements last month to collaborate on energy initiatives such as carbon capture, hydrogen and ammonia, and Japanese utility group Jera has signed several agreements with partners across southwest Asia, including in Thailand and Malaysia, to collaborate on developing ammonia projects. But further bilateral and regional co-operation will also need to be needed if southwest Asian governments are to compete successfully for the investment they need to get clean hydrogen development off the ground.

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Argus Hydrogen and Future Fuels

Issue 22-01 | Tuesday 8 November 2022

HYDROGEN PRICES

Northwest Europe average cost \$/kg

North America average cost \$/kg

Northeast Asia average cost \$/kg

European average cost \$/kg

Regional hydrogen cost markets

Process		2010-12 actual		2012-23 forecast	
		\$/kg	± 1 %	\$/kg	± 1 %
Europe					
Northwest Europe	SMR	3.24	+0.40	3.28	+0.40
North America	SMR	3.08	+0.17	3.76	+0.17
Northeast Asia	SMR	4.07	+0.10	4.47	+0.41
Middle East	SMR	3.56	+0.58	3.97	+0.54
Asia					
Northwest Europe	SMR-123	3.40	+0.47	3.75	+0.49
North America	SMR-123	3.40	+0.48	3.94	+0.17
Northwest Asia	SMR-123	3.80	+0.11	4.29	+0.11
Middle East	SMR-123	4.00	+0.34	4.71	+0.30
Latin E					
Northwest Europe	SMR-123	3.70	+0.34	4.40	+0.34
North America	SMR-123	3.70	+0.35	4.47	+0.48
Northwest Asia	SMR-123	4.34	+0.10	5.04	+0.10
Middle East	SMR-123	3.70	+0.34	4.47	+0.34
Mexico					
Northwest Europe	Steam-methane-PSA	2.23	no	2.32	no
North America	Steam-methane-PSA	3.78	no	3.90	no
Northwest Asia	Steam-methane-PSA	19.45	no	6.57	no
Middle East	Steam-methane-PSA	3.90	no	3.90	no
Europe					
European landfall	SMR	3.90	+0.50	3.46	+0.46
SMR-1	SMR-123	3.46	+0.40	3.71	+0.47
European land E	SMR-123	4.20	+0.40	3.46	+0.46
European land E	Steam-methane-PSA	3.47	no	3.47	no

Argus hydrogen scenarios

Scenario	Fuels	Prices		Growth
		2022	2030	
Baseline	SMR	30 \$/kg	115 \$/kg	+3.3
SMR-1	SMR	30 \$/kg	108 \$/kg	+3.8
European land E	SMR-123	30 \$/kg	108 \$/kg	+3.8
Asia E	SMR	30 \$/kg	115 \$/kg	+3.3

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Argus clean ammonia subject matter expertise

Argus Ammonia Analytics



0	Executive Summary
1	Russia-Ukraine Conflict Special Focus
2	Demand
3	Supply
4	Costs and Inputs
5	Trade
6	Balance and Prices
7	Green Ammonia Supply

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SPECIAL FOCUS: Environmental regulation and legislation

European and Canadian emissions targets may result in reduced fertilizer usage and lower food output

Introduction to environmental regulation and legislation

In this section we will report on key policies that have the potential to cause disruption or significant alterations within the fertilizer market as a whole that can increase directly to the nitrogen fertilizer markets in many instances.

It is important to point out that the original reports covering environmental regulation and legislation discussed in the following policy are proposals that have not yet been adopted, signed, endorsed or even, in some instances, widely debated. Therefore, we are not able to quantify the impact on the nitrogen fertilizer market and specifically the nitrogen market. Instead, we are using this Special Focus to highlight that these policies are in development and have the potential to disrupt the market.

The policies covered in this Special Focus are:

- A Carbon Border Adjustment Mechanism (CBAM)
- The EU ban on NPK 2021 strategy
- Healthy Environment Healthy Economy (HEHE)

This Special Focus explores the options in the carbon policy documentation relating to the nitrogen fertilizer market and aims to create a more general scenario analysis on the impact of carbon pricing on the nitrogen fertilizer market and fertilizer participants.

Indirectly reducing greenhouse gas (GHG) emissions from fertilizers. The focus is generally aimed at nitrogen and phosphorus, but also includes potassium. The focus is on reducing the growing adoption of efficiency improving inputs with nitrogenous components to prevent the subsequent long-term GHG and avoid carbon-intensive production and emissions further backlogs.

Countries directly affected by the proposed regulation and legislation

• EU
 • Canada, P&F

Direct potential impact on fertilizer market

Policy	Location	Impact
CBAM	EU	Export
P&F	EU	Export
HEHE	Canada	Export

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Global green ammonia capacity tracker, 2021-2036

Argus is tracking about 70mn t/yr of speculative green ammonia capacity — 97pc is merchant capacity

Argus' ammonia capacity forecast is based on its selection of the most credible ammonia capacity projects, all of which are merchant capacity. Projects that do not meet this criteria are excluded from our base forecast, and are included for projects with capacity.

- **Base:** Projects are fully licensed, and the EPC contractor has commenced construction. Typically, most large engineering will have been delivered by the site and all required gas conditioning and infrastructure will be in place. We report base projects on having passed the gate 400.
- **Pipeline:** Projects are those that are probable to be licensed and the greenfield at least will have begun. However, there will be no complete competitive data, such as complete gas pipelines, political data or contracts.

Global green ammonia speculative capacity by region

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Russia/Ukraine conflict: Argus' impact analysis summary

Key points

Summary

- The ammonia market has been the most affected of all fertilizer markets worldwide in the months since the conflict. Russian ammonia accounts for more than 30pc of the merchant ammonia market. Large regions of Russian ammonia have been forced to find alternative supplies or at least high ammonia market following the Russian export restrictions.
- All the major players, including the top export port for Russia of Odessa (Ukraine), have halted operations — about 2.5m tonnes of ammonia are expected through this port.
- Ammonia exports through the Baltic ports of Lithuania and Poland are significantly reduced — although both have not been officially announced, several EU member states have announced that they will not accept ammonia to be imported from the Baltic.
- EU sanctions on Russian fertilizer company OJSC have further complicated the supply of ammonia.
- European nitrogen gas prices surged to all time highs — the start of the Russian-Ukraine conflict resulted in a sharp increase in gas prices. The start of the conflict also saw European ammonia prices rise, as the transportation and infrastructure related to the importation of ammonia is a result of rising production costs.
- World fertilizer production is being put at risk by the Russian and Ukrainian ammonia exports — the Russian and EU both have been reported to the market.
- Russia is Russia's largest ammonia importer in volume terms — ICP reported from the Russian port of ammonia through Poland in 2021. ICP has had to source ammonia from an increasing port of suppliers since.
- Ukraine announced an effective ban on exports of nitrogen, phosphate, potash and urea complex fertilizers — the announcement was made to ensure domestic supplies in response to the current climate appears to be significantly reduced.
- Distribution of Russian ammonia projects are likely to be delayed because of equipment, transportation and component issues.

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Argus clean ammonia subject matter expertise

Argus clean ammonia and net zero consulting



Green ammonia demand forecast: Upside case



- Our ambitious scenario assumes a much faster improvement in production costs and cleaner market incentives and, therefore, market penetration for green ammonia.
- The key differentiator demand pattern for a scenario sees ammonia leading candidate for targets, while in the assumed a mix of the as the widespread use for reaching the same.

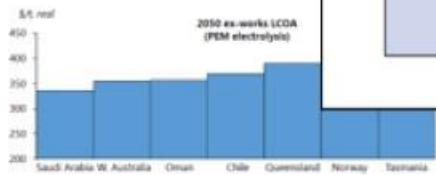
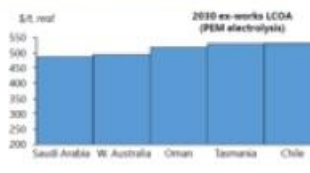
Green vs grey ammonia: Upside case



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Green ammonia cost curve (ex-works levelised costs): 2030 and 2050

- Middle East and Australian locations would have low levelised costs of hydrogen and ammonia on an ex-works basis.
- Electrolyser technology maturity, economies of scale and increased efficiencies are expected to generate significant cost improvements across all locations.
- However, we note that a key element to completing this analysis is freight costs, which will determine each location's competitiveness on a delivered basis in key demand clusters for green ammonia, namely Europe and Japan. This will be shown in the next slide.



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Argus Consulting – 2022 Green Hydrogen/Ammonia Project Credentials

Segment	End Client Profile	Location	Project Focus	Key Client Questions
Existing Ammonia Players	Fertilizer producer (ammonia buyer)	MENA	Impact of CBAM	<ul style="list-style-type: none"> How is CBAM likely to be implemented? What will be impact on our competitive landscape?
	Industrial producer (ammonia buyer)	Europe	Green ammonia pricing	<ul style="list-style-type: none"> What price should I be paying for low-carbon ammonia? What is the value of being first mover?
	Fertilizer industry	MENA	Decarbonization strategy	<ul style="list-style-type: none"> What are the GHG emission from fertilizer in our country? What examples of decarbonization can we observe in other regions?
	Integrated nitrogen fertilizer producer	Central Asia	Decarbonization strategy	<ul style="list-style-type: none"> How should our core business adapt to decarbonization trends? What new low-carbon business opportunities should we pursue?
	Ammonia Producer	Europe	Clean ammonia IPO support	<ul style="list-style-type: none"> How can we leverage our competitive position in traded grey ammonia to develop the clean ammonia market?
New Ammonia Players			Clean ammonia bunkering	<ul style="list-style-type: none"> How will low-carbon fuels affect global bunkering market? What investments have been made in clean ammonia bunkering?
	Oil & Gas Producer	Europe	Gas diversification	<ul style="list-style-type: none"> How will low-carbon developments affect current grey ammonia market? Should we invest in LNG or ammonia as means of monetising gas?
	Oil Refinery	Europe	Decarbonization strategy	<ul style="list-style-type: none"> What market trends are affecting our core business in refining and storage? How should we position ourselves within low-carbon hydrogen economy?
	Utility	Europe	Pink ammonia review	<ul style="list-style-type: none"> What are customer perceptions of ammonia colour: pink vs blue and green? What is regulatory environment for pink hydrogen and ammonia?
			Low-carbon ammonia customer analysis	<ul style="list-style-type: none"> How is low-carbon ammonia demand expected to develop in Europe? Which customers should we be targeting for low-carbon ammonia?
	Utility	Europe	Green ammonia customer analysis	<ul style="list-style-type: none"> How cost competitive is green ammonia produced in Europe? Which customers should we be targeting for green ammonia?
	Renewable Energy Developer	Oman	Green ammonia project feasibility	<ul style="list-style-type: none"> How cost competitive is project in Oman? How suitable is proposed offtake agreement?
	Industrial Conglomerate	India	Green hydrogen commercialization	<ul style="list-style-type: none"> How best should we monetize proposed green hydrogen capacity? What is the price sensitivity of green hydrogen/ammonia demand?

