



argusmedia.com

Review of global ammonia supply

Oliver Hatfield

VP Business Development, Argus Media

*AEA Conference
November 2020*

London
Houston
Washington
New York
Calgary
Santiago
Bogota
Rio de Janeiro
Singapore
Beijing
Tokyo
Sydney
Dubai
Moscow
Astana
Kiev
Cape Town
Riga

Market Reporting

Consulting

Events

illuminating the markets

Disclaimer and Notices

2

- This presentation (the “Report”) is confidential, made available strictly under licence and has been prepared solely for the internal use of the applicable Argus licensee (a “Client”). Any use or disclosure of this Report and its contents without specific written permission from Argus is strictly prohibited. No duty of care is owed by Argus to any third party and Argus disclaims all liability in relation to any third party who seeks to rely upon or use the Report or any of its contents. The Report, including the Argus trademarks and logo/legal notices, may not be altered. Derivative works of all or part of the Report may not be created without prior written permission.
- The data, information or opinions contained in this Report are provided on an “as is” basis without any warranty, condition or other representation as to its accuracy, completeness, or suitability for any particular purpose and shall not confer rights or remedies upon the recipients of this presentation or any other person. Data and information contained in the Report come from a variety of sources, some of which are third parties outside Argus’ control and some of which may not have been verified. Argus does not warrant that this Report is in all respects accurate and complete and does not warrant any results obtained or conclusions drawn from the use of this Report. Argus has no obligation to maintain or update this Report.
- All analysis and opinions, data, projections and forecasts provided may be based on assumptions that are not correct or which change, being dependent upon fundamentals and other factors and events subject to change and uncertainty; future results or values could be materially different from any forecast or estimates described in the Report.
- Subject to any agreement between Argus and its Client, Argus expressly disclaims any and all liability for any direct, indirect or consequential loss or damage, claims, costs and expenses, whether arising in negligence or otherwise, in connection with access to, use or application of these materials or suffered by any person as a result of relying on any information included in, or omission from, this Report and related materials or otherwise in connection therewith, to the maximum extent permitted by law.
- The Client’s use of the Report is entirely at the Client’s own risk. This Report does not offer or provide financial, tax or legal advice.

Copyright notice

- Copyright © 2020 Argus Media group. All rights reserved. All intellectual property rights in this presentation and the information herein are the exclusive property of Argus and and/or its licensors and may only be used under licence from Argus. Without limiting the foregoing, you will not copy or reproduce any part of its contents (including, but not limited to, single prices or any other individual items of data) in any form or for any purpose whatsoever without the prior written consent of Argus.

Trademark notice

- ARGUS, the ARGUS logo, Argus publication titles, and Argus index names are trademarks of Argus Media Limited. For additional information, including details of our other trademarks, visit argusmedia.com/trademarks.

Agenda

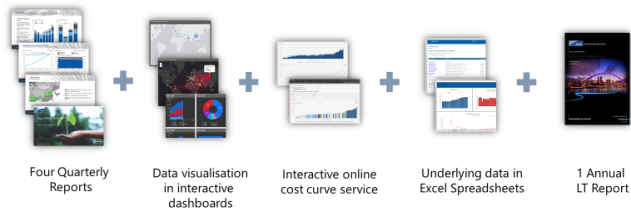
- Overview of global ammonia capacity – gross, merchant, geography, orientation
- Consideration of the availability and flexibility of supply
- Conclusions

Argus is the leader in ammonia price assessments and analytics +

4

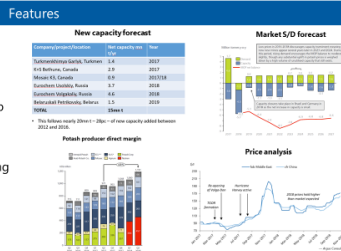
Ammonia analytics service

Argus Analytics services – covering the markets for ammonia, urea, phosphate rock, processed phosphates, potash, sulphur, sulphuric acid, NPKs and Technical Grade Urea
What do subscribers receive?



This presentation showcases our analytics services, which offer sector leading service features....

- Primary features:
- 15-year supply/demand/price/trade forecasts
 - Trade matrices
 - Global cost curves
 - Our demand model based on calorie and crop forecasts to guide our view of future fertilizer consumption
 - Project gateway assessment, to assess which new projects will be realised and which existing capacity will close
 - Robust price forecast methodology

