Use of Natural Gas for Ammonia Production in Israel

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Presentation Highlights

- Global Market
  - Production
  - Trade
  - Cost Benchmarks

- Israeli Market
  - Local demand
  - Logistics

- The project
  - General Parameters
  - Linde Ammonia Concept (LAC)
  - Summary of Advantages of Linde Engineering Niche Technology for Ammonia Production
  - Modern Integrated Industrial Site Concept
  - Views of Existing Linde Engineering Ammonia Plants of Different Capacities
  - Ammonia Production in Israel from NG: Economical and General Considerations
China accounts for the largest share of projected new capacity.

Due to rising domestic energy costs and expected closures of inefficient capacity it is unlikely to significantly increase its ammonia exports.
Most ammonia is consumed in its domestic market as it is expensive and difficult to transport.

North America is the largest importer with 35-40 % of world trade.

Europe, a higher-cost producer, accounts for about 25 %

The former Soviet Union, Latin America, the Middle East and North Africa are the primary exporting regions due to their lower-cost gas positions and limited domestic consumption.
Global Ammonia Market

Cost Benchmarks

- Access to lower-cost natural gas and proximity to markets are critical to success in the ammonia traditional business oriented toward urea production.

- High-cost producers in Western Europe and Ukraine currently set the floor for nitrogen prices.

- Israel is considered as a niche market.
Ammonia has been declared by MOI a “national strategic raw material”.

Used for fertilizers, food refrigeration, DeNOx, explosives, yeast, pharmaceuticals.

**Yearly Consumption MT/year**

- **HCL, 80,000**
- **ICL, 36,700**
- **Others, 3,300**
- **Others**
The Israeli Market Logistics

12 shipments per year from the black sea - 10,000 each

Storage tank in Haifa Bay – 12,000 MT

5.5 km pipeline from the storage tank to HCL North (120,000 MT/year)

Pipeline from HCL North to Deshanim (40,000 MT/year)

Other Local Logistics including HCL South by Road Trucks
The Project

General Parameters

- **Capacity Basic Project**
  - 480 MTPD - 160,000 MT/year Ammonia
  - NG Consumption: 0.16 BCM/year

- **Relevant economically viable and proven technology suppliers for niche markets:**
  - Linde Engineering

- **Project Location**
  - Mishor Rotem

- **Estimated Project Timetable**
  - Project Development: 0.5 years
  - Project Execution: 2.0 years
  - Project Operating Life: 25 years
A combination of proven technologies

Figure 1

Linde Ammonia Concept (LAC)
Linde Ammonia Concept (LAC)
Comparison of LAC process with conventional scheme

**Conventional Ammonia Plant**
- Feed
- Air
- Desulfurization
- Primary Reformer
- Secondary Reformer
- HT Shift
- LT Shift
- CO₂ Removal
- Methanation
- Ammonia Synthesis
- Purge gas Separation
- NH₃
- CO₂

**Linde Ammonia Concept (LAC)**
- Feed
- Air
- Desulfurization
- Primary Reformer
- Isothermal Shift
- PSA
- Ammonia Synthesis
- Nitrogen Unit
- NH₃

**Cost related facts:**
- number of temperature changes
- temperature levels
- flowrate
- number of equipment and catalyst

**Efficiency related facts:**
- heat exchange losses
- pressure drops

Downstream this point the flowrate of a conventional plant is 30 to 80% higher compared to the LAC-process.

*Figure 3*
Linde Ammonia Concept (LAC)
Possible valuable By-Products

Hydrocarbon Feed → CO₂ → CO → H₂ → CO Recovery → H₂ Unit with PSA Purification → MEOH Unit → N₂ Unit

Atmospheric Air

Rare → Ar → O₂ → N₂

Methanol

Ammonia Synthesis Loop

Ammonia Product

Figure 8
Summary of Advantages of Linde Engineering Niche Technology for Ammonia Production versus Conventional Technologies

- Elimination of three catalytic process steps, reducing the total catalyst volume to approx. 50% of that in a conventional plant, reduced number of equipment items.
- Recovery of CO\textsubscript{2} through an additional washing unit, allowing adjustment of CO\textsubscript{2} quantity to the demand.
- Reduced start up and shut down time resulting in important savings in feedstock consumption.
- Savings in investment costs (15 to 20%), construction time, site area, maintenance and spare parts costs as well as catalyst replacement costs.
- Valuable by-products may be produced.
- Tailored for Israeli Market needs economically proven available technology (14 plants in operation worldwide) for niche Ammonia markets not sensible to world commodities (Urea) market fluctuations.
- A relatively low investment required to economically manufacture in development area a strategic product for the Israeli local necessities.
Governments promote and support projects oriented toward national benefit:

- Minimize environmental impact
- Optimize investments
- Minimize need of Governmental grants for development.

<table>
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<tr>
<th>CENTRAL ADMINISTRATION UTILITIES AND INFRASTRUCTURES AREA FOR ALL PLANTS LOCATED AT THE INTEGRATED SITE</th>
<th>AMMONIA PLANT</th>
<th>PROPYLENE PLANT</th>
<th>MALEIC ANHYDRIDE PLANT</th>
<th>OTHER PLANT</th>
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<td>METHANOL PLANT</td>
<td>MELAMINE PLANT</td>
<td>OTHER PLANT</td>
<td>OTHER PLANT</td>
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Linde Ammonia Concept
Moura, Australia - 230 mtpd NH3
Linde Ammonia Concept (LAC)
Phosphate Hill, Australia - 600 mtpd NH3
Linde Ammonia Concept (LAC)
Phosphate Hill, Australia - 600 mtpd NH3
Ammonia Production In Israel From NG: Economical and General Considerations

- NG Price: 5.5 - 6.0 $ per 1MM BTU
- Plant Capacity: 160 ktpa (480 tpd)
- Capex: 160 - 180 MM $
- Opex: 40 - 42 MM $ per year
- ROI: 2.5 – 3.5 years
- Operational Production Cost versus actual local Ammonia Market Price: ~ 30% - 35%
- Additional National benefit – Saving of foreign currency for importing Ammonia
- Enhancing foreign world leaders as Linde Group active commitment and participation in the Israeli industry
- Supply by local facility of a recognized nationally important strategic material, drastic improvement of safety and security nationwide.
THANK YOU