Argus clean ammonia subject matter expertise

Conferences and events



26 November - 30 November 2022
Hamburg, Germany & Online access

Argus Clean Ammonia Europe Conference

13 days

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Bringing together industry pioneers driving the clean ammonia market within Europe and globally


The Argus Clean Ammonia Europe conference is pleased to be launching in-person in Hamburg, Germany and online on 26-30 November 2022.

Following on from the highly successful Argus Clean Ammonia Virtual conference series launched in 2021, which brought together more than 330 key stakeholders in the clean ammonia space globally, the Argus Clean Ammonia Europe conference is not one to miss!

Join senior industry colleagues from across the value chain as well as across sectors for three days of networking and insight into the latest market developments and dynamics from industry-leading speakers and companies trailblazing the path to net zero.

[Book a pass](#)

By utilising our dedicated Clean Ammonia advisory board, and through an expert line-up of speakers, we will cover all your key questions, bringing solutions and new perspectives on the future of the clean ammonia market.



19 October - 21 October 2022
Miami, Florida

Argus Fuel Oil and Alternative Marine Fuels US Summit

0 days to go

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Bringing together America's fuel oil and alternative marine fuels markets for insight on the future of fueling the bunker industry

After a couple of years apart, we are excited to reunite with the fuel oil and marine fuels sector in Miami at the 2022 Argus Fuel Oil & Alternative Marine Fuels US Summit, October 19 - 21. New for the 2022 event, the Argus Fuel Oil Summit will provide you with critical insight on the future role of alternative marine fuels in the bunker industry as the sector moves full steam ahead towards decarbonization.

Network back in-person with 150+ refiners, ship owners, ship charterers, fuel suppliers, fuel blenders, traders, brokers, utilities fuel buyers, analysts and financiers plus many others in Miami for the industry's flagship event.

VENUE UPDATE:

The Argus Fuel Oil and Alternative Fuels US summit will now take place at The Miami Beach EDITION. For more information please email [conferences@argusmedia.com](#)

[Book a pass](#)

- Global perspective ←
- India focus

- Global perspective

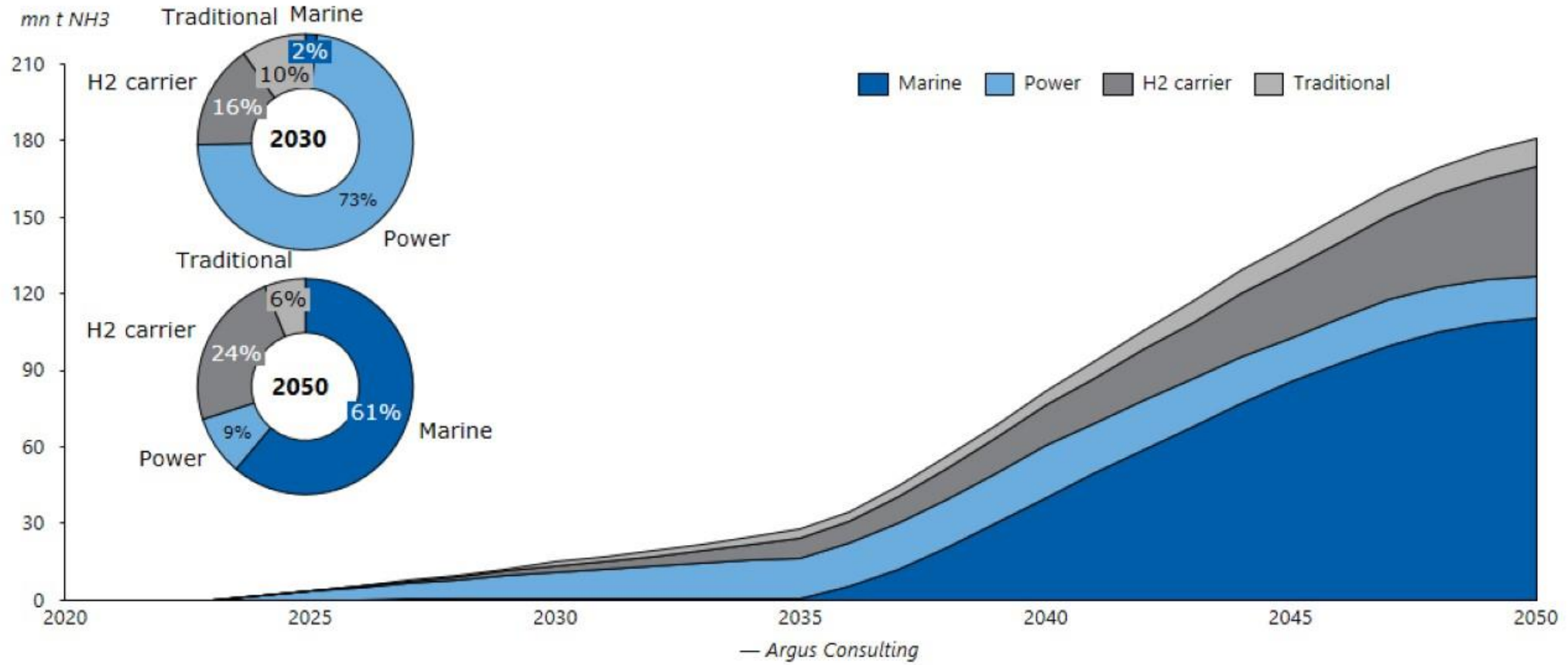
- Green ammonia potential by end use
- Project activity
- Pricing and production costs



- India focus

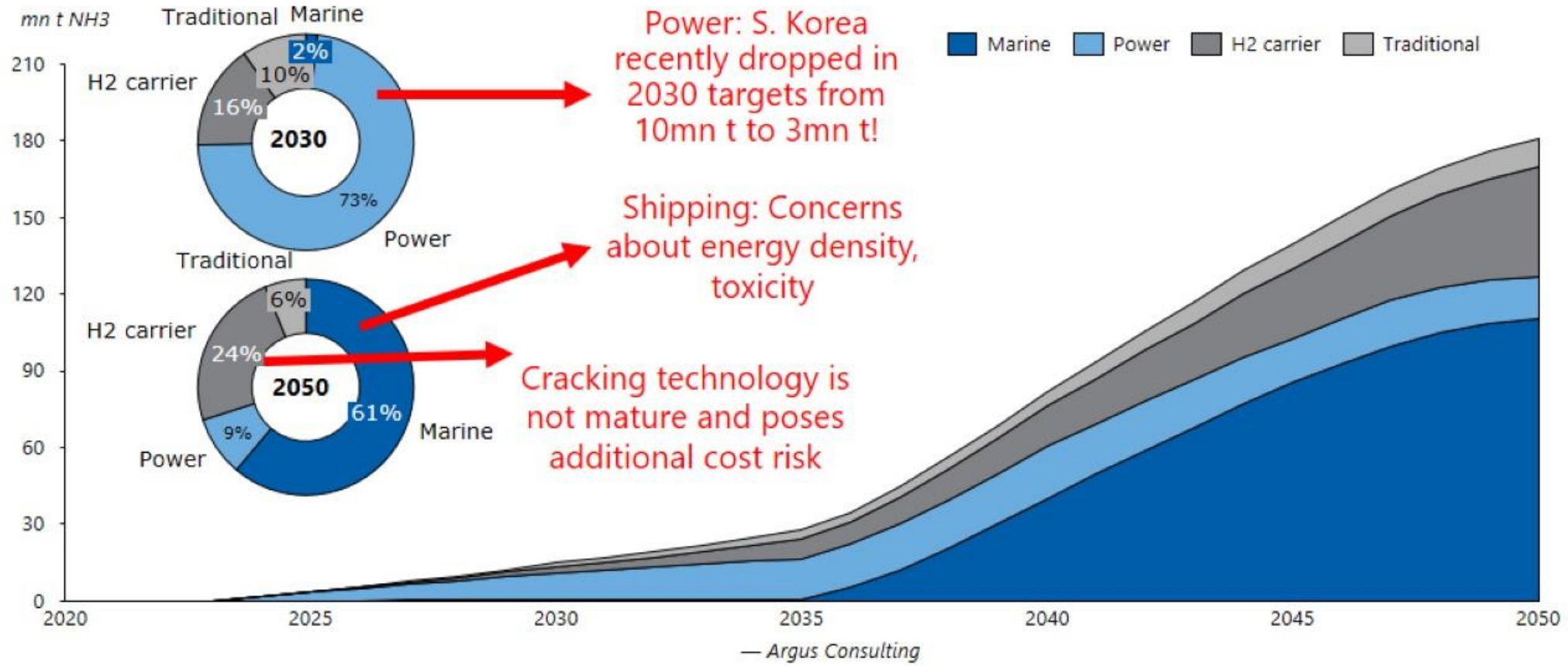
Demand outlook - Power is first major demand segment, likely overtaken by marine and H2 carrier uses in long-run

