Air Products’ Gasification Technologies and Sale of Gas Model

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Air Products Today

$8.9 billion in FY18 sales

~16,000 employees

50+ countries

~$50B market cap

7+ decades in business

170,000+ customers

1800 miles of industrial gas pipeline

750+ production facilities

30+ industries served
Air Products has the Core Competencies Required to be a Supplier of Syngas

- We recently acquired Shell and GE gasification technologies to enhance our core competency in gasification
## Air Products Gasification Technologies

<table>
<thead>
<tr>
<th>Gasification Type</th>
<th>Shell</th>
<th>GE</th>
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<tbody>
<tr>
<td>Coal / Solid Gasification</td>
<td>100%</td>
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<tr>
<td>Residue / Liquid Gasification</td>
<td>50%</td>
<td>100%</td>
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<tr>
<td>POx / Gas Gasification</td>
<td>0%</td>
<td>100%</td>
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GE Solids Gasifier

Slurry Feed + Oxygen

Syngas + Slag

Shell Solids Gasifier

Syngas

Membrane Wall

Dry Feed + Oxygen + Steam

Slag
Multiple Cooling Options for Best Project Efficiency vs. CAPEX

- GE Quench
- GE Radiant Syngas Cooler (RSC) + Quench
- Shell Syngas Cooler
- Shell Bottom Quench
GE Liquids Gasifier
(it’s similar for solids and POx)

Shell Liquids Gasifier

Gasifiers are similar:
• Single feed injector
• Top fired
• Refractory lined
• Both offer a waste heat boiler and a quench version
Moving forward

- Countries with massive resources of **coal** that want to **reduce dependence on imported oil** for the production of liquid fuel or high-end chemicals
  - South Africa, China, India

- Countries with significant **natural gas reserves** that want to create additional value by converting natural gas to liquid fuel or high-end chemicals
  - United States, Russia, Uzbekistan

- Refineries all over the world that need to find a use for **low-value heavy residues** which can no longer be used as fuel for ships (IMO 2020)

- Continue **licensing** model and add **Sale of Gas (SOG)** model

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<tr>
<th>License:</th>
<th>AP (Shell):</th>
<th>Customer</th>
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<tr>
<td>Develop</td>
<td>License</td>
<td>Finance</td>
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<tr>
<th>SOG:</th>
<th>AP:</th>
<th>Air Products build, own, operate:</th>
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Executing our gasification strategy
Energy, environmental, emerging markets

Project capital represents 100%, not APD share
Project dates represent actual or expected onstream
Air Products & Lu’An Clean Energy Company
$1.5 billion coal-to-syngas production joint venture

- JV: Air Products Lu’An (Changzhi) Co., Ltd
  - Ownership: 60% APD / 40% Lu’An
  - Lu’An supplies coal, steam, and power
  - Produces up to 750,000 Nm³/hr syngas
  - Onstream Q4 FY18
Jazan Project – Saudi Arabia
Expanded scope

- **Refined products to market**
- **400,000 BBL/day refinery**
- **Vacuum resid**

**Gasifier** (Air Products/Shell)
- **Hydrogen**
- **Syngas**
- **Power Block**
  - **3,800 MW of power**
- **Oxygen**
- **Nitrogen**

**ASU**
- **75,000 TPD**
  - Built by Air Products
  - Owned by Air Products and ACWA

- **Utilities**

- **Crude oil**
- **To Saudi power grid**

- **Acquired by JV for over $8B**

Only major product flows shown
Air Products & Yankuang/SFEC
$3.5 billion coal-to-syngas joint venture

- Investment Cooperation Agreement
  - Signed November 9, 2017 in the presence of President Trump and President Xi during the U.S. Department of Commerce’s Trade Mission to China

- $3.5 billion coal-to-syngas production facility JV
  - Yulin City, Shaanxi, China
  - Air Products majority JV control (55-60%)
  - Onstream expected 2022
Juitai New Materials

• **Customer:** Juitai New Materials coal-to-MEG project
• **Location:** Hohhot, Inner Mongolia China
• **Scope:** ASU, gasification and syngas cleanup *(Greenfield)*
• **Cost:** $650M, 100% owned by Air Products
• **Contract:**
  o Air Products supplies *syngas* to Juitai and receives *coal and utilities* from Juitai
  o Air Products is responsible for *capital and operating costs / efficiency and reliability* (consistent with our typical on-site projects)
• **Project on-stream** before 2022.
Debang Group JV

- **Customer/Partner**: Debang Group coal-to-chemicals plant
  - Relocation of existing Debang coal-to-chemicals
- **Location**: Xuwei National Petrochemical Park, Lianyungang City, Jiangsu Province (East Coast of China)
- **JV**: 80% Air Products / 20% Debang
  - JV owns/operates ASU, gasification and purification assets
- **Merchant business**: 100% Air Products
- **Cost (100%)**: ~$250 million
- **On-stream**: 2023
- **Contract**:
  - JV supplies syngas to Debang, receives coal & utilities from Debang
  - JV (Air Products operating responsibility) responsible for capital and operating costs, efficiency and reliability (consistent with our typical on-site projects)
Thank you
tell me more