Potential ammonia pricing models

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 Agenda

• Key issues for pricing green molecules
• Role of project economics in price setting
• Historical case study: is the LNG comparison still valid?
• Forward-looking model for pricing development:
  ◦ Blue vs green, levelized costs, spot pricing
  ◦ Potential benchmarks for indexation
  ◦ Emerging subsidies: IRA, CfDs

• Questions
Key issues for pricing green molecules

- Different project economics
- Different end uses
- Different appetites for green premium
- Different carbon intensities
- Lack of cohesive certification approaches
- Different approaches to supply and demand stimulation
Examples of different project economics: NWE “green” H2 at times less expensive than blue

- Hydrogen baseline SMR northwest Europe average EUR/kg
- Hydrogen BAT+ SMR+CCS northwest Europe average EUR/kg
- Hydrogen low-C ATR+CCS northwest Europe average EUR/kg
- Hydrogen no-C renewables+PEM northwest Europe averag...
Examples of different project economics: Very different picture in gas-rich countries, but subsidies could make “green” H2 competitive...
Levelized costs of green hydrogen are shaped by the power price and by electrolyser capital intensity.

**Electrolyser CAPEX intensity**

- **US$/kW**
- **Base**
- **Optimistic**
- **Pessimistic**

*Notes: in real 2021 US$  
— Argus Consulting*

**Electrolyser manufacturing cost components**

- **Membrane electrode assembly (MEA)**: 29%
- **Frame**: 13%
- **Porous transport layer (PTL)**: 13%
- **Catalyst coated membrane**: 16%
- **Other BoP components**: 4%
- **Cooling system**: 11%
- **Hydrogen processing unit**: 7%

*Notes: based on 10MW/year production scale  
— IRENA*
Green H2 economics suggest that contractual practices for green ammonia will be focused on covering capital servicing.
Blue ammonia offers the opportunity for more familiar pricing arrangements, especially for retrofits of existing plants.
Evolution of LNG pricing mechanism in Asia – is this a template for the evolution of clean ammonia prices?

- **First stage**  
  Fixed Prices

- **Development stage**  
  Oil price linked

- **Innovation stage**  
  Multiple methods coexisting

- **1960s**  
- **1970s**  
- **1980s**  
- **1990s**  
- **2000s**  
- **2010s**  
- **2020s**

- This situation is somewhat similar to low-carbon ammonia/hydrogen
- Many low carbon ammonia projects are in planning stage, both conversion of existing ammonia facilities and greenfield projects.
- Production economics are very different between blue and green

But the tools for a liquid market are potentially available!
Different pricing models for clean ammonia, depending on stage of market development – but is there a desirable end state?

- **Grey ammonia market**
  - Risk of Initial overlap between fertilizer and industrial markets and new uses (power, etc) if grey ammonia is procured. Potential grey ammonia price impact

- **First wave of Blue NH3**
  - Example of pricing structures: Blue ammonia indexed to grey ammonia + CCS or carbon price, or gas indexation, cost-plus?

- **First wave of green NH3**
  - Example of pricing structure: Long-term fixed price contract to guarantee return on investment for early high-cost projects, or S-Curve structure

- **Development of certification systems, carbon pricing leads to colour agnosticism**

- **Price of NH3 molecule + certificate**

**Evolution of low-carbon ammonia pricing**

- Efficient long-term market should be based on a certification system:
  - The ammonia molecule is traded simply as ammonia (and potential mixed by trading firms and importers) on a contract or spot basis
  - A “carbon intensity” certificate is awarded to the producer, who sells it to the buyer, and can be traded separately
  - “Low-carbon” ammonia labelling rather than “blue”, depending on C intensity

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Government-led mechanisms can create a transparent price environment – CBAM example

Nominal prices, assumes base-case CO₂ price of $90/t

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Spot pricing might allow formula linkages to existing products – potential benchmarks available for Ammonia pricing

- **Characteristics of a well-defined benchmark price:**
  - **Wide acceptability** by the market having stood the test of time. This is indicative of robustness of the price underpinned by its liquidity.
  - **Ability to mitigate volatility** using hedging instruments.
  - **Efficient** in that it is reflective of the market.

- **Potential options for underlying benchmarks to price clean ammonia off of:**
  - Natural gas-based benchmark price
    - TTF/LNG/Henry Hub?
  - Crude oil-based benchmark price
    - Brent, JCC, etc.
  - Grey ammonia benchmark price
    - NW Europe cfr, fob Middle East, cfr East Asia, etc.
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<th><strong>BENCHMARK</strong></th>
<th><strong>ACCEPTABILITY</strong></th>
<th><strong>RISK MITIGATION</strong></th>
<th><strong>EFFICIENCY</strong></th>
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| Ammonia        | • Suitable for projects that will retrofit existing ammonia facilities with CCS  
                 • Outside of the fertilizers/chemicals markets, limited understanding of grey ammonia benchmarks. | • Spot market is small but will grow with fuel uses  
                 • Financial instruments for risk mitigation are not available now, but are likely to emerge in the near future | • Direct linkage with the commodity we are looking to price; intuitive appeal. |
| Crude oil      | • Utilities in Asia are conversant with the benchmark (JCC).  
                 • Maritime industry is quite conversant with crude oil price benchmarks. | • Highly liquid  
                 • Futures markets available; can be hedged  
                 • Relatively volatile | • Not directly linked to the commodity that we are looking to price, i.e. ammonia. |
| Natural gas    | • Utilities in Asia are conversant with gas/LNG benchmarks.  
                 • Maritime industry is quite conversant with crude oil price benchmarks. | • Highly liquid  
                 • Futures markets available; can be hedged (but link to ammonia prices is not that strong) | • Direct linkage with competing end-use cases in key regions (e.g. power generation in Japan) |
The role of subsidies: the most drastic form of direct subsidy (so far) is the Inflation Reduction Act in the US.
Other forms of support: CfD mechanisms, cost/price matching

Support only applies down to sales price

Reference price (Achieved sales price)

Strike price

Size of subsidy

Support only applies down to natural gas price

Reference price (natural gas)

Time

Japan to subsidise H2 and ammonia producers

Tokyo, 15 December (Argus) – Japan’s trade and industry ministry (Meti) on 13 December revealed its draft plan to subsidise hydrogen and ammonia producers to make their selling prices as competitive as that of LNG and coal.

Mets aims to provide direct financial support to clean energy manufacturers for 15 years with a possible five-year extension.

The ministry plans to boost hydrogen and ammonia investment by providing financial support to its producers so that they can avoid the risk of selling prices becoming too expensive for consumers. Meti also expects the subsidy to help producers avoid the risk of being unable to manufacture sufficient volumes to break even with their capital investment.

Mets aims to set LNG and coal prices as the “reference prices” for hydrogen and ammonia, respectively, with these cleaner fuels usually used as alternatives of its respective conventional fuel. The ministry will refer to the “reference prices” to ascertain the subsidy amount needed to narrow the price gaps in the market.
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