Estimated future blue & green ammonia demand by segment



Demand outlook - Power is first major demand segment, likely overtaken by marine and H2 carrier uses in long-run, but there are risks to this outlook¹⁰

Estimated future blue & green ammonia demand by segment

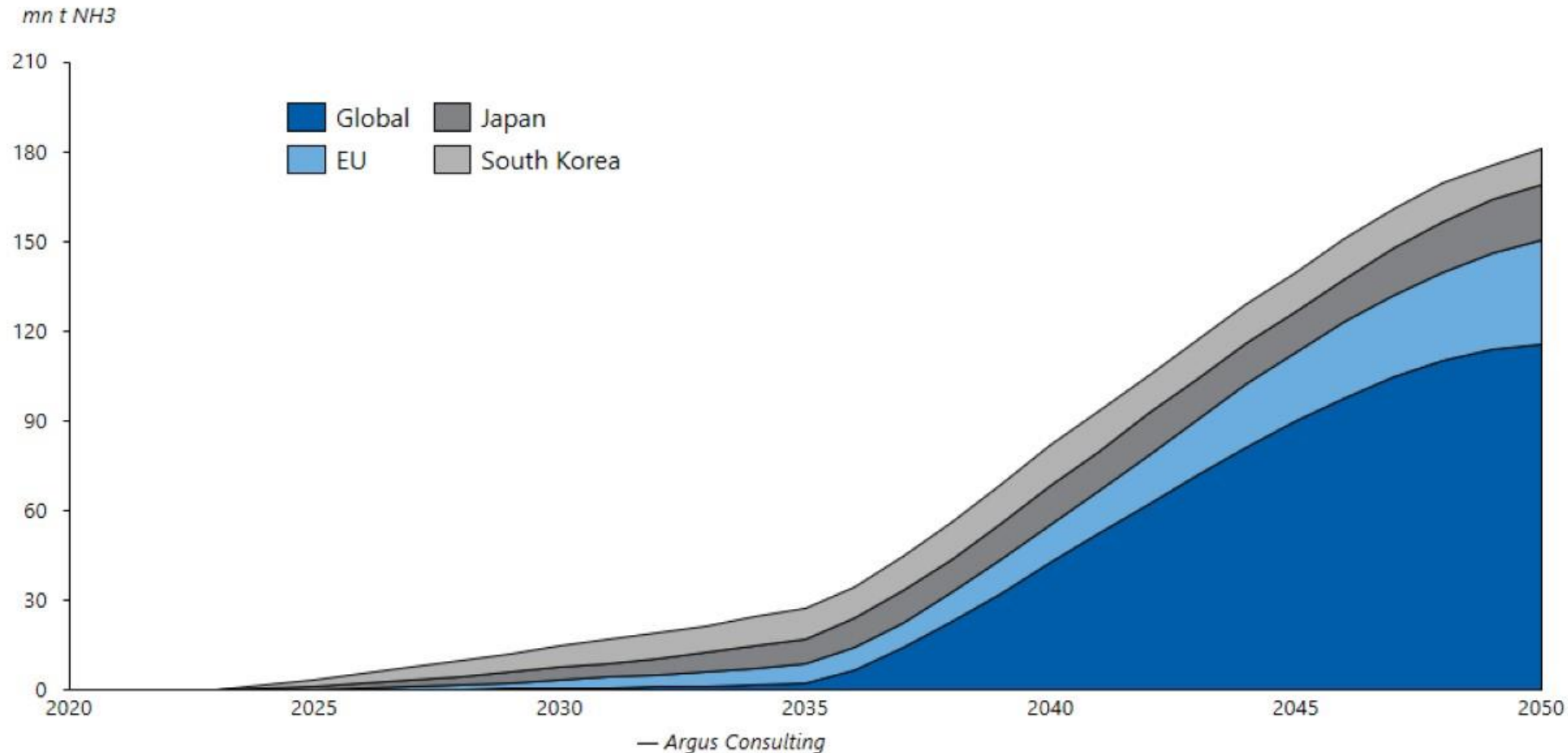


Regional demand outlook: Argus base-case scenario

11

East Asia is a first mover, but Europe could emerge as dominant demand centre in the long-run

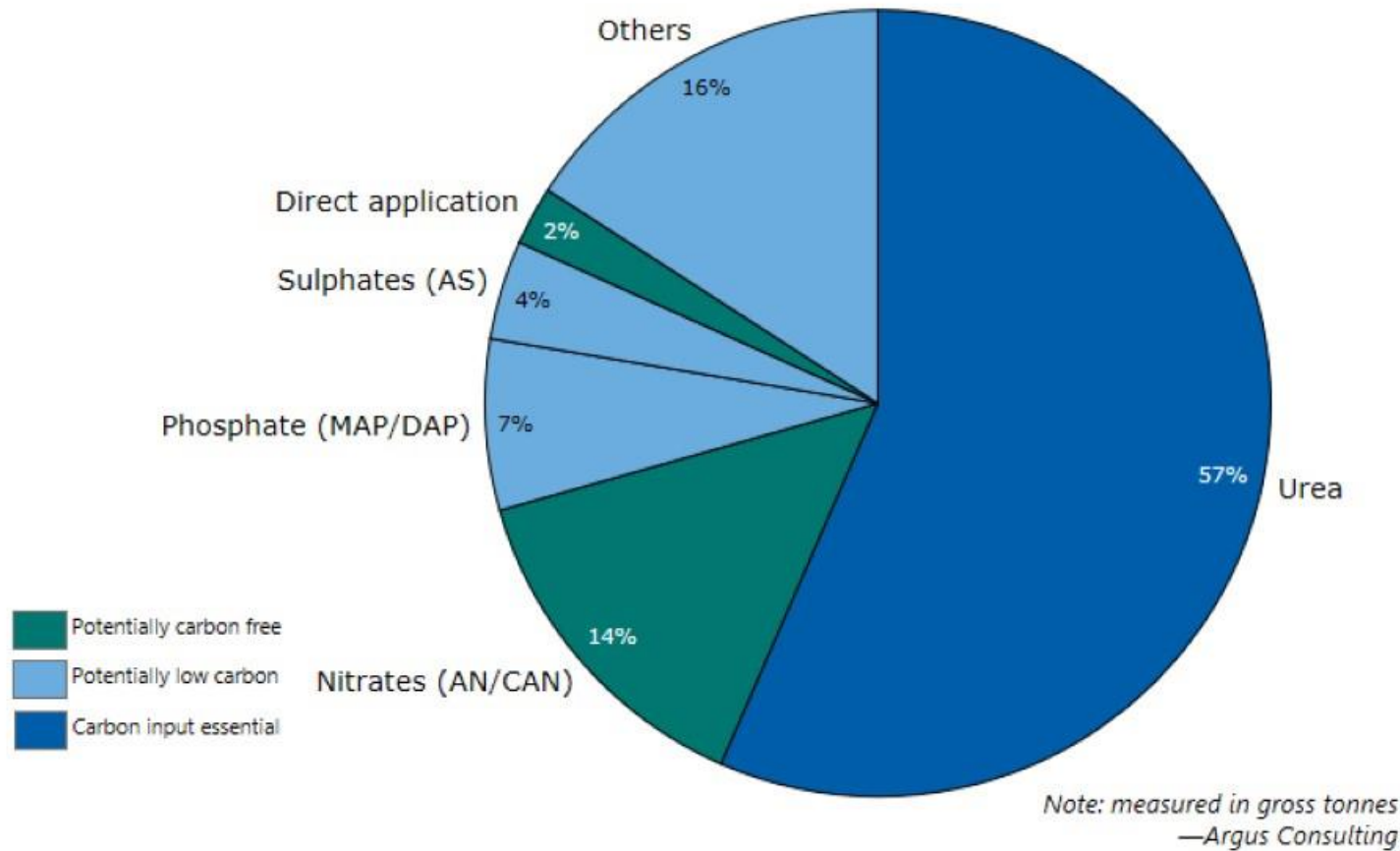
Estimated future blue & green ammonia demand by geography




Demand for traditional uses is likely to be small

As long as urea is the main nitrogen product the use of green ammonia in fertilizers could be limited

Downstream nitrogen fertilizers that require a carbon input from upstream ammonia production



- Global perspective
 - Green ammonia potential by end use
 - Project activity 
 - Pricing and production costs
- India focus

Capacity outlook for green ammonia

We are tracking around 70mn t of speculative green ammonia capacity

- **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 we have graded as probable will be financed and the groundwork at least will have begun. However, there will be an area/s 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 are currently either at the feasibility stage or have progressed to construction but face significant delays due to 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 yet to commence.

