Review of global ammonia supply
Oliver Hatfield
VP Business Development, Argus Media

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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 +

Ammonia analytics service

Price assessments and 12m outlook

+ Comprehensive fuel sector market coverage:
  e.g. marine fuels
Ammonia capacity is global, with a broad distribution

<table>
<thead>
<tr>
<th>Region</th>
<th>Capacity (million t)</th>
<th>Gross Production (million t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>224.6</td>
<td>182.6</td>
</tr>
<tr>
<td>Africa</td>
<td>10.2</td>
<td>9.7</td>
</tr>
<tr>
<td>Australasia</td>
<td>2.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Central &amp; Eastern Europe</td>
<td>15.2</td>
<td>8.9</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>9.8</td>
<td>6.7</td>
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<tr>
<td>Middle East</td>
<td>20.5</td>
<td>16.8</td>
</tr>
<tr>
<td>North America</td>
<td>24.4</td>
<td>22.2</td>
</tr>
<tr>
<td>Northeast Asia</td>
<td>76.1</td>
<td>55.1</td>
</tr>
<tr>
<td>Russia &amp; Central Asia</td>
<td>23.4</td>
<td>22.9</td>
</tr>
<tr>
<td>South Asia</td>
<td>18.7</td>
<td>19.3</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>12.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Western Europe</td>
<td>11.3</td>
<td>8.5</td>
</tr>
</tbody>
</table>

Ammonia capacity map
Most ammonia is consumed captively on-site, but there is a significant merchant market.
Ammonia capacity has grown steadily over decades; trade growth has stalled

**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

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.

<table>
<thead>
<tr>
<th>Region</th>
<th>Capacity utilization</th>
<th>'Spare' capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>81%</td>
<td>42.0</td>
</tr>
<tr>
<td>Northeast Asia</td>
<td>72%</td>
<td>21.0</td>
</tr>
<tr>
<td>Central &amp; Eastern Europe</td>
<td>59%</td>
<td>6.2</td>
</tr>
<tr>
<td>Middle East</td>
<td>82%</td>
<td>3.7</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>68%</td>
<td>3.1</td>
</tr>
<tr>
<td>Western Europe</td>
<td>75%</td>
<td>2.9</td>
</tr>
<tr>
<td>North America</td>
<td>91%</td>
<td>2.2</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>84%</td>
<td>2.0</td>
</tr>
<tr>
<td>Russia &amp; Central Asia</td>
<td>98%</td>
<td>0.5</td>
</tr>
<tr>
<td>Australasia</td>
<td>81%</td>
<td>0.4</td>
</tr>
<tr>
<td>Africa</td>
<td>96%</td>
<td>0.4</td>
</tr>
<tr>
<td>South Asia</td>
<td>103%</td>
<td>-0.5</td>
</tr>
</tbody>
</table>
There is always flex between ammonia and downstream products like urea.

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

We are never short of ammonia projects! Over supply is more common than under-supply.
Ammonia supply will continue to grow with demand including energy demand

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

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

| Economic cost* | Water | Renewable Energy | Air
|----------------|-------|-----------------|--------|
| Green Ammonia production | **Hydrogen** | **Nitrates** | **Green Ammonia**
| Power | Neutral cruise | Air
| Fuel | Neutral cruise | Air
| Capital | Neutral cruise | Air

*Based on an energy mix 30% gas, 70% coal at the NEOM site.

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.
Conclusions

- 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.