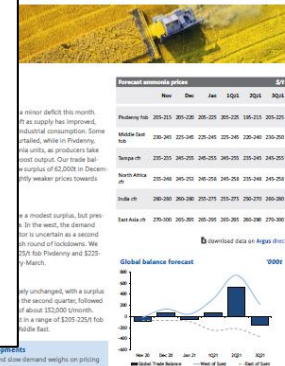


Price assessments and 12m outlook

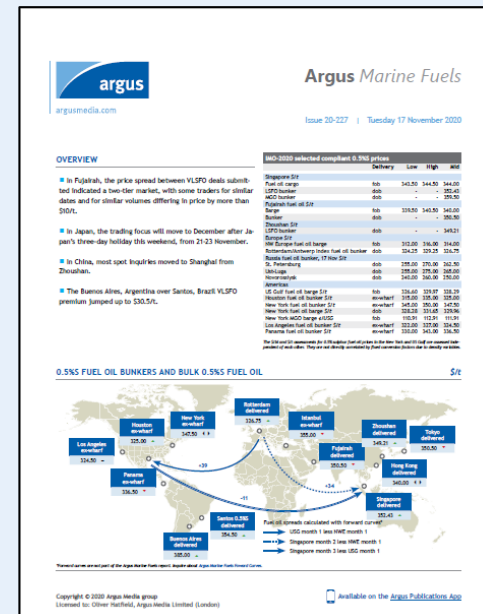


consulting services

Monthly Ammonia Outlook

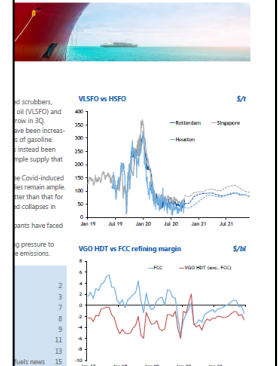


+ Comprehensive fuel sector market coverage: e.g. marine fuels



consulting services

Monthly Marine Fuels Outlook



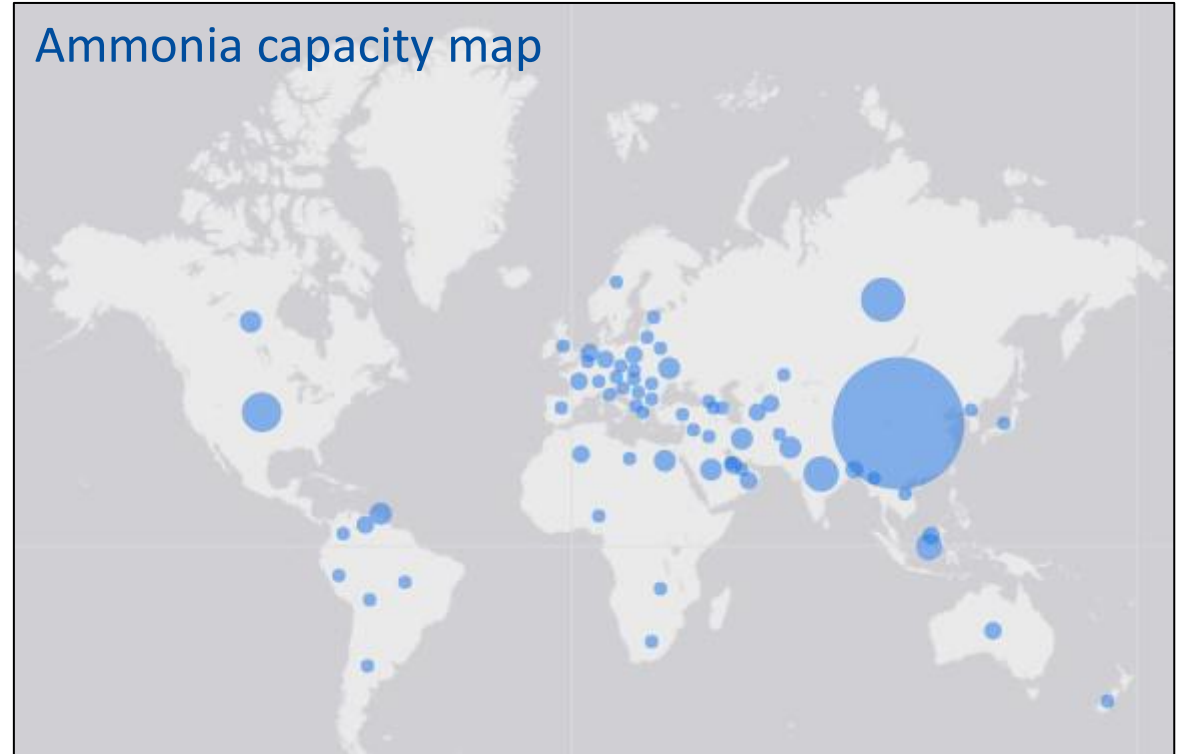
Ammonia capacity is global, with a broad distribution

5

Capacity and production by region (million t)

Region	Capacity	Gross Production
World	224.6	182.6
Africa	10.2	9.7
Australasia	2.3	1.9
Central & Eastern Europe	15.2	8.9
Latin America & Caribbean	9.8	6.7
Middle East	20.5	16.8
North America	24.4	22.2
Northeast Asia	76.1	55.1
Russia & Central Asia	23.4	22.9
South Asia	18.7	19.3
Southeast Asia	12.5	10.5
Western Europe	11.3	8.5

