Improving Project Profitability
By
Partnering with Expert through B00

From
Anish Paunwala
Linde
Leading.

INDIAN Petrochem-2018
Mumbai
2nd November’2018
AGENDA

• Brief Information about Linde Group
  • Linde Gas & Linde Engg Capabilities – Technology, Execution, Operation & Maintenance

• Industrial Gases -> Petrochemical Connection

• Project Investment through B00 (Build Own Operate)
  • B00 Structure(s) – Buy/Sell and Tolling
  • B00 - Typical Commercial Structure
  • Key advantages of B00

• Linde B00 Reference in Refinery & Petrochemical Complex

• Summary
# The Linde Group Overview

<table>
<thead>
<tr>
<th>Founded</th>
<th>1879</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (2017)</td>
<td>€ 17.37 billion</td>
</tr>
<tr>
<td>Employees</td>
<td>&gt;57,000</td>
</tr>
<tr>
<td>Countries</td>
<td>&gt;100</td>
</tr>
</tbody>
</table>

## Linde Engineering

- **Technology-focused**
  - Air Separation
    - Global #1
  - Hydrogen/Syn Gas
    - Global #2
  - Olefins
    - Global #2
  - Natural Gas
    - Global #3

## Linde Gas

- **World-class operations**
  - HyCO Tonnage Plants
    - >70 plants
  - ASU Tonnage Plants
    - >300 plants
  - ECOVAR Std Plants
    - >800 plants

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**Leveraging Synergies**
Linde Engineering
Leading market position in multiple segments

- Air separation plants
- Hydrogen and synthesis gas plants
- Petrochemical plants
- Natural gas plants

Providing plants for Linde Gas and third-party customers
Providing plants for chemical industry and energy-related industries

Technology & Plant Supply Capability

- Air Separation Unit – Oxygen, Nitrogen, Ar
- SMR, Partial Oxidation for H2, CO and Syngas
  - Third Party alliance – Gasification, Ammonia, MeoH, SRU
- Petrochemicals – Steamcracking, Acetylene Recovery, Linear Alpha Olefins, Polyolefins, OCM
  - Third Party – EO/EG, Butadiene, Acrylic Acid and derivatives, Methanol
- LNG and NG processing – LNG, NGL, Nitrogen Rejection, He Recovery & Liquifaction
- PSAs, VSAs, TSAs, Cryogenic Process
Clean Coal Gasification Process and Downstream Products
Linde technology and product coverage

**Syngas Island**

**End Products**
- H₂
- CO
- H₂/CO
- NH₃/Urea
- SNG
- MeOH/MTO
- CTL
- Power

**FEEDS**
- Coal & Petcoke

**FEEDS**
- e.g. Coal Slurry

**ASU**

**O₂**

**ASU**

**Gas Conditioning**

**Shift**

**Rectisol**

**CO plant**

**Sulfur recovery**

**Clean Syngas**

**Steam**

**Traces**

**CO₂**

**Feasibility & Value Integration Studies**

**EPC**

**O&M & BOO**
# Technology Portfolio for Gases and link to PC

## Gas Networks by Linde

### Feed

- Air
- Offgases
- NG
- LPG
- Naphtha
- Fuel Oil
- Residue
- Asphalt
- Pitch
- Petcoke
- Coal
- Raw SG

### Conversion, Purification, Separation and Synthesis Process

#### Gas Generation
- Steam Reforming
- Steam/CO2 Reforming
- Gas Heated Reforming
- Autothermal Reforming
- Partial Oxidation
- Shift Conversion

#### Gas Impurity Removal & Purification
- Chemical Wash
- Physical Wash
- Caustic Wash
- Cryogenic Processing
- Adsorption
- Sulfur Processing
- Membrane

#### Gas Synthesis
- NH3 Synthesis
- MeOH Synthesis
- Methanation

### Gases

- O2
- H2
- H2 + CO
- CO
- Syngas
- NH3
- MeOH
- CO2
- Sulphur

### Petro-Chemical

- EO
- PO
- Polyols
- Acetic Acid
- Oxo Alchol
- Olefins
- Urea
In total Linde is operating more than 1000 plants producing industrial gases in all continents with a particularly strong focus in Asia.

