

Altamont Landfill Gas to LNG Project Status Report

Linde Gas



August 2010
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- Linde operates in over 100 countries - \$17 billion in revenues, 50,000 employees
- \$2 Billion revenues in North America, 4,000 employees
- Supplier of compressed gases and cryogenic liquids and technology
 - Atmospheric gases: oxygen, nitrogen, argon, helium, CO₂, rare gases
 - Fuels: LNG, biogas, LPG, H₂
- Plant engineering and supply
 - LNG, natural gas processing, petrochemicals, atmospheric gases

Some global activities in LNG follow



Eastern Australia

Linde Gas

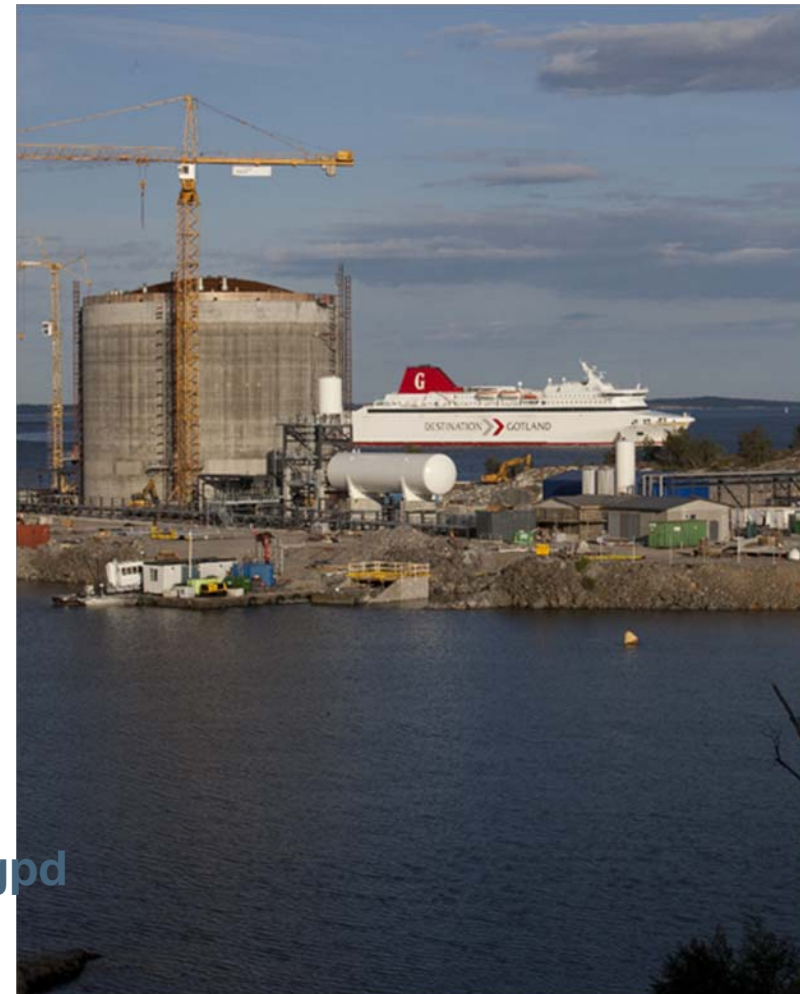


- Linde operates an LNG peak shaver near Melbourne
- Building additional plants and stations
 - Phase 1 plant is nearing completion: 30,000 gallons per day (Tasmania)
 - Phase 2: Two plants & eight refueling stations

• Will develop the eastern coast and L



- Linde Scandinavia (AGA) will own and operate an LNG import terminal 60 km south of Stockholm
 - To commence operations May 2011
 - Will supply LNG for naphtha conversions and other customers, including Baltic Sea fleets
 - Also backs up 12 AGA biogas stations in Stockholm
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- ✓ Storage capacity 20,000 m³
 - ✓ Throughput capacity >500,000 gpd
 - ✓ Unloading to ships possible



- 11,000 gallons per day LNG
- Simple, liquid nitrogen-based facility based on pipeline gas
- Customer: Bayernwerk AG
- LNG is used as a fuel for vehicles and feedstock in industrial production facilities



Other Linde-built LNG plants from 10 thousand to 7 million gallons per day



China



UK



Norway



Australia

Altamont project overview



A Renewable Fuel Joint Venture Company

- Located near Livermore, CA
- Linde and Waste Management 50/50 JV
 - Linde brings liquefaction, purification, operations and logistics expertise
 - WM brings landfill management and gas collection expertise



Altamont landfill gas to LNG project



A Renewable Fuel Joint Venture Company

- The largest of its kind in the world - 13,000 gpd
 - Purification train
 - Mixed refrigerant liquefaction developed under license from GTI
- Environmental benefits
 - Reduces nearly 30,000 tons CO₂ annually
 - Uses renewable feedgas and electricity
 - Supplies 300 WM refuse trucks
- Financials
 - \$15.5 million capital
 - \$2 million government funding
 - CIWMB, CARB, CEC, SCAQMD