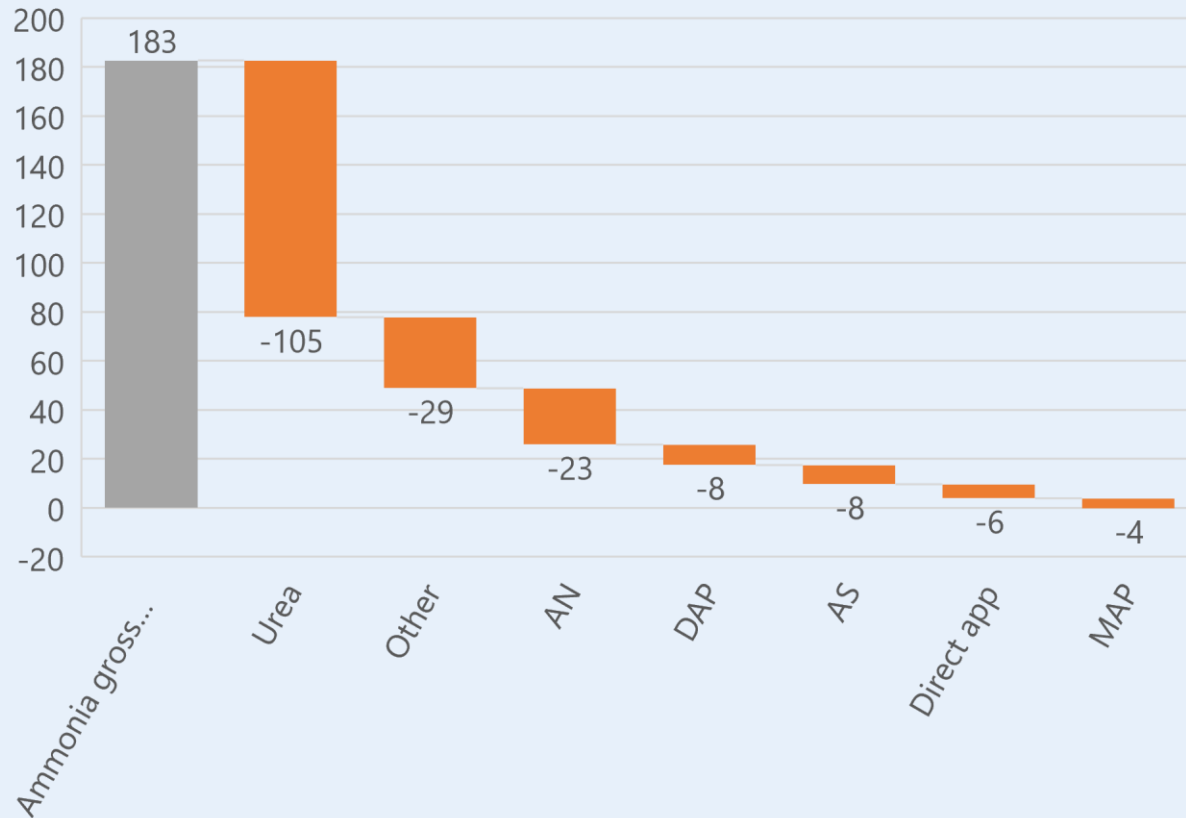
Ammonia capacity map



Most ammonia is consumed captively on-site, but there is a significant merchant market

6

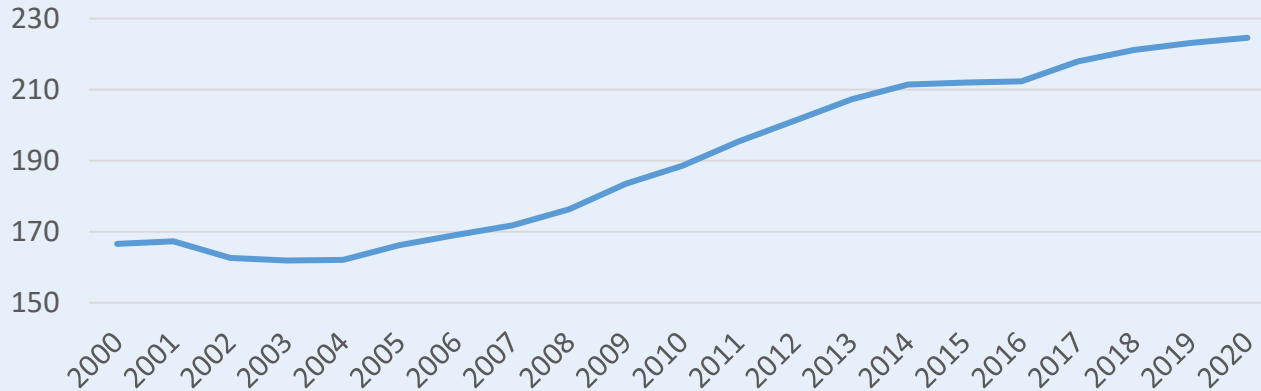
Ammonia consumption by end-use 2020 (million t)



Ammonia capacity has grown steadily over decades; trade growth has stalled

7

Ammonia capacity (million tpy)

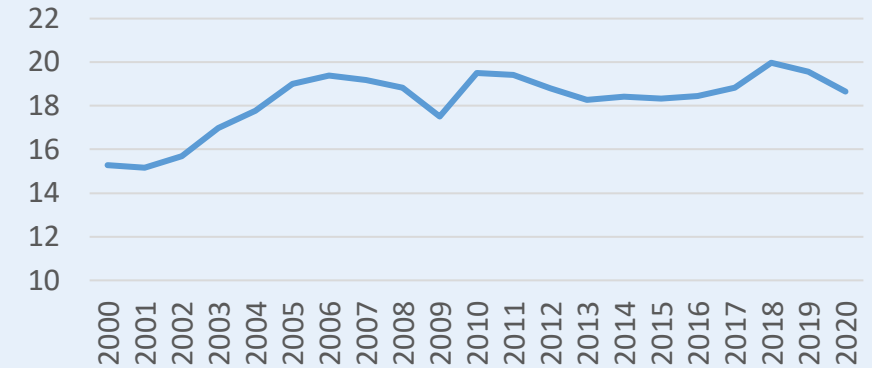


Annual growth in capacity, 2000-2020:

- Net 58 million tpy of net capacity change
- 105 million tpy of capacity added:
 - ~ 100 significant revamps/debottlenecks, +19 million tpy of new capacity
 - ~ 190 new lines/projects; +85 million tpy of capacity
- 47 million tpy of capacity closed

Changes are cyclical!