<table>
<thead>
<tr>
<th>HYCO Tonnage</th>
<th>Air Tonnage</th>
<th>ECOVAR® (standard plants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂, CO, CO₂, Synthesis gas</td>
<td>O₂, N₂, Ar, Kr, Xe</td>
<td>O₂, N₂, H₂</td>
</tr>
<tr>
<td>Up to 250,000 Nm³/h</td>
<td>3,000 – 50,000 Nm³/h</td>
<td>50 – 3,000 Nm³/h</td>
</tr>
<tr>
<td>&gt; 120 plants</td>
<td>&gt; 350 plants</td>
<td>&gt; 1000 plants</td>
</tr>
</tbody>
</table>
Petrochemical Project – Challenges

• Traditional Models for Chemical Project are being challenged
• Project Returns/Profitability not realized fully due to:
  • Delay in project completion
  • Efficiency and Reliability not fully achieved over investment cycle
  • Time challenge in NOC in managing more stake holders during project and operation phase
  • Obligations/Liability from different supplier ends in first few years of complex start-up
• Huge Investment requirement - Funding challenge and hence higher IRR expectation
What is Build Own Operate (BOO)

BOO = We Eat what We Cook
Details on Build Own Operate (BOO)

• BOO Supply Schemes
  • Lease and O&M (Tolling) Arrangement
  • Buy/Sell Arrangement
• Key Commercial and Contractual Terms of BOO
  • Gas Pricing Structure
  • Terms & Condition
• Key benefits of BOO concept in Refining & Petrochemical
• Linde’s Regional Operation Center (ROC) for Operation Efficiency
**BOO Supply Schemes**

**Tolling Concept**

### Linde or Linde JV

- **H₂ production plant**
- **Design/Construct/Comm./start up**
- **Plant operation, maintenance & insurance**
- **Backup system & logistics**

### Customer

- **Base facility fee (BFF)**
- **Variable unit fees for products**
- **Continuous supply of product**
- **Feedstock, utilities free issue**

### Linde Responsibility

- Capacity & flexibility
- Availability, reliability & quality
- Specific consumption (Linde guarantees)
- O&M budget

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15-20 years supply agreement

— Fixed Fee (BFF) for capital recovery and fixed operational costs
BOO Supply Schemes
Buy-Sell Concept

Linde or Linde JV

- H₂ production plant
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Linde Responsibility
- Capacity & flexibility
- Availability, reliability & quality
- Specific consumption
- O&M budget

- Fixed Fee (BFF) for capital recovery and fixed operational costs
- Variable Charge (VC) for molecules adjusted with actual price of feedstock & utilities
## Different BOO Solutions

<table>
<thead>
<tr>
<th>Approach</th>
<th>Supply Chain</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| **A** Standalone Approach | Linde Plant → Pipeline Supply → Customer Production | • Linde’s technology, project & ops expertise  
• Operation at process and cost optimum |
| **B** Piggyback Approach | Linde Plant → Pipeline Supply → Customer Production | • Benefits same as **A**, plus:  
• Economies of scale  
• Synergies  
• no Embedded Lease |
| **C** Cluster Approach | Linde Plant → Pipeline Supply | • Benefits same as **A**, plus:  
• Economies of scale  
• Synergies  
• no Embedded Lease |
Benefits of Outsourcing - BOO (Build Own Operate)

Effective Utilization of Capital
- Refinery & Petrochemical Operator can divert funding to other projects to maximize value
- Lower funding by converting some CAPEX into OPEX.

Guaranteed OPEX (yield and utility consumption) for project life
- Linde is technology supplier and knows the process best. Conditions continuously being optimized/benchmarked, effectively reducing Opex
- Customer gets Yield and Utility Cons. Guarantee linked with financial penalty for entire contractual period.

Guaranteed Higher Reliability (On-stream Availability) and High Safety
- Intense focus on safety
- Preventive maintenance, rigorous monitoring, ready access to pool of spare parts, global sharing of best practices and world class tech support
- Linde will guarantee reliability for >15 years*
Benefits of Outsourcing - BOO (Build Own Operate)

Timely Completion of Project
- Execution risk (capex and schedule) is fully under Linde
- Linde will commit firm date for on-stream once BOO contract is signed

Operation & Maintenance managed by experienced professionals
- O&M risk (Availability, Opex, Safety and High Reliability) is fully taken care of by Linde
- Linde will guarantee Utility Consumption and Product generation for >15 years