Gross green ammonia speculative capacity expansions



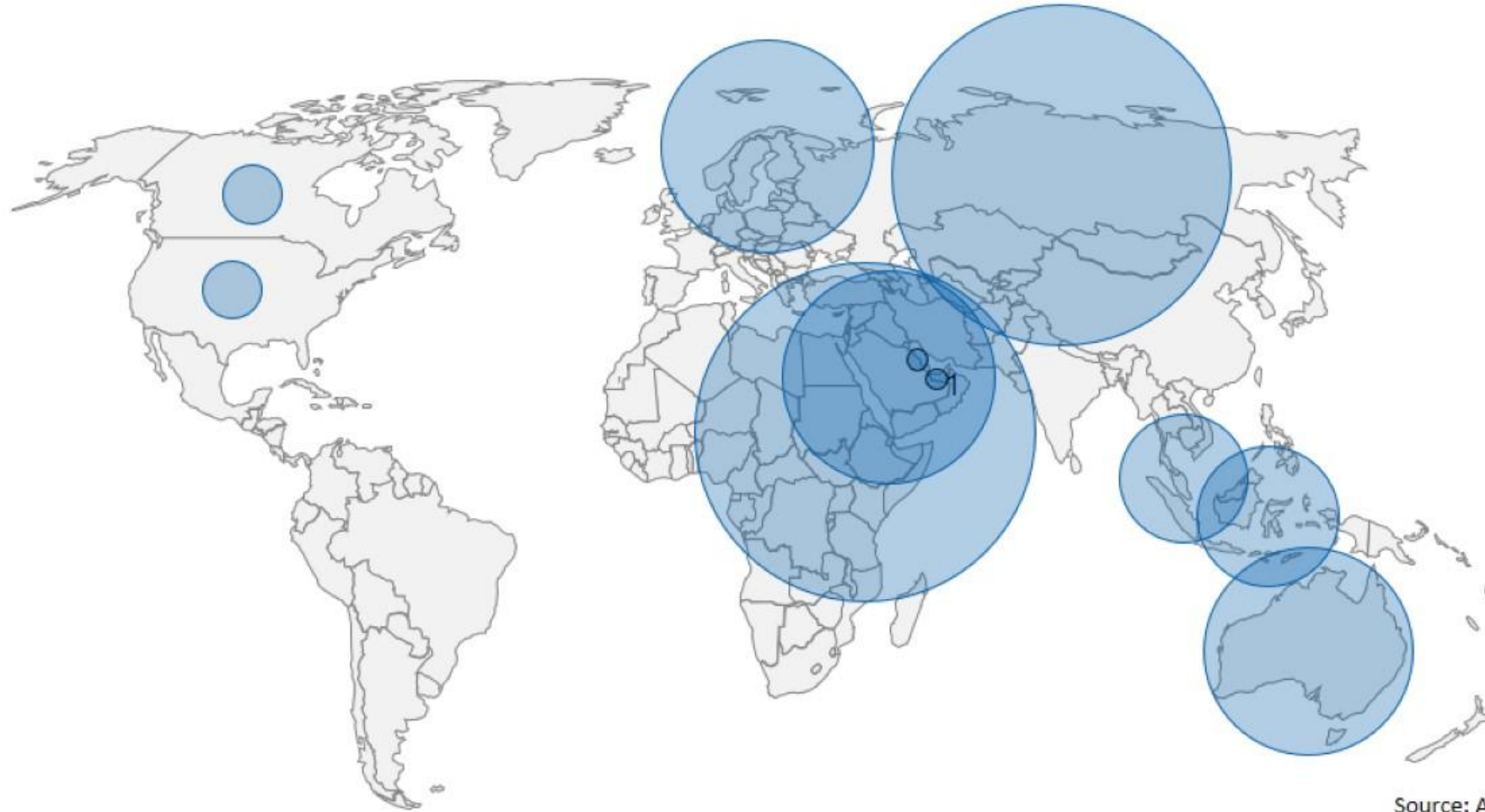
Source: Argus Analytics

Planned blue ammonia projects

>20mn t of blue ammonia capacity announced, a marked increase since last year

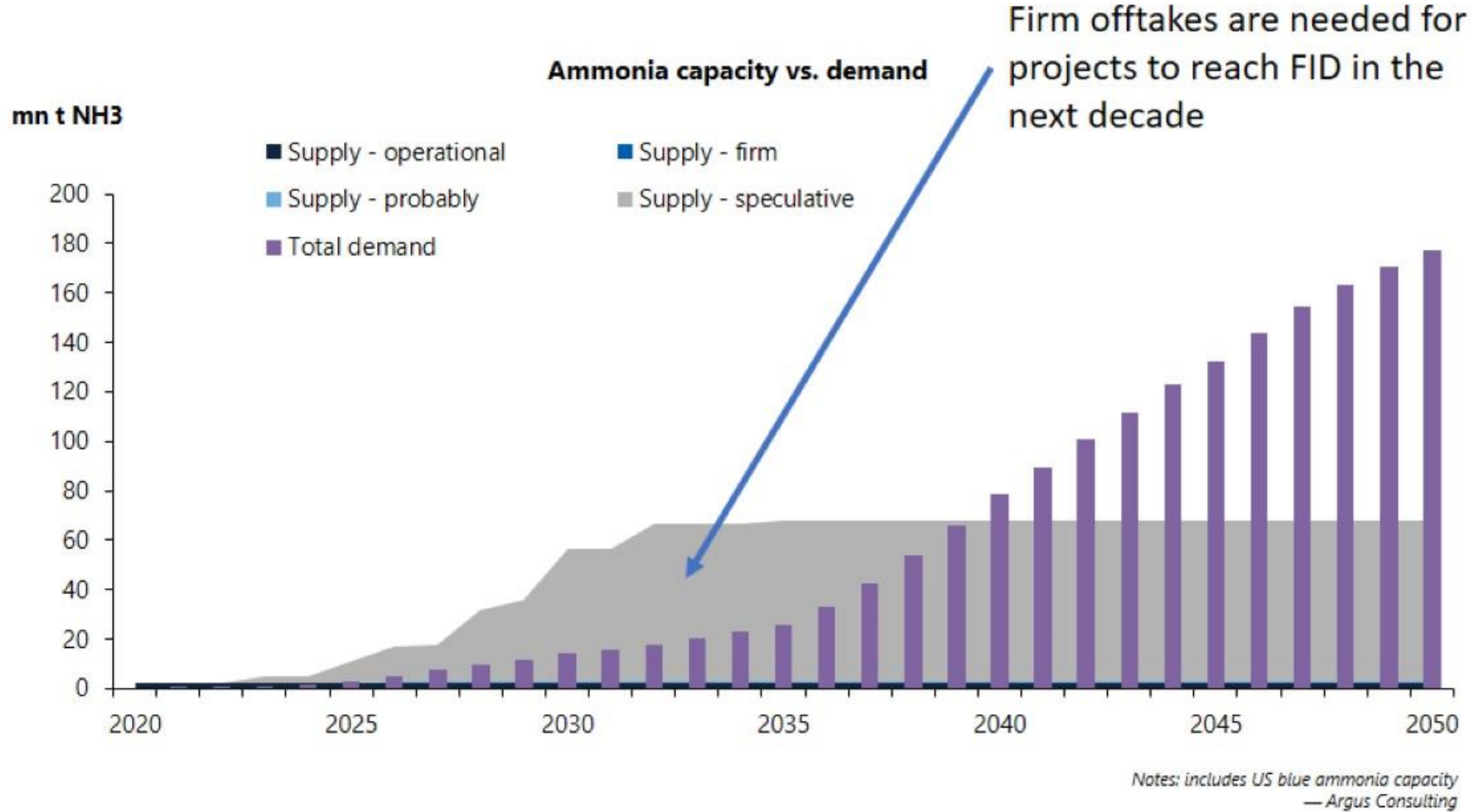
15

Blue ammonia project capacity overview



Source: Argus Analytics

Large number of projects and limited short-medium term demand potential means that many projects will fail to materialise

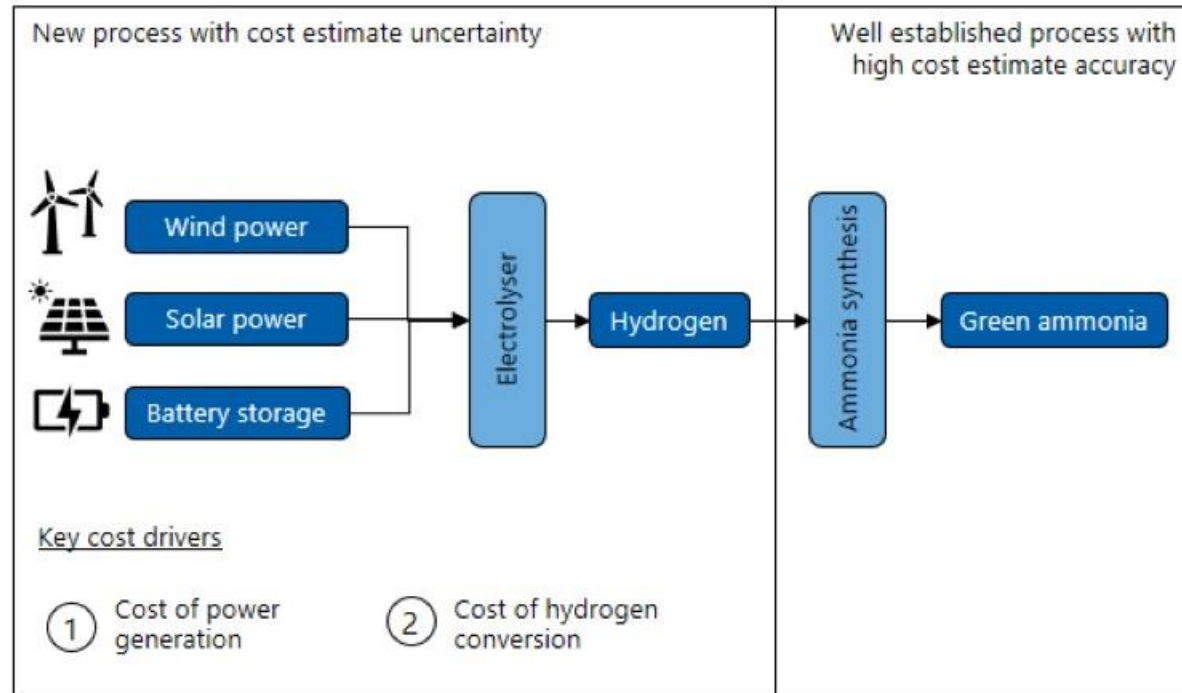


- Global perspective
 - Green ammonia potential by end use
 - Project activity
 - Pricing and production costs
- India focus