International ammonia trade (million t)



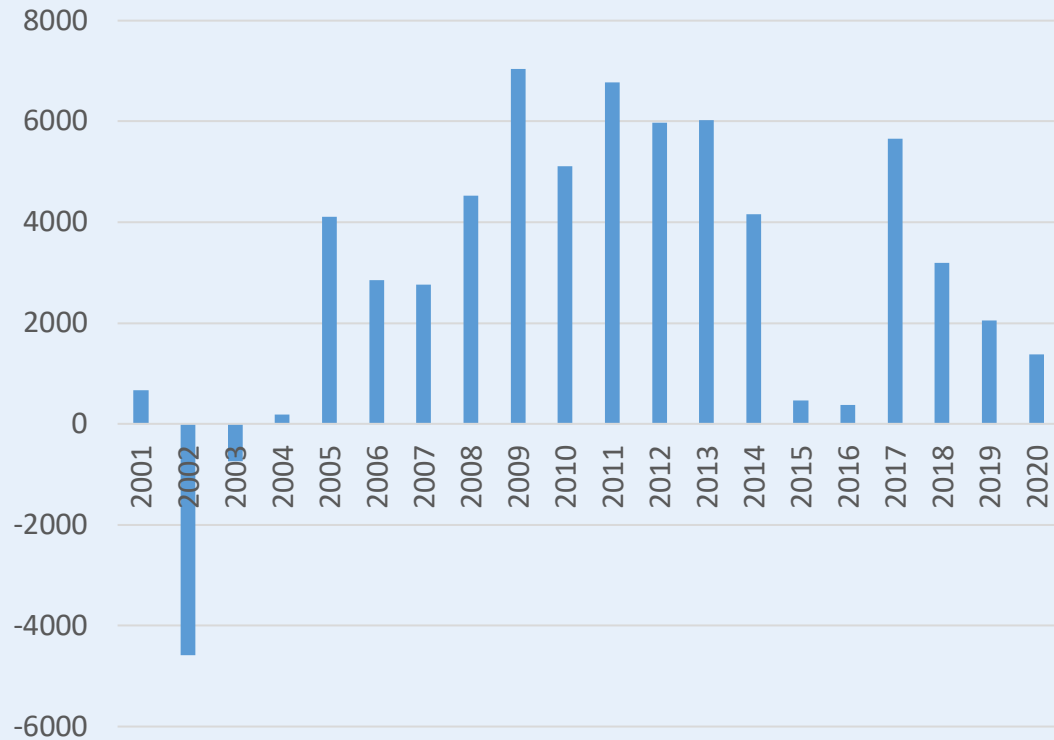
International ammonia trade grew in the 2000s, but recently stalled:

- Growth in 2000s associated with expansion of downstream sectors like processed phosphates and industrial end-uses; plus uneconomic ammonia plant closures
- Flat trade more recently: growth in integrated processed phosphates operations and construction of integrating ammonia plants

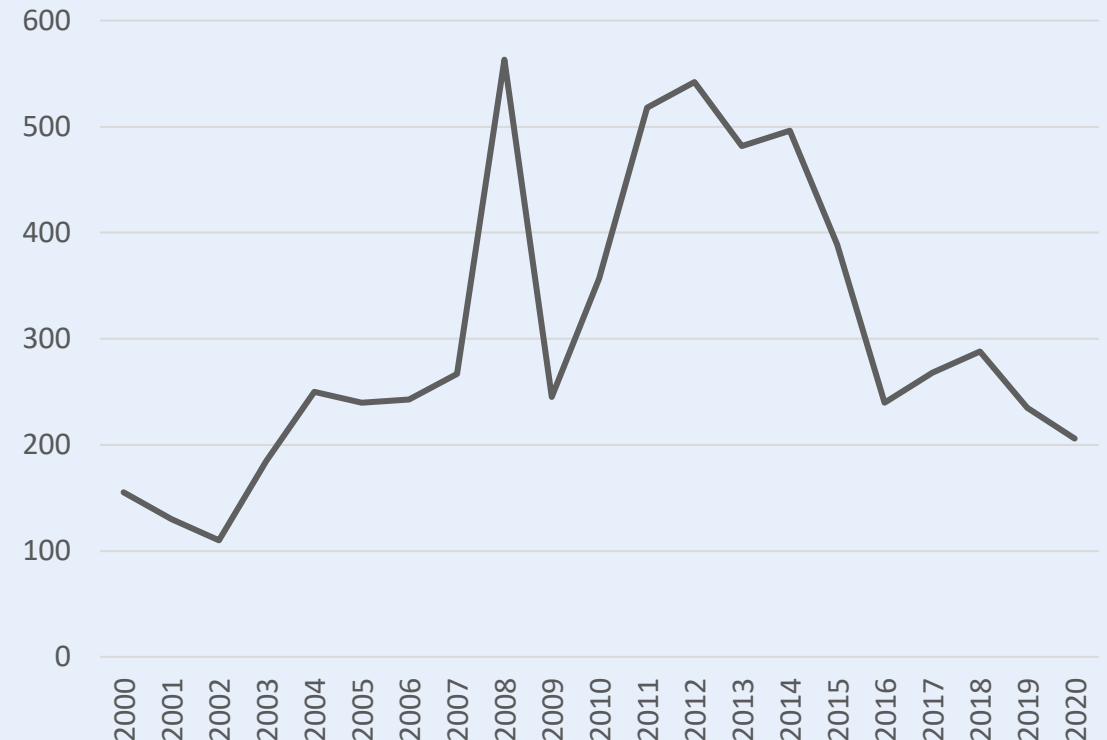
Capacity growth spurts related to price fly-ups and changes in production costs/competitiveness

8

Annual change in ammonia capacity (thousand tpy)



Annual ave. ammonia price, fob Black Sea (US\$/t)



