New Linde LNG Fuel Station Technology

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The Linde Group
Based on two pillars with extensive synergies

- $20B Revenues and over 130 years of experience
- Global Network – 62,000 employees in 100 countries
- Self-finance $2B/year CAPEX for Linde Operating Plants
## Linde Gases

Wide range of products and services combined with leading customer applications equipment

<table>
<thead>
<tr>
<th>Air Gases</th>
<th>Fuels and Other Gases</th>
<th>Specialty and Medical Gases</th>
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<tbody>
<tr>
<td>Nitrogen</td>
<td>LNG</td>
<td>Pure Gases</td>
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<tr>
<td>Oxygen</td>
<td>Propane</td>
<td>Specialty</td>
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<td>Argon</td>
<td>Hydrogen/HyCO</td>
<td>Gas Mixtures</td>
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<td>Rare Gases:</td>
<td>Acetylene</td>
<td>Medical Oxygen</td>
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<tr>
<td>Krypton, Neon, Xenon</td>
<td>Helium</td>
<td>Nitric Oxide (NO)</td>
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<td>Carbon Dioxide</td>
<td>Nitrous Oxide (N2O)</td>
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Processes and equipment for use of gases in the most diverse applications
Completing the LNG Jigsaw Puzzle
Internal Customer

—Fred Kinkin - Head of production and distribution for Linde’s $2.5B RNA business unit
—70 production sites in US, Canada, Mexico
—10,000-plus customers – hospitals, aerospace, steel mills, food processors etc.
—35,000 deliveries/month
—80 million miles a year

“I would love to take advantage of the upsides, but how can I entrust my company to the vagaries of a new fuel source?”
The Linde Fleet

• **Linde has 800+ Class 8 tractors**
  – Field trial of 3 LNG tractors in California
  – Introduced a further 20 LNG tractors in 2012
    – Expanded fleet in California
    – Introduced to new locations in Texas and Indiana
    – Planning to add more LNG tractors in 2013

• **80% of Fleet fuelling is at base**
  – Currently fuelling at local fuelling stations where available
  – Indiana location is using a Linde Mobile Fueller
  – A permanent LNG station solution is needed
Linde Mobile Fuelling Rig

- Used to introduce LNG trucks to Linde fleet locations
- Fully self-contained mobile LNG fuelling rig
- Self sustaining, has on-board power, etc.
- Minimal site permitting required
- Ideal fuelling solution bridge from demonstration to full deployment stage for fleets

Linde Mobile Fuelling Rig supporting a Peterbilt LNG Demo truck with C-Cross Transportation in South Carolina
Internal Customer Convinced

- Roll out more LNG trucks to the fleet
- Permanent infrastructure is needed

“I really believe in the value of LNG as a fuel and despite my initial reservations, I’m excited about the road ahead.”
LNG Fuel Station Design

— Completed industry review and consultation

— Outline of issues and features to incorporate into new design

LNG Station Constraints Today

— LNG has a ‘shelf life’, need to manage fuel conditions
  — Station has to be designed to fleet size today, hard to scale
  — Boil-off gas
— Stations are expensive
— Can have a long lead time
— Cases where two types of LNG need to be dispensed, two tanks and two distinct dispensers are required, adding cost, footprint and complexity
— On site fabrication can add cost and time to installation
— Management of gases vented back to station
Linde Design Brief

An LNG Station designed for customers with back to base fleets where on-site fuelling infrastructure is attractive:

• Improve Fuel Management
  — Single LNG Tank
  — Minimise/eliminate boil-off
  — LNG conditioning to maintain fuel temperature in tank
  — Single LNG dispenser capable of dispensing two LNG conditions

• Reduce capital costs
  — Reduce complexity
  — Integrate components to minimize expensive pipe work
  — Build as much “off-site” and minimize on site fabrication

• Reduce lead time and installation complexity
  — Integrate station components onto common skids
  — Minimise connections needed to be completed on site

• Minimise footprint
  — Systems integration
Trial System Installation – Melbourne, Australia
Linde LNG Fuelling Station

- Single LNG Storage Tank
- On the fly conditioning
- Integrated Pump and Dispenser Skid
- Minimal on-site fabrication
- Minimised Footprint
LNG Fuel Management

- Maintain sub-cooled LNG by using LIN
- On the fly conditioning brings LNG to required pressure/temperature
- Single LNG Storage Tank
- Single dispenser providing sub-cooled and saturated LNG
Minimal Footprint

- Integrated LNG Pump and Dispenser reduces space requirements
- Single LNG Storage Tank but still able to dispense two conditions of LNG
- 25’ by 35’ (7.62m by 10.67m) footprint for single dispenser system
- Second dispenser available
Linde LNG Fuel Station – Roll out

Currently there are 4 Stations under trial
- 2 in Australia
- 2 in UK

- First NA station will be built at Linde Plant location near South Bend, IN
  - Commissioning planned for Q4 2013
  - Will fuel 10 Linde LNG tractors

- Commercial Stations being offered
Station Summary and Specifications

- LNG Tank Capacity – 15,000 gallon
- Nitrogen Tank Capacity – 1,500 gallon
- LNG Fuelling Nozzle - JC Carter
- Required Footprint - 25’x 35’
  - Single dispenser system
- PLC Controlled
- Integrated Safety Features
  - IR flame detection and methane detection
  - Break away connection
- Modular
  - Easily expanded to have multiple dispensers and extra storage tanks
- Flow meter built to weights and measures standards
- Card reader capable
- Stainless steel components for durability
Look for more information at www.lindelng.com

Thanks for your attention.