Forecasting future green ammonia prices a unique challenge

New electrolyser technology is immature, and renewable generation as a feedstock to fertilizers is rare



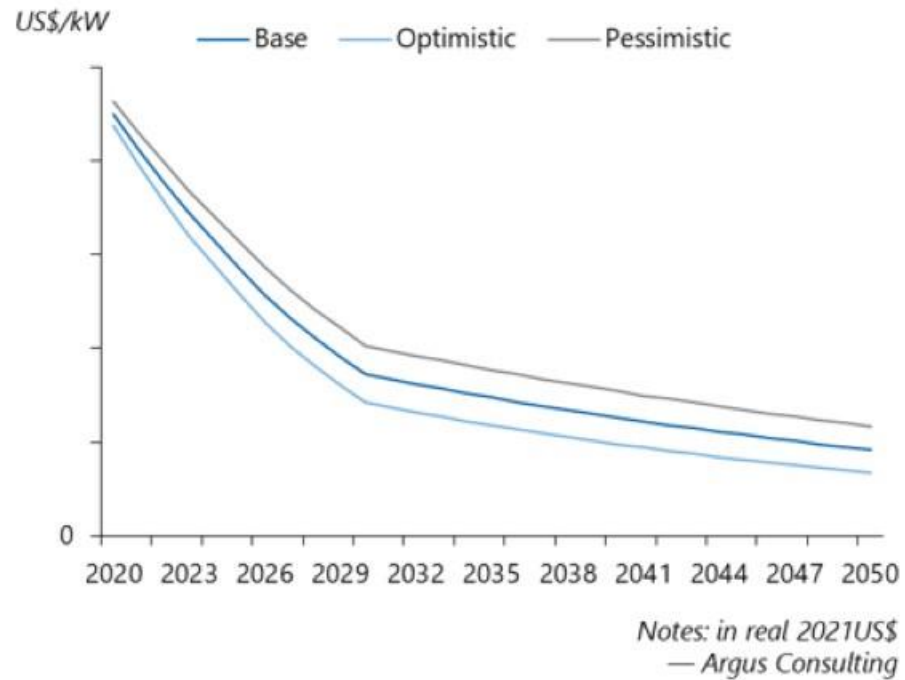
- The ammonia synthesis combining hydrogen with nitrogen using the Haber-Bosch methodology is a well established process.
- The hydrogen feedstock production however utilises novel technologies for which important technological progress is anticipated
- Given the high impact of hydrogen prices on green ammonia costs as well as the uncertainty in the speed of cost reduction, scenarios best incorporate key drivers of hydrogen generation cost:
 1. Cost of power generation
 2. Cost of hydrogen conversion (impacted by electrolyser technology)

Source: Argus Consulting

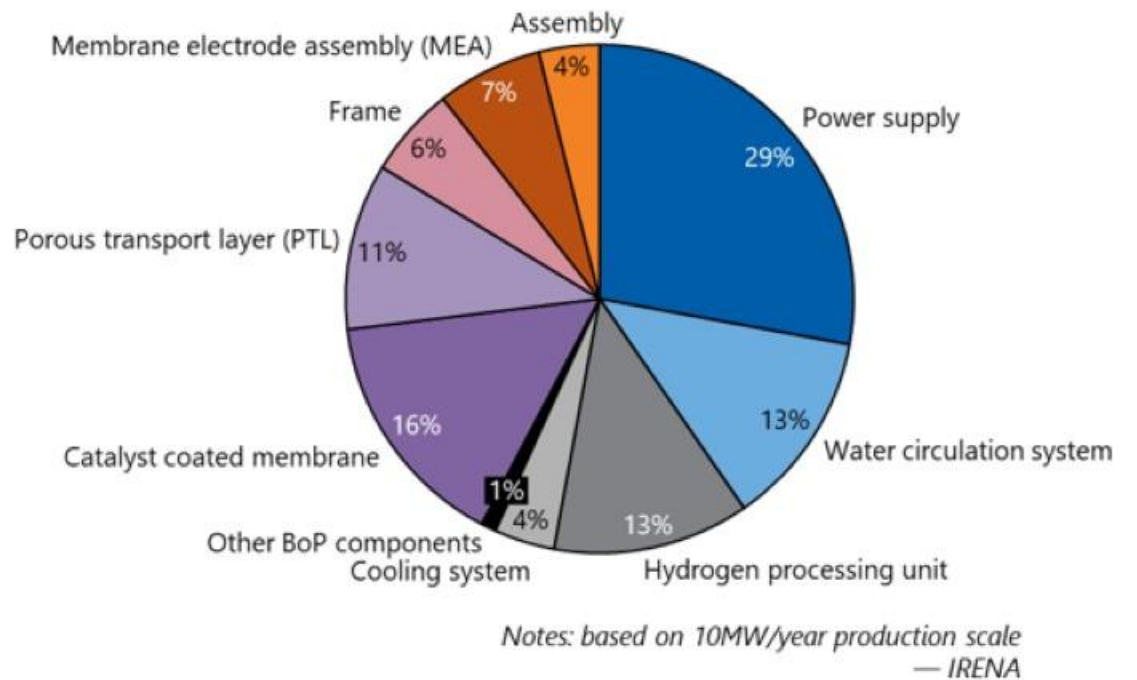
Levelized costs of green hydrogen are shaped by the power price and by electrolyser capital intensity