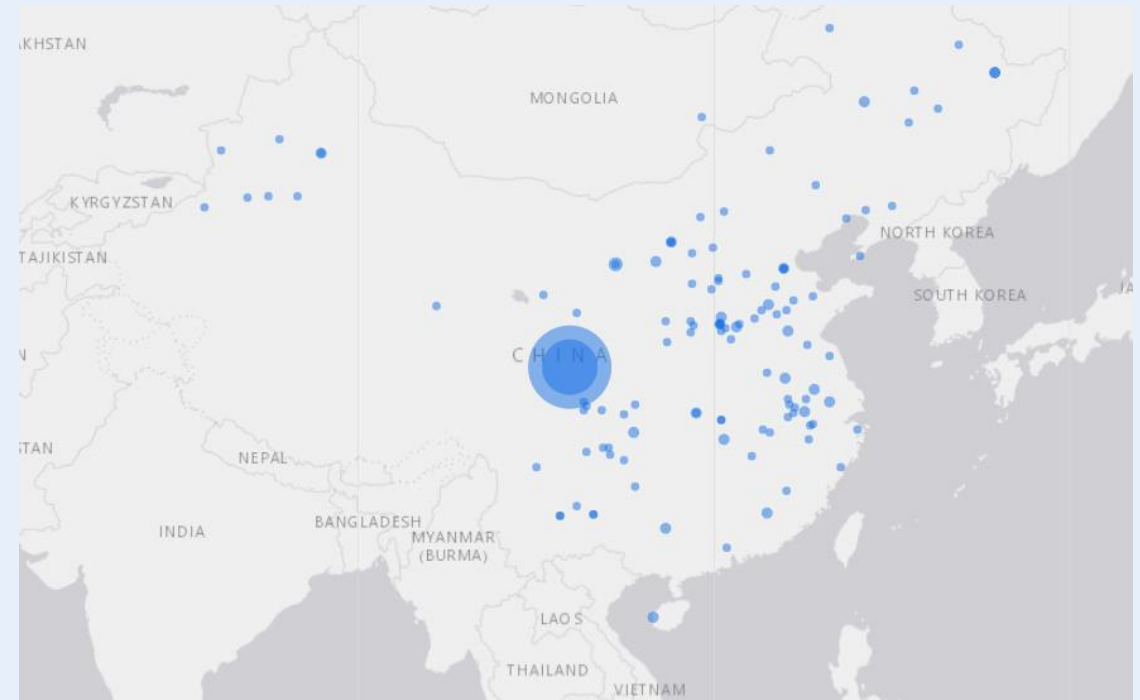
Nominally, there is significant spare capacity; price signals could bring it to market but there are constraints

9

Global ammonia capacity 'spare' capacity 2020 (million tpy)

Region	Capacity utilization	'Spare' capacity
Total	81%	42.0
Northeast Asia	72%	21.0
Central & Eastern Europe	59%	6.2
Middle East	82%	3.7
Latin America & Caribbean	68%	3.1
Western Europe	75%	2.9
North America	91%	2.2
Southeast Asia	84%	2.0
Russia & Central Asia	98%	0.5
Australasia	81%	0.4
Africa	96%	0.4
South Asia	103%	-0.5

Map of Chinese ammonia capacity



There is always flex between ammonia and downstream products like urea

10

UPGRADING MARGIN: Ammonia initially squeezed harder by Covid-19 than urea

UM rallied in ammonia's favour in Q2 2020 as urea weakened, but further recovery unlikely as urea gains in H2

44

Our urea-ammonia upgrading margin (UM) is created by subtracting the product of the ammonia price and the ammonia consumption rate (assumed at 575kg per tonne urea) from the urea price. This provides us a measure of the value-added in the urea market over the input value of the ammonia consumed in urea's production.

The historical average is around \$85/t, a value that needs to cover the conversion costs on a urea plant (power, chemicals and consumables, labour and maintenance), provide a level of return to incentivise the operator to produce and sell urea, rather than selling the ammonia, and in the long term, attract capex to build urea plants. At \$85/t a marginal plant can easily cover \$40-50/t of additional urea processing costs.

To calculate the historic upgrading margin:

$$UM = P_{urea} - P_{ammo} \times 0.575$$

To forecast the future ammonia price:

$$P_{ammo} = \frac{(P_{urea} - UM)}{0.575}$$

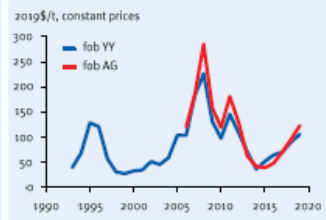
The adjacent chart outlines the historical urea upgrading margin over the last 15 years. There have been three phases, a period of ammonia oversupply, followed by structural deficit and the current period of weakness.

Below, a running average shows how the real LR average has settled at around \$85/t fob Yuzhny over the last ten years. And that the UM at fob Mid East carries a small premium.

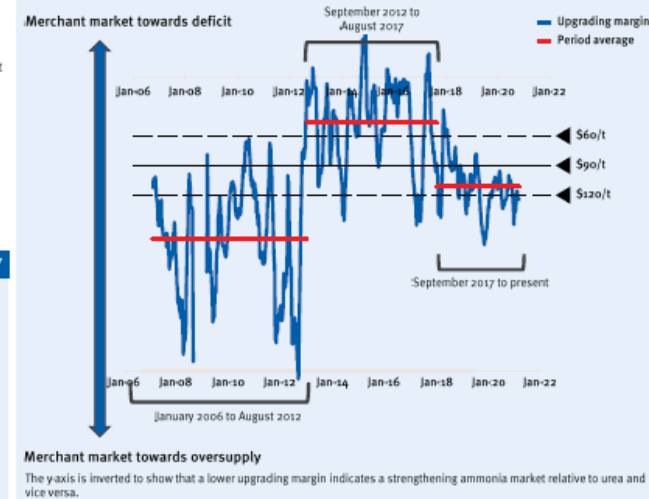
Real LR Equilibrium averages \$85/t



UM shows small premium at fob ME vs fob YY



Real upgrading margins at fob Middle East



— Fertilizers —

Licensed to: Oliver Hatfield, Argus Media Limited (London)

Copyright © 2020 Argus Media group.
All rights reserved



- Merchant ammonia availability is also responsive to 'upgrade margin' (UM).
- It's a calculation which indicates which nitrogen product is most attractive to sell.
 - Deduct the ammonia price at its consumption rate from the urea price.
- A high UM incentivizes/attracts ammonia to downstream products and vice versa.
- Recent ammonia prices have been relatively weak and incentivizing volumes to move downstream.
- But the reverse position is equally possible.