Commercial Reference – Proven Approach
- Globally BOO schemes have been increasingly applied for large refineries & Petrochemical. H2, O2 & N2, SynGas, CO2 manufacturing is increasingly spinned off from their core refining business
- Linde has reference for Technology, execution and operation all these plants.
Benefits of BOO
Increased Petrochemical Complex Performance

All relevant Solomon Index for Fuels Refinery Performance Analysis will increase:

Energy Intensity Index (EII):
- Sales, instead use of, refinery Sour Gas and Sour Water to the Linde Unit
- Guaranteed S production efficiency

Mechanical Availability with TAR (%)
- Guaranteed reliability

On-stream Availability with TAR (%)
- Guaranteed reliability

Maintenance Index
- No maintenance cost for Gas Plants in the books of Main Project
- Maintenance cost for Gas Plant is managed and optimized by Linde

Personnel Index / 100 EDC
- No personnel cost for the operation of Gas Plant in the books of Refinery
- Required on-site FTE (Full Time Employee) in the Linde Unit is optimized. Expertise comes from Linde’s Remote Operation Center (ROC) and Global Operation Center (GOC)
Remote Operation Center (ROC) – Hicom, Malaysia

The Linde Group
Operational Excellence – Benchmarking and Tracking

**Reporting and Tracking of Main KPI’s of Tonnage Plants**

- The gas experts in the GOC (Global Operation Centre) centre monitor the performances of all gas plants based on KPIs which measures reliability and efficiency of the plants.
- Should a plant not meet the predefined KPIs immediate actions are taken to improve.
- The COG Team develop also improvement plans for all the Linde’s plants and support in case of Troubleshooting.

**Linde model predictive control optimised for gas plants**

- Key enabler for higher efficiency
- Provides automatic load change and higher
- Operating stability
- Used to drive plant closer to the limit
# Key Difference between BOO vs Captive

## For Refinery

<table>
<thead>
<tr>
<th></th>
<th>Linde Responsibility and Liability</th>
<th>Captive Project Responsibility and Liability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Execution Risk – Capex Over-run and Schedule</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Project Capex/Investment</strong></td>
<td>Linde Invests</td>
<td>Customer Invests</td>
</tr>
<tr>
<td><strong>Initial Plant Performance Guarantee (SOR)</strong></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>15 (20)-year Plant Capacity Guarantee</strong></td>
<td>✓</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>15 (20)-year Feed Efficiency Guarantee for Conversion</strong></td>
<td>✓</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>15 (20)-year 99% Reliability Guarantee (volumes/outages) – Onstream Availability</strong></td>
<td>✓</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Safety in Operation (Best Gas Operation Practice)</strong></td>
<td>✓ (Higher)</td>
<td>✓</td>
</tr>
</tbody>
</table>

*Schedule depend upon execution model*
Linde key BOO References in Refinery & Petrochemical Complex
– Success Story
Linde awarded the biggest Hydrogen and CO complex in Saudi Arabia for Aramco and Dow

- Aramco/Dow (Sadara) and Linde signed 20 year supply contract for industrial gases in Jubail
- Linde will invest USD 380 million in the project to supply the Sadara petrochemical complex with Hydrogen, CO and Ammonia
- Production commenced in 2016
- For more information visit:
**Al Jubail, KSA**

<table>
<thead>
<tr>
<th>Prospect:</th>
<th>Al Jubail 10, Kingdom of Saudi Arabia</th>
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</thead>
<tbody>
<tr>
<td>Customer:</td>
<td>Petrochemical Industry</td>
</tr>
<tr>
<td>Plant Supplier:</td>
<td>Linde Engineering (LE)</td>
</tr>
<tr>
<td>CAPEX:</td>
<td>380 mio US$</td>
</tr>
<tr>
<td>Main Products:</td>
<td>CO: 18,300 Nm³/h</td>
</tr>
<tr>
<td></td>
<td>H₂: 91,000 Nm³/h</td>
</tr>
<tr>
<td></td>
<td>NH₃: 22,6 t/h (545 tpd)</td>
</tr>
<tr>
<td></td>
<td>Steam: 63 t/h</td>
</tr>
<tr>
<td>Onstream since:</td>
<td>2016</td>
</tr>
</tbody>
</table>

**Scope of the Plant:**

- 2 x HyCO Trains: Steam Reformer, MDEA Wash Unit with CO₂-recycle, Cold Box, PSA, Flare
- 1 x Ammonia Converter (Casale), Ammonia B Tank, Flare.
Togliatti, Russia