19

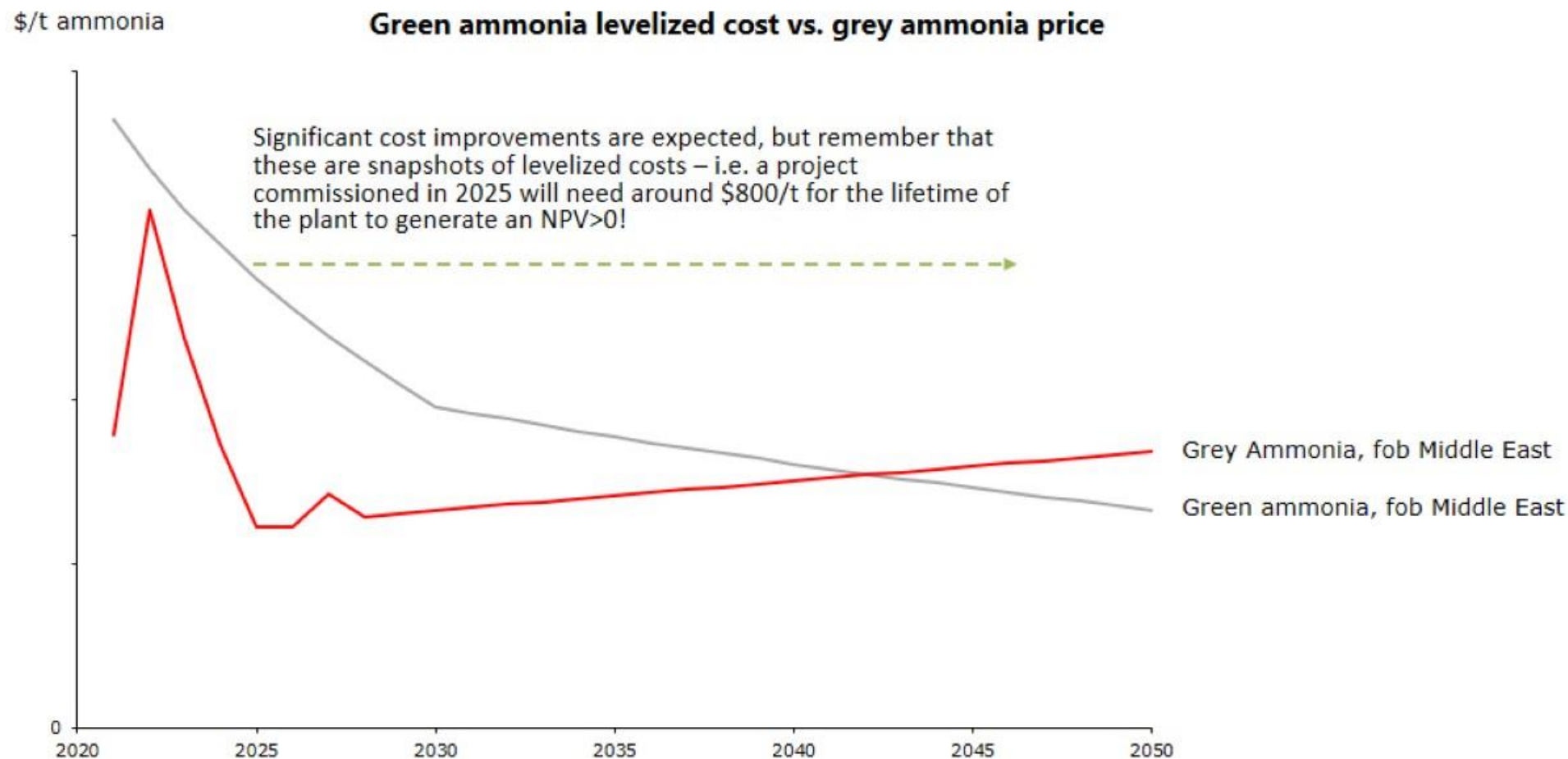
Electrolyser CAPEX intensity



Electrolyser manufacturing cost components

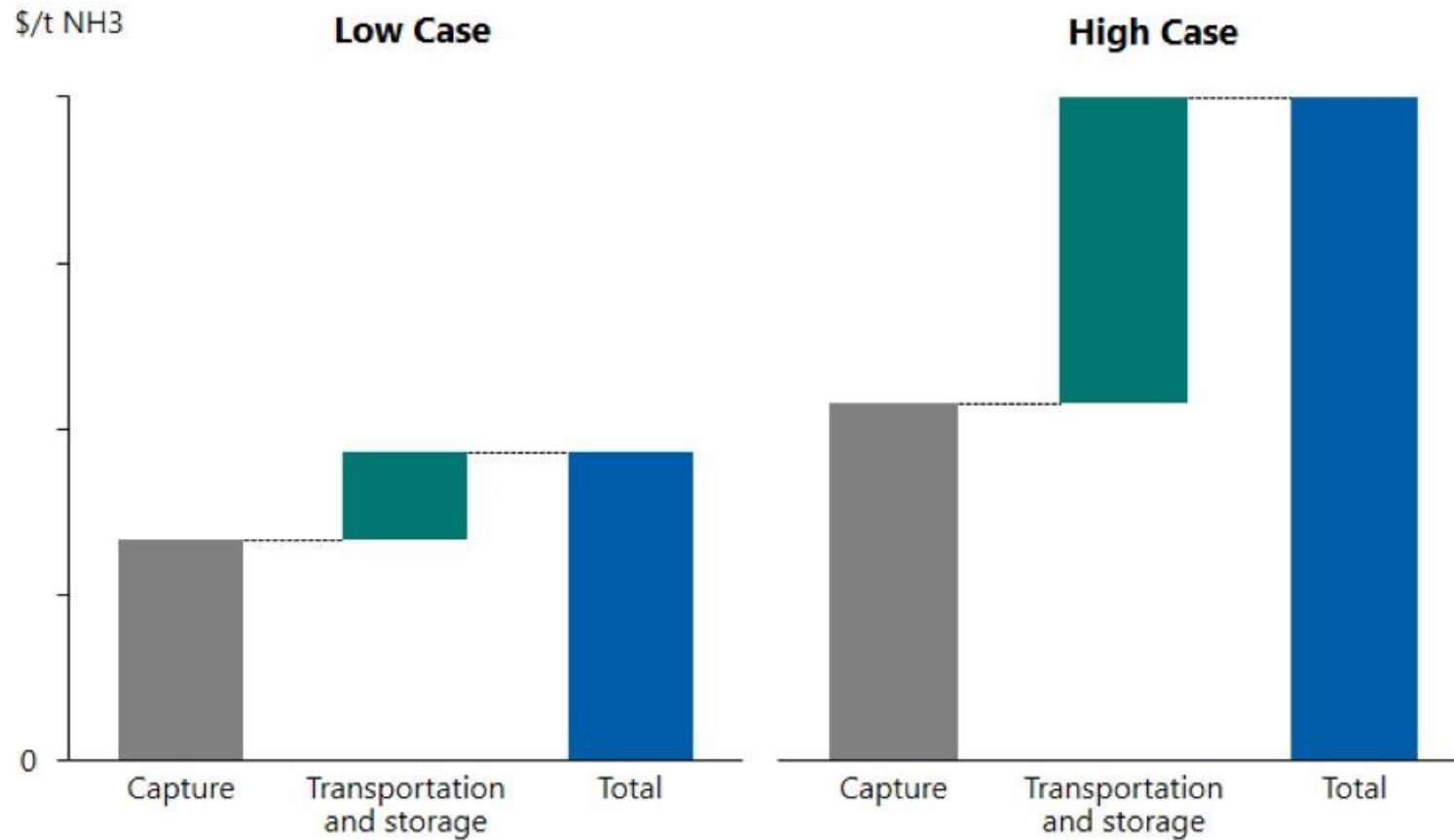


Green H2 economics suggest that green ammonia will be significantly more expensive vs. grey ammonia in the short and medium term



Source: Argus Analytics

Blue ammonia offers lower production costs and the opportunity for more familiar pricing arrangements, especially for retrofits of existing plants




- Most Blue Ammonia projects are being planned by existing producers
- Grey NH₃ + CCS cost or Grey NH₃ + carbon price would be a likely pricing strategy

Source: IEA, Argus Consulting

- Global perspective
- India focus



- Global perspective
- India focus
 - Background 
 - Demand and addressable market
 - Supply and projects
 - Challenges

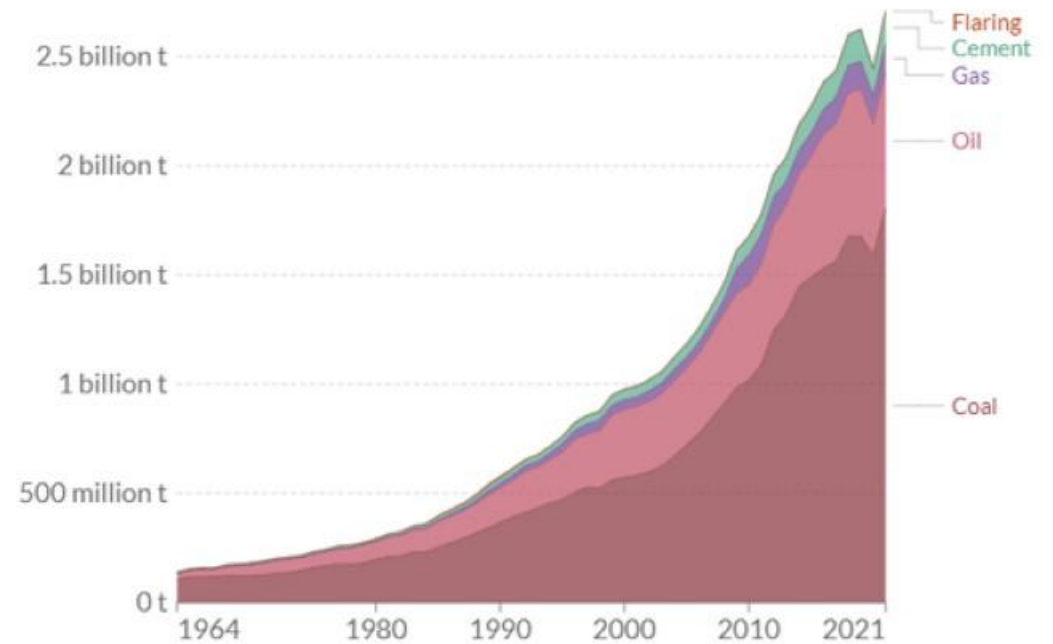
Policy Background

- India makes up around 8% of global GHGs
- It has a five-point plan to reach net zero greenhouse gas (GHG) emissions by 2070,
- The focus is largely on ramping up renewables development by 2030; reducing CO2 emissions by 1bn t from now to 2030, and cut the economy's carbon intensity by 45pc over 2005-30.

CO2 emissions by fuel or industry type, India

Our World
in Data

↔ Change country □ Relative



Source: Our World in Data based on the Global Carbon Project (2022)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Position on ammonia and hydrogen

The country's **national hydrogen roadmap** set a production target of 5mn t/yr by 2030, ambition to make India a green hydrogen hub, including for export. Several commitments and initiatives at the draft stage

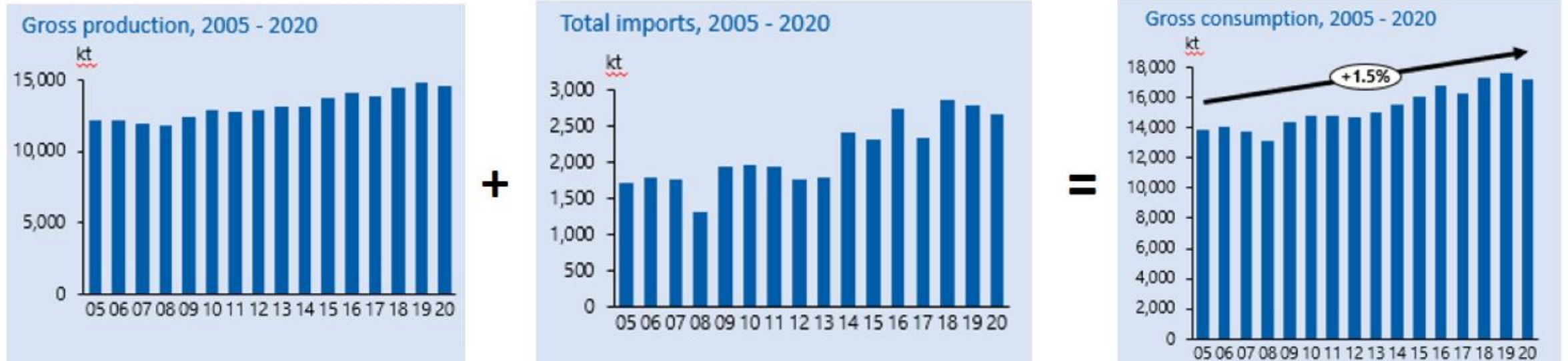
- **Demand**
 - Green hydrogen purchase obligation (GHPO) for several sectors
- **Supply**
 - Plan to introduce production-linked incentive (PLI) schemes for electrolyser manufacturing for the first 4mn-5mn t/yr of renewable hydrogen output
 - E.g. Tax rebates, export duty concessions, easier land acquisition terms
 - Power-related measures to spur project investment
 - A waiver on inter-state electricity transmission fees for green hydrogen producers (in production before mid-2025)
 - Producers will be able to bank' their surplus renewable power in the grid, with an option to use it within 30 days to address intermittency
 - Hydrogen and ammonia projects will be prioritised for grid access
- **Other**
 - Ministry for New and Renewable Energy (MNRE) has said that India's focus will be on green hydrogen using renewable capacity with no place for blue
 - Export focus: permission granted for producers to set up storage near ports to facilitate exports; other measures to stimulate export business

- Global perspective
- India focus
 - Background
 - Addressable market
 - Supply and projects
 - Challenges



Ammonia demand

India's ammonia consumption is growing steadily, with most of the demand met by domestic production and ~13% via imports