— Fertilizers —

Fundamentally, ammonia is a typical commodity; supply availability is rarely a constraint...

11

We are never short of ammonia projects! Over supply is more common than under-supply.

Grey

Global ammonia capacity forecast (exc. China)

We are currently forecasting 10.7mn t/y gross & 0.8mn t/y merchant ammonia capacity at the construction stage

17

Project specifications						Forecast		Project milestones							Start of commercial ops.	
Name	Site	Country	Gross capacity tpd	Merchant capacity t/y	Major product	Rating		Contracts EPC	Gas Supply	Financing	Progress indicators	Groundwork	Construction	Commissioning	Original target	Argus forecast
Yara T4T	Trinidad	Trinidad	9,000	6,270	Merchant	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Complete	Dec-19	Jan-20
Kina	Axson	Egypt	1,200	396	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Feb-19	Jul-20
Naturem	Portefar	Trinidad	9,000	6,270	Merchant	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Complete	Oct-20	Oct-20
LJFC	Erdogan	Iran	2,050	627	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q1-19	Nov-20
RFL	Rangas	India	2,000	726	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q4-18	Q2-19
Novosibirsk	Novosibirsk	Uzbekistan	2,000	650	330	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q1-18	Q2-19
Alcon	Novosibirsk	Russia	—	—	(445)	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q4-20	Jan-21
Metallurg	Gubakha	Russia	900	297	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q4-20	Q2-21
Indonesian	Elmori	Nigeria	2,300	726	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
Satish	Satish	China	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
IRI	Singapore	Brunei	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
Warden	Ras Alkhaima	Saudi	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
HRL	Goshapur	India	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
Taka	Tuplari	Russia	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
HRL	Baram	India	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
Total FIRM																
Dangote	Lekki	Nigeria	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
RSC	Al-Jubail	Egypt	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
Vogel	Tuplari	Russia	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
HRL	Sivri	India	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
GSA	Texas City	USA	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
EuroChem	Kirovsk	Russia	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
Salalah	Salalah	Oman	—	—	—	Urea	Fin	●	Signed	In place	Finalised	Complete	Complete	Complete	Q2-19	Q2-19
Total POSSIBLE																
— Fertilizers																
Licensed to Oliver Hartfield, Argus																

Global ammonia capacity tracker (exc. China)

We are tracking over 18mn t/y gross and 4.9mn t/y merchant capacity outside of our base capacity forecast

18

Project specifications						Forecast		Project milestones							Start of commercial ops.	
Name	Site	Country	Gross capacity tpd	Merchant capacity t/y	Major product	Rating		Contracts EPC	Gas Supply	Financing	Progress indicators	Groundwork	Construction	Commissioning	Original target	Argus forecast
Dangote	Lekki	Nigeria	2,200	726	—	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q4-18	Hz 2022
Koch	Enid, OK	USA	—	—	(50)	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
Mutik	Panagarh	India	2,200	726	—	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
BCIC	Poland	Bangladesh	1,500	530	—	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
GemlikGubne	Gemlik	Turkey	650	200	—	Urea/Nitrate	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
HRL	Tuplari	Russia	2,200	726	—	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
Shchelinsk	Elmori	Russia	1,500	530	119	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
Cromus	Tuscola	USA	2,300	759	759	Merchant	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
Pandemon	Burnup	Australia	3,500	1,155	—	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Hz 2022
MP	Nakhodka	Russia	5,400	1,800	1,800	Merchant/Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Post 2024
Promat	Tuplari	Russia	2,200	726	—	Urea	Possible	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-19	Post 2024
Total POSSIBLE			7,917	3,358												
MSFC (MS)	Khuzestan	Iran	2,270	750	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q4-19	Hz 2022
Axon	Tres Lagoas	Brazil	2,200	726	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q4-19	Hz 2022
WPC	Hengsen	Iran	2,200	726	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q4-19	Hz 2022
Lavon	Lavon	Iran	2,050	627	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q4-19	Hz 2022
Gladiolus	Gladiolus	Australia	1,000	330	330	Nitrate	Specul.	In progress	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Hz 2024
Uzbekistan	Yuliyev	Uzbekistan	2,000	650	348	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Hz 2024
QCP	Nigeria	Nigeria	2,270	750	500	Phosphates	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Hz 2024
Monsieith	Indonesian	USA	813	275	275	Merchant	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Hz 2024
Grandmont	Grandmont	Belarus	2,350	759	759	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
QCP	Dine Dama	Ethiopia	1,900	645	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
Midwest	Vernon	USA	2,200	726	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
Unichem	Soye	Angola	2,000	650	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
Naturem	Oman	Nigeria	1,500	530	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
PT Bukit	PT Bukit	Indonesia	993	328	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
ENR	Alin Sokhna	Egypt	1,200	436	—	Merchant	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
KiaAnte	KiaAnte	Kazakhstan	1,440	475	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
MongKut	MongKut	Turkmen	780	260	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
OWFCO	OWFCO	Iran	2,200	726	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
OWFCO	OWFCO	Iran	2,200	726	—	Urea	Specul.	Signed	No gas	Finalised	Complete	Complete	Complete	Complete	Q1-20	Post 2024
Total capacity forecast (POSSIBLE + SPECUL.)			18,359	4,943												
— Fertilizers																
Licensed to Oliver Hartfield, Argus Media Limited (London)																

Copyright © 2020 Argus Media group. All rights reserved

argus

Green

Global Green Ammonia Capacity Tracker

Argus is tracking about 15mn t/y of speculative green ammonia capacity — over 95pc is merchant capacity

2

Argus' ammonia capacity forecast is based on its selection of firm and probable ammonia capacity projects, all of which are financed, have received all required permits and have begun construction. Projects that do not meet this criteria are excluded from our base forecast, and are 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 connecting 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 that targeted completion date, such as political risks or sanctions.