Prospect: Togliatti, Russia
Customer: Chemical Industry
Plant Supplier: Linde Engineering (LE)
CAPEX: total 270 mio EUR
Main Products:
- $H_2$: 130,000 Nm$^3$/h
- thereof 10,000 Nm$^3$/h for export
- $NH_3$: 55.8 t/h (1340 tpd)
Steam export: 50 t/h
Onstream since: 2017

Scope of the Plant:
1 x HyCO train: Steam Reformer, Isothermal Shift, PSA, flare
1 x Ammonia Converter (Casale), flare, steam driven syngas and refrigeration unit
Linde established a JV with Petronas Gas Berhad (PGB) to build a state-of-the-art industrial air gas facility producing oxygen and nitrogen to supply the world-scale the Pengerang Integrated Petroleum Complex (PIPC or previously known as RAPID project) in Johor, Malaysia.

The Air Separation Unit (ASU) will supply gaseous oxygen (GOX) and gaseous nitrogen (GAN) to multiple customers, including the oil refinery and a EO/EG plant in the newly developed industrial cluster.

<table>
<thead>
<tr>
<th>Start-up</th>
<th>Location</th>
<th>Customers</th>
<th>Capacity</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 2018</td>
<td>Pengerang, Malaysia</td>
<td>Petronas, Saudi Aramco, BASF</td>
<td>41,000 Nm³/h</td>
<td>Oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24,000 Nm³/h</td>
<td>Nitrogen</td>
</tr>
</tbody>
</table>
Gasification Experiences (I)
Extensive operation & global references

Operations
- Operates 4 gasification/POX units allowing for continuous improvements

Singapore

Brisbane, Australia

Clear Lake

Laporte, North America

Large-Scale ASU’s & Rectisol® Units
- 65 Rectisols globally
- More than 20 world-scale ASUs for China gasification projects, e.g., Shell-Sinopec Yueyang
- Largest ASU build for Shell-Pearl GTL 30,000MTD O2
In 2004 Linde Gas took over the operation of a partial oxidation plant from Chevron Texaco in Singapore. This plant is supplying up to 30,000 Nm³/h of CO and up to 20,000 Nm³/h of H2. The feedstocks are heavy residues from refineries and oxygen from an air separation unit, which is also owned and operated by Linde Gas.

H2 and CO production in Singapore
VB Residue Gasification

CO: 30000 Nm³/h
H2 25000 Nm³/h
Feed: VB Residue

Linde Gas took over this plant in 2004 and dramatically improve the reliability of the unit.

Linde gas constantly invests in improving and expanding the plant to better satisfy the Refinery and Acetic Acid Producer.
BP and Sunoco Refineries, Toledo, USA
Steam Reformer

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- Average Reliability of each train >>99.5%
- The high reliability of this concept ensure uninterrupted supply of H₂ to the two refineries supplied by this plant.
- The plant integrate an off gas stream from the refinery which is purified in a separate PSA. The tail gas of the PSA is integrated as reformer feed in addition to the natural gas.
- 2 x Top-fired Selas Reformer Trains
- 12 bed Linde PSA
- No Pre-reformer

<table>
<thead>
<tr>
<th>Location</th>
<th>Customers</th>
<th>Capacity</th>
<th>Products</th>
<th>Feedstocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toledo, Ohio, USA</td>
<td>Sunoco &amp; BP</td>
<td>144,000 Nm³/h</td>
<td>H₂</td>
<td>Natural gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>67.8 t/h</td>
<td>Steam</td>
<td>Refinery off-gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Refinery fuel gas</td>
</tr>
</tbody>
</table>
Linde is a technology-driven company with significant SMR, ASU, and Gasification experience in EPC, Operation and Maintenance through BOO.

Linde brings unique strengths to improve project feasibility/bankability by:

- Offering single point project accountability by integrating complex with all process blocks optimally.
- Offering higher reliability and efficiency in complex utilizing strong operation experience.
- Offering Capex Investment into project improving overall economics.
- Offering execution expertise to meet project schedule.

BOO approach has been used across all Industrial segment and by major Operators with key focus on:

- Improving focus on core unit operation.
- Bringing expert to manage Gas plants.
- Improving overall project economics.
Let’s Work Together