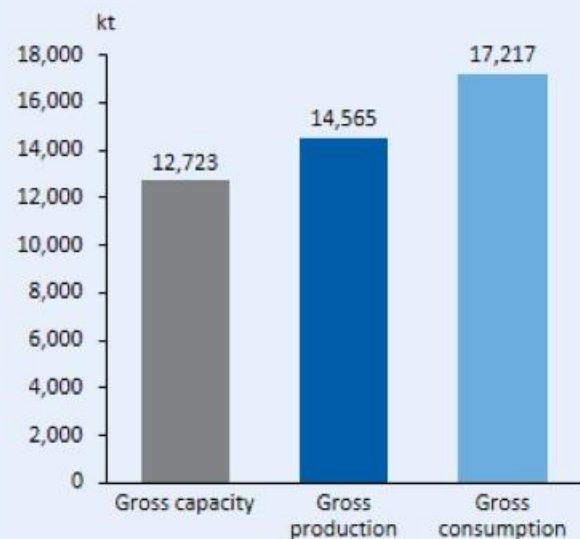


Source: Argus Analytics

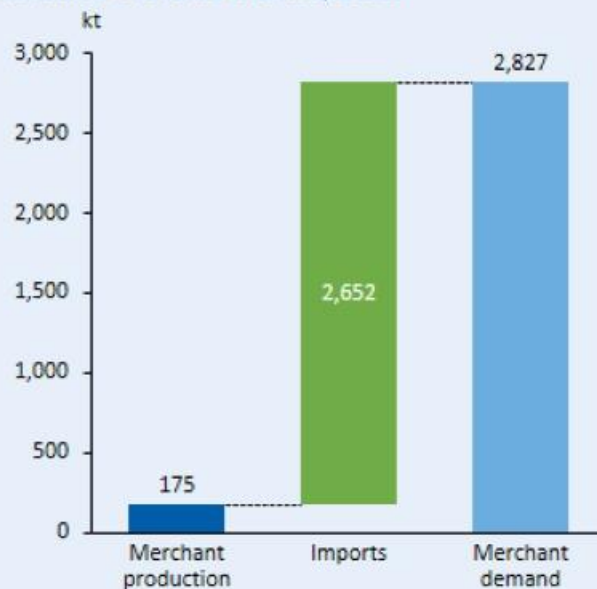
India's merchant ammonia market, 2020

India has a 17.22 mn t ammonia market, of which merchant ammonia accounts for 2.8 mn t or just over 16%

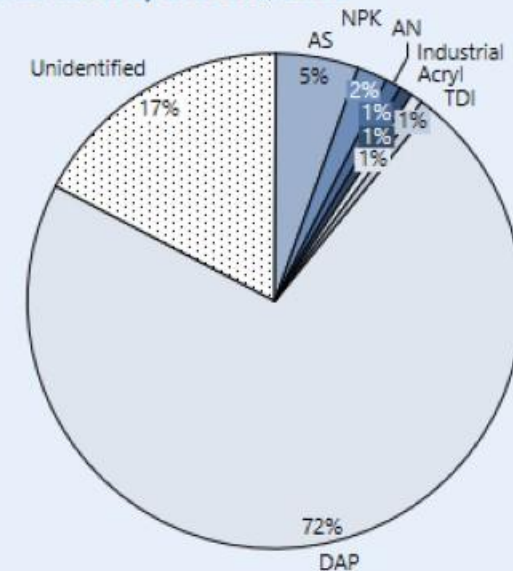
Ammonia market, 2020



Merchant Ammonia market, 2020



Merchant demand by end-use, 2020



Source: Argus Analytics

- Global perspective
- India focus
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 - Supply and projects
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A spate of clean NH3 project announcements over the last year or so

Initial agreements for green hydrogen, ammonia projects in Karnataka

Company	Investment in bn USD	Ammonia output target in mn t/yr
Acme Cleantech Solutions	6.26	1.2
ReNew Power	6.03	1
ABC Cleantech	6.03	1
Avaada Energy	5.43	1
JSW Energy	5.24	-
Petronas	3.76	0.5
O2Power	2.15	-
— Karnataka state government		

- **Avaada** project to build green power plant and green ammonia capacity in Rajasthan, signed an agreement with state government for 1 million tpy of ammonia. Rajasthan largest solar energy producing state. \$5bn capex
- Indian state-controlled Oil and Natural Gas Corporation (**ONGC**) and renewable energy developer Greenko last month [announced plans for a 1.3GW electrolyser site](#), which could produce 1mn t/yr of ammonia from 2026 onwards, utilising wind, solar and hydroelectric power.
- **Acme Cleantech Solutions** has also [unveiled a number of planned projects in recent months](#).
- ABC Cleantech, a subsidiary of solar and wind energy firm Axis Energy, plans a facility that would produce 200,000 t/yr of hydrogen and 1mn t/yr of ammonia, fed by 5GW of renewable energy.
- Malaysia's state-owned **Petronas**, intends to build a plant that will eventually produce 500,000 t/yr of ammonia.
- **Acme** will set up a 1.2mn t/yr green hydrogen and green ammonia plant along with a captive solar power unit in Mangalore city between 2022 and 2027, the firm said on 6 June. The total investment in the project is 520bn rupees (\$6.7bn)
- **Jakson Group** is planning a \$2.8bn renewable hydrogen and ammonia project in Kota in northwest Rajasthan. Jakson plans to build the project in phases between 2023 and 2028, with the plant to produce 15,000 t/yr of renewable ammonia by 2025. Once completed, combined output of hydrogen and ammonia could reach 3.65mn t/yr, the company said.


These projects are early stage, and we need to see greater progress before we consider them firm or probable

Source: Argus Direct

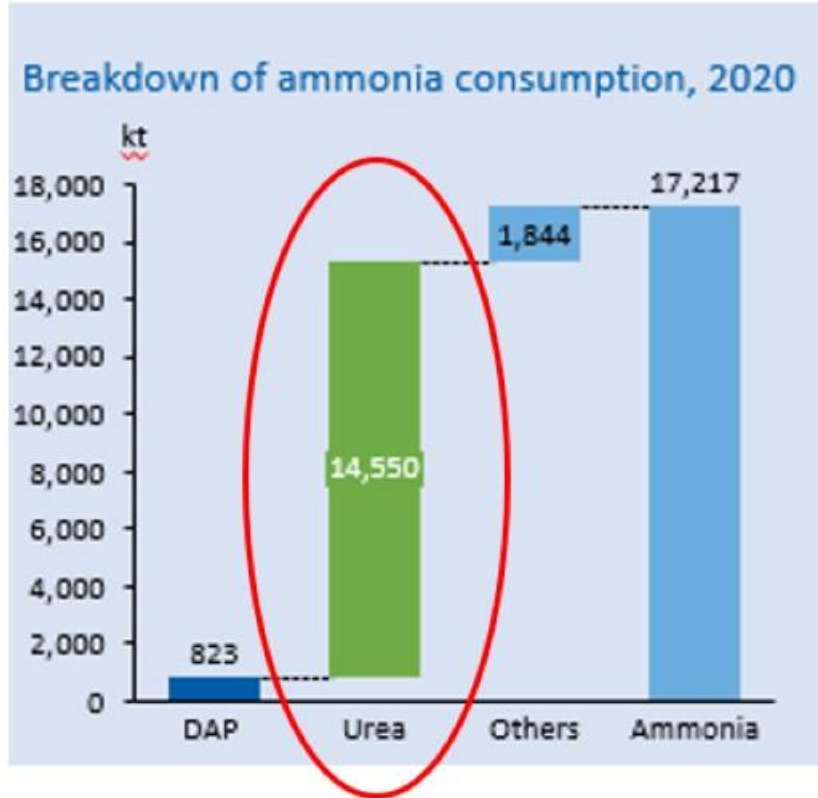
And H2 project activity ramping up

- Indian state-controlled refiner **IOC** aims to produce 5pc green hydrogen out of its total hydrogen production by the 2027-28 fiscal year ending 31 March and up to 10pc by 2029-30, although it has yet to disclose actual figures. Its Mathura refinery will house a 40MW green hydrogen plant and its Panipat site will have a 16MW plant
- Indian stainless steel producer **Jindal Stainless** plans to build a green hydrogen plant in the northern Haryana state with renewables developer Hygenco India, targeting commissioning in the third quarter of calendar 2023. The solar-powered plant will house an alkaline electrolyser that has a potential to produce up to 250 t/yr but is targeting initial production of 75 t/yr, Jindal Stainless said on 14 September, describing the venture as a first for a stainless steel producer in India. It expects the plant to help it reduce CO2 emissions by 2,700 t/yr. The hydrogen produced is planned to replace ammonia in its in-house annealing of stainless steel, which is part of the heat treatment process.