• Possible: Projects that are current stage or, have progressed to some delays due to political or physical in ones we believe have strong potential, construction over the early stages or yet to commence.

• Speculative: Projects that are at early feasibility, EPC contracting has begun in most cases, and the early stages or yet to commence.

— Fertilizers

Green green ammonia speculative capacity expansions



Global green ammonia capacity tracker

We are tracking over 15.0mn t/y gross and 14.5mn t/y merchant green capacity

3

Project specifications						Forecast		Project milestones							Start of commercial ops.	
Name	Site	Country	Gross capacity tpd	Merchant capacity t/y	Major product	Renewable source	Rating	Contracts EPC	Renewable supply	Financing	Progress indicators	Groundwork	Construction	Commissioning	Original target	Argus forecast
Yara 1	Pilbara	Australia	93	30	30	Merchant	S	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2022	2022
Dyno Nobel 1	Aboukh	Australia	10/4	4/4	—	Nitrate	S	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	n/a	2022
Queensland Nitrate 1	Aboukh	Australia	60	20	—	Nitrate	S, W	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	n/a	2022
BP Australia 1	Genolth	Australia	60	20	20	Merchant	S, W, G	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	n/a	Post 2024
H2U 1.1	Port Lincoln	Australia	60	20	20	Merchant	S, W	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2022	2022
H2U 1.2	Gladiolus	Australia	1,000	1,650	1,650	Merchant/Hydrogen	S, W, G	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2025	Post 2024
H2U 1.3	Cape Hardy	Australia	1,200	396	396	Merchant/Hydrogen	S, W, G	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	n/a	Post 2024
AREX 1.1	Pilbara	Australia	10,000	9,900	9,900	Hydrogen	S, W	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2027/28	Post 2024
AREX 1.2	Antofagasta	Chile	15	18	—	Nitrate	S	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2024	2024
AREX 1.3	Antofagasta	Chile	2,250	700	700	Nitrate, Hydrogen	S	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2026	Post 2024
Believe-Agri Nutrients 1.1	Taranaki	New Zealand	12	4	—	Urea, Hydrogen	W	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2023	2023
Yara 2	Stake	Netherlands	227	75	—	Urea	W	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2024-25	Post 2024
Yara 3	Stake	Netherlands	16	5	—	Nitrate	S, H	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2022	2023
Moey 1.1	Moey	Saudi Arabia	1,500	1,155	1,155	Hydrogen	S, W	Specul.	No EPC	No supply	Port funded	Not started	Not started	Not started	2025	Post 2024
Energy Energy 1.1	Orkney	UK	11	4	4	Merchant, Hydrogen	W	Specul.	In place	No supply	Port funded	Not started	Not started	Not started	n/a	2024
CT Industries	Donaburnville	USA	55	18	—	Urea	G	Specul.	In place	No supply	Port funded	Not started	Not started	Not started	2023	2023
Total SPECULATIVE			15,015	14,515												

1 Includes greenfield ammonia plant construction

2 Includes greenfield electrolyser construction

3 Includes renewable generation capacity

— Fertilizers

Renewable sources key:

S = Solar power generation

W = Wind power generation

G = Grid power/Supplementary grid power

H = Hydro power generation

G = Grid power/Supplementary grid power

Copyright © 2020 Argus Media group. All rights reserved

argus

— Fertilizers

Copyright © 2020 Argus Media group. All rights reserved

Ammonia supply will continue to grow with demand including energy demand

12

NEOM PROJECT REVIEW: Green ammonia production costs will be high 50

Air Products will have to charge a high premium over brown ammonia to breakeven on their investment in NEOM

A joint-venture between Air Products, ACWA Power and NEOM (equal shares) is planning the construction of a 3,600 tpd green ammonia plant. The \$5bn investment, based in the north west of Saudi Arabia, will use renewable electricity from over 4GW of solar and wind farms to produce hydrogen and nitrogen for ammonia production.

At a basic level, green ammonia is simply the removal of the SMR process and its methane feedstock from ammonia production, and its replacement with an electrolyser and an integrated renewable power supply. NEOM will use 100% renewable energy to power the electrolyser, the ASU (air separator) and the ammonia synthesis process at the new project. This means that there will be no carbon emissions produced by the ammonia plant. NEOM will use Air Products' own in-house technology for the ASU and thysenkrupp technology for the electrolyser. Ammonia synthesis will be supplied by Haldor Topsoe.

Access to Resources: Few locations globally provide suitable conditions for a mix of renewable sources that would meet a large electrolyser's baseload power requirements, 24 hours a day. Saudi Arabia is one of the better locations for the construction of a renewables-based electrolyser given its abundance of solar flux. NEOM's coastal location also means reliable wind generation is viable. Both electricity and hydrogen storage will be used to maintain constant ammonia production through periods of low solar or wind power output.

Access to Markets: Air Products will be the exclusive ammonia off-taker. Outside of the project scope assessed here, Air Products will invest \$2bn in a carbon-free hydrogen distribution network using the green ammonia produced. Ammonia will act as the hydrogen carrier. Each tonne of ammonia will 'carry' 176kg of hydrogen which is dissociated back into hydrogen at the destination.

Access to Capital: The plant will form part of NEOM – a new industrial hub focussed on sustainability that came from the Saudi Vision 2030 initiative. NEOM is a closed joint-stock company fully owned by Saudi's Public Investment Fund, which have invested \$500bn into the NEOM masterplan. State financing will provide extremely favourable loan rates for this project, helping to keep debt costs to a minimum.

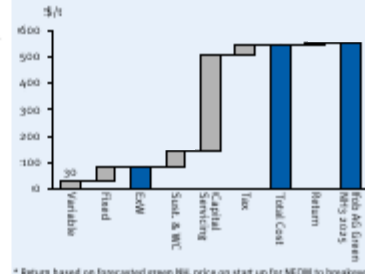
The \$5bn of capex quoted for this project initially looks like a lot of capital for an investment in an ammonia plant. However, most of this will be used to build the wind and solar generators. We also need to take into account the speculative nature of a worldscale green ammonia plant. The largest installed electrolysers in the market today are in the 5-10MW range. The capacity needed to supply hydrogen to a 1.2mn t/y ammonia plant is around 2GW. The step up in capacity is considerable. For 4GW of renewable generation, 2GW of electrolysis, as well as the ammonia plant equipment and lithium ion storage to fit within a \$5bn envelope, investment costs for each technology will need to come down significantly from today's levels (2019\$ terms).

Project details and assumptions

Site location	Saudi Arabia
Start of production	2025
Target market	Green H ₂
Capacity	1,260 kt/yr
Capex	\$ 5.0 bn
Cost of equity	13 pc
Corp. WACC	10 pc
Project WACC	4.6 pc
Project gearing	450 pc

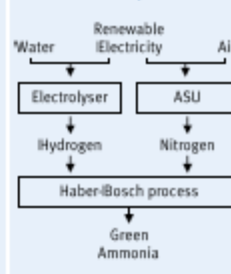


Economic cost*



* Return based on forecasted green NH₃ price on start-up for NEOM to breakeven

Green ammonia production



Fertilizers

Licensed to: Oliver Hatfield, Argus Media Limited (London)

Copyright © 2020 Argus Media group.
All rights reserved



Grey

- Price will continue to incentivize construction of new capacity, and raise production from spare capacity.
- Projects are feasible when there is availability of the right priced capital and raw material resources, and market access.

Green

- Price will also incentivize supply.
- For now it's a higher price, but the fundamentals are the same.
- And technology is similar and widely available.

Fertilizers

- There is a substantial stock of existing ammonia supply, widely available geographically.
- Ammonia supply is rarely a market constraint. There are periods when demand grows more quickly, resulting in higher prices, but this normally brings significant supply response:
 - Short term (within months): higher output/utilization, use of spare capacity; N product switching.
 - Within quarters/years: expansionary revamps (including green retrofit?).
 - ~3 years: greenfield and brownfield new plants/lines (longer for green projects?).
- So, there are no obvious fundamental supply constraints to market growth for ammonia for energy use.

For more information please contact:

14

Oliver Hatfield
VP Business Development
oliver.hatfield@argusmedia.com

Registered office

Lacon House, 84 Theobald's Road, London, WC1X 8NL
Tel: +44 20 7780 4200
Email: sales@argusmedia.com

ISSN: 1467-3916

Copyright notice

Copyright © 2020 Argus Media group
All rights reserved
All intellectual property rights in this publication and the information published herein are the exclusive property of Argus and/or its licensors (including exchanges) and may only be used under license from Argus. Without limited the foregoing, by accessing this publication you agree that you will not copy or reproduce or use any part of its contents (including, but not limited to, single prices or any other individual items of data) in any form or for any purpose whatsoever except under valid licence from Argus. Further, your access to and use of data from exchanges may be subject to additional fees and/or execution of a separate agreement, whether directly with the exchanges or through Argus.

Trademark notice

ARGUS, the ARGUS logo, ARGUS MEDIA, other ARGUS publication titles and ARGUS index names are trademarks of Argus Media Limited.
Visit www.argusmedia.com/Ft/trademarks for more information.

Disclaimer

The data and other information published herein (the "Data") are provided on an "as is" basis. Argus and its licensors (including exchanges) makes no warranties, express or implied, as to the accuracy, adequacy, timeliness, or completeness of the Data or fitness for any particular purpose. Argus and its licensors (including exchanges) shall not be liable for any loss, claims or damage arising from any party's reliance on the Data and disclaim any and all liability related to or arising out of use of the Data to the full extent permissible by law.

All personable contact information is held and used in accordance with Argus Media's Privacy Policy
<https://www.argusmedia.com/en/privacy-policy>

Publisher

Adrian Binks

Chief operating officer

Matthew Burkley

Global compliance officer

Jeffrey Amos

Commercial manager

Jo Loudiadis

Editor in chief

Diane Munro

Managing editor

Andrew Bonnington

Consulting Services, SVP

Lloyd Thomas

Customer support and sales:

Technical queries
technicalsupport@argusmedia.com
All other queries
support@argusmedia.com

London, UK

Tel: +44 20 7780 4200

Astana, Kazakhstan

Tel: +7 7172 72 92 94

Beijing, China Tel: +86 10 8535 7688

Dubai Tel: +971 4434 5112

Houston, US

Tel: +1 713 968 0000

Moscow, Russia Tel: +7 495 933 7571

New York, US

Tel: +1 646 376 6130

Sao Paulo, Brazil

Tel: +55 11 3235 2700

Singapore Tel: +65 6496 9966

Tokyo, Japan Tel: +81 3 3561 1805



THE QUEEN'S AWARDS
FOR ENTERPRISE:
2015



INVESTORS
IN PEOPLE