Source: Argus Direct

- Global perspective
 - India focus
 - Background
 - Demand and addressable market
 - Supply and projects
 - Challenges
- 

Urea is a problem



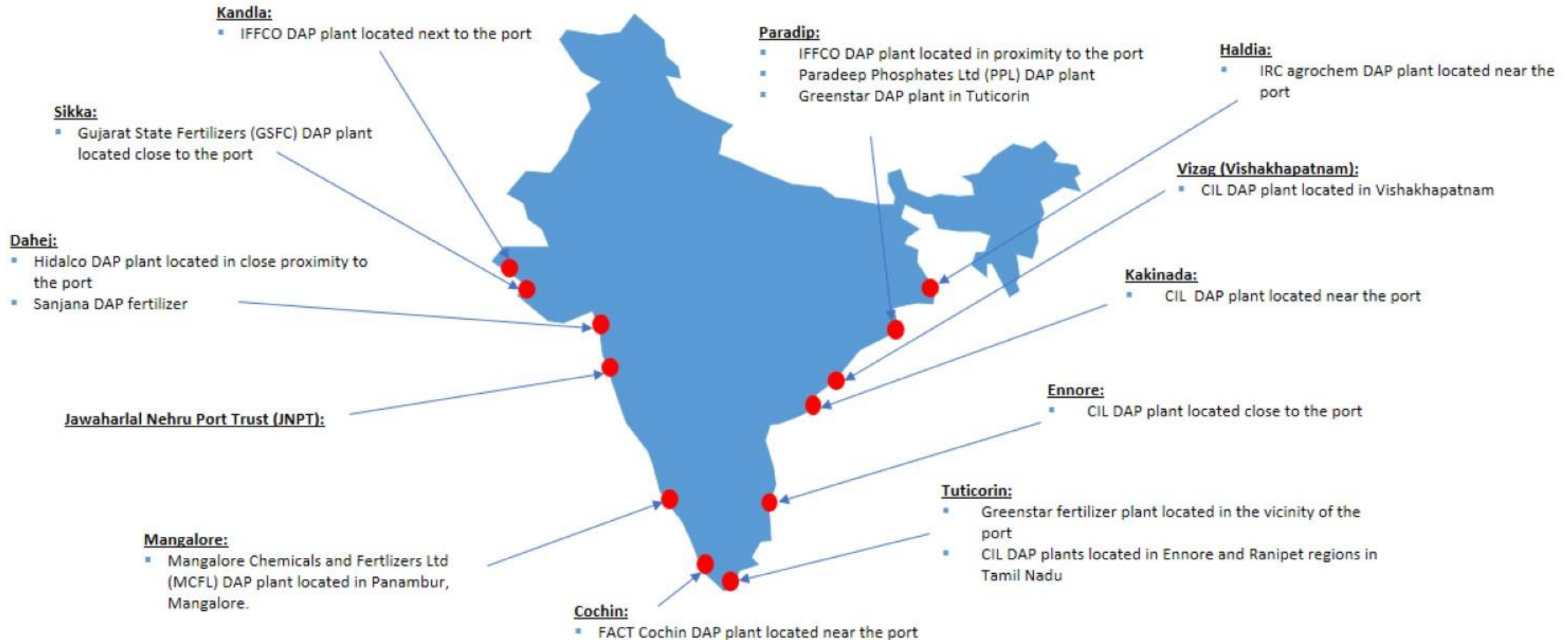
- By far the biggest use of ammonia is for urea, which cannot be decarbonized. Use of recycled/biogenic carbon would seem unlikely on a large scale.
- Existing ammonia/urea plants could switch to a 10% green H₂ blend with gas. Perhaps this would allow for partial decarbonization.
- Furthermore.
 - India's fertilizer subsidy budget for 22/23 is around US\$14 billion, primarily composed of urea, which is sold to farmers at a mandated Rs6 per kg (US\$ 70 pt)
 - Higher priced ammonia feedstock, at least in the s-m term, would inflate the budget further

Source: Argus Analytics

Is India the logical supplier to the balance of the domestic NH3 market?

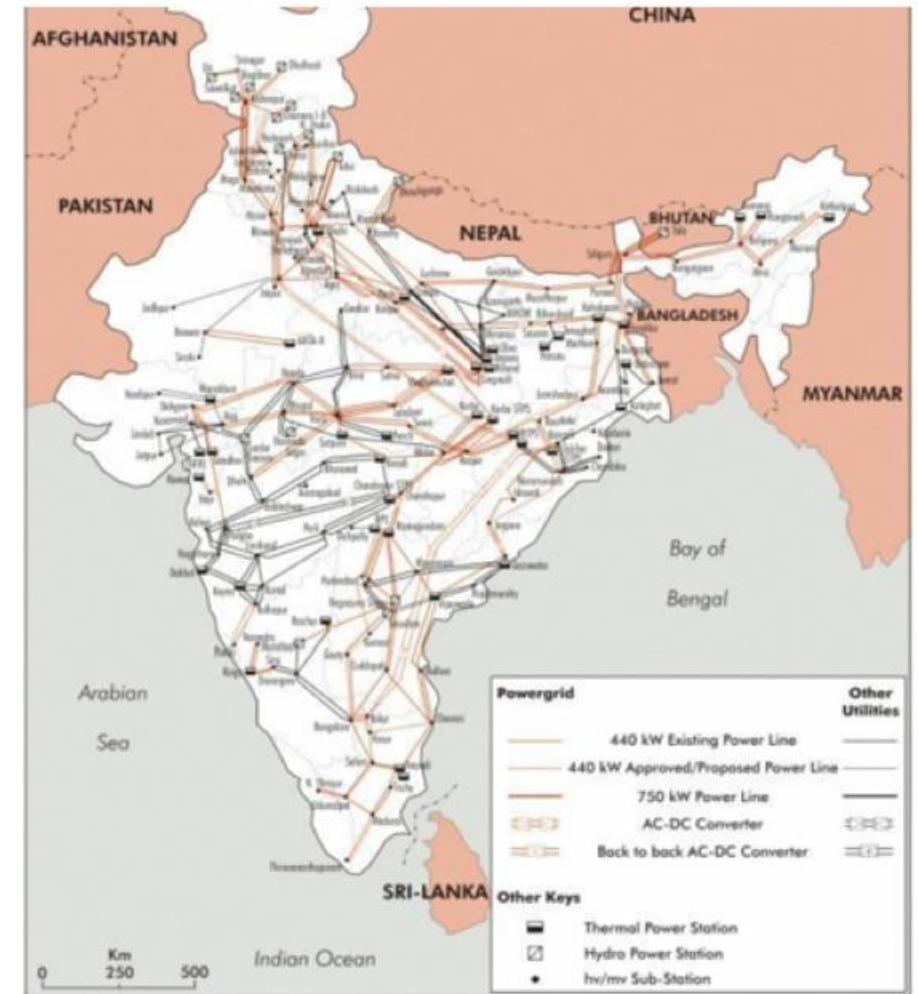
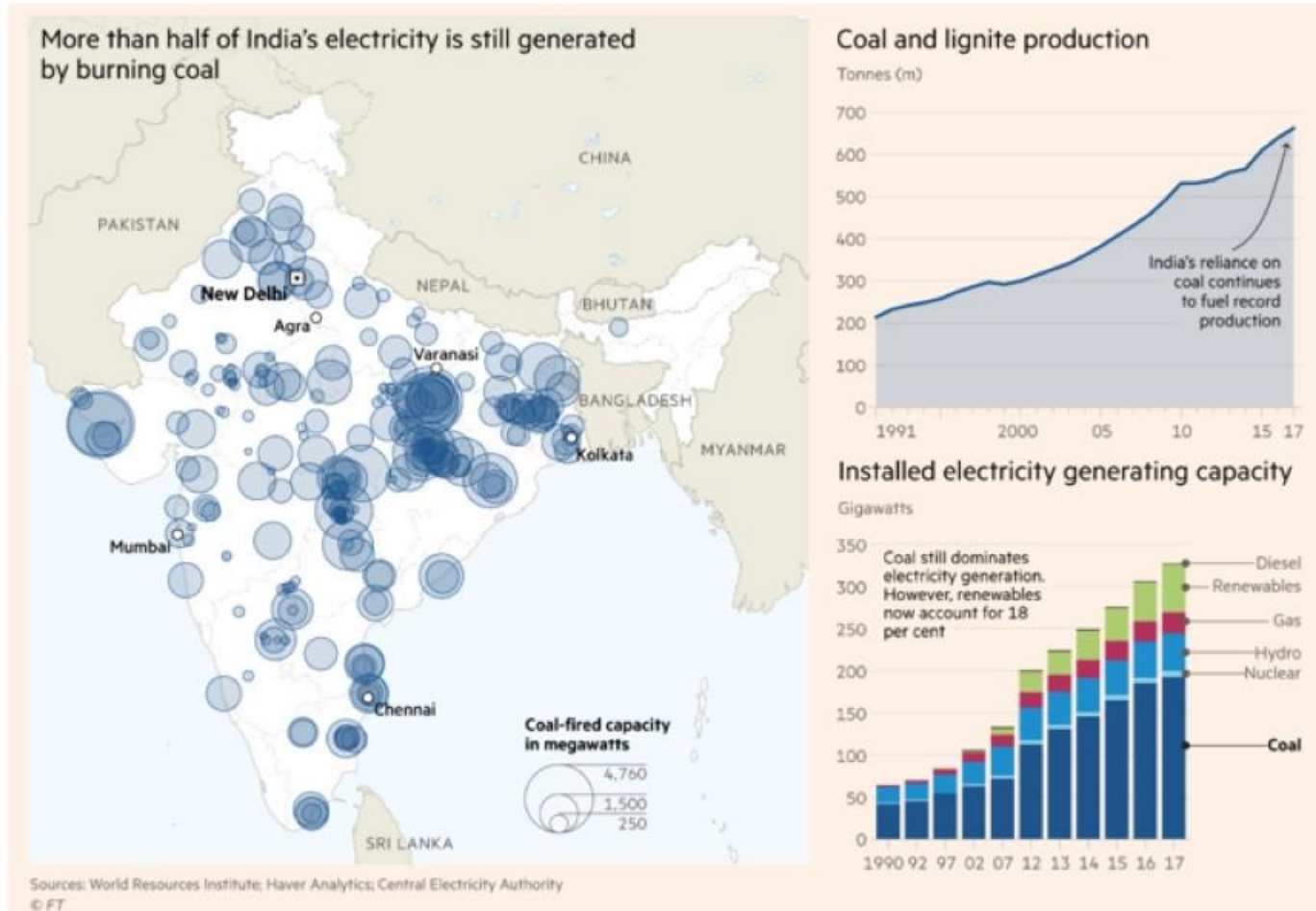
34

India's ammonia imports typically satisfy demand located near the port – inland ammonia transportation is minimal



Source: Argus Analytics

Is green NH3 the best use of Indian clean energy resources?



Source: FT, Geni.org



consulting services

argusmedia.com

Thank You

Oliver.Hatfield@argusmedia.com

Sources

Argus Consulting Analytics Reports; Argus Monthly Outlook reports; IFA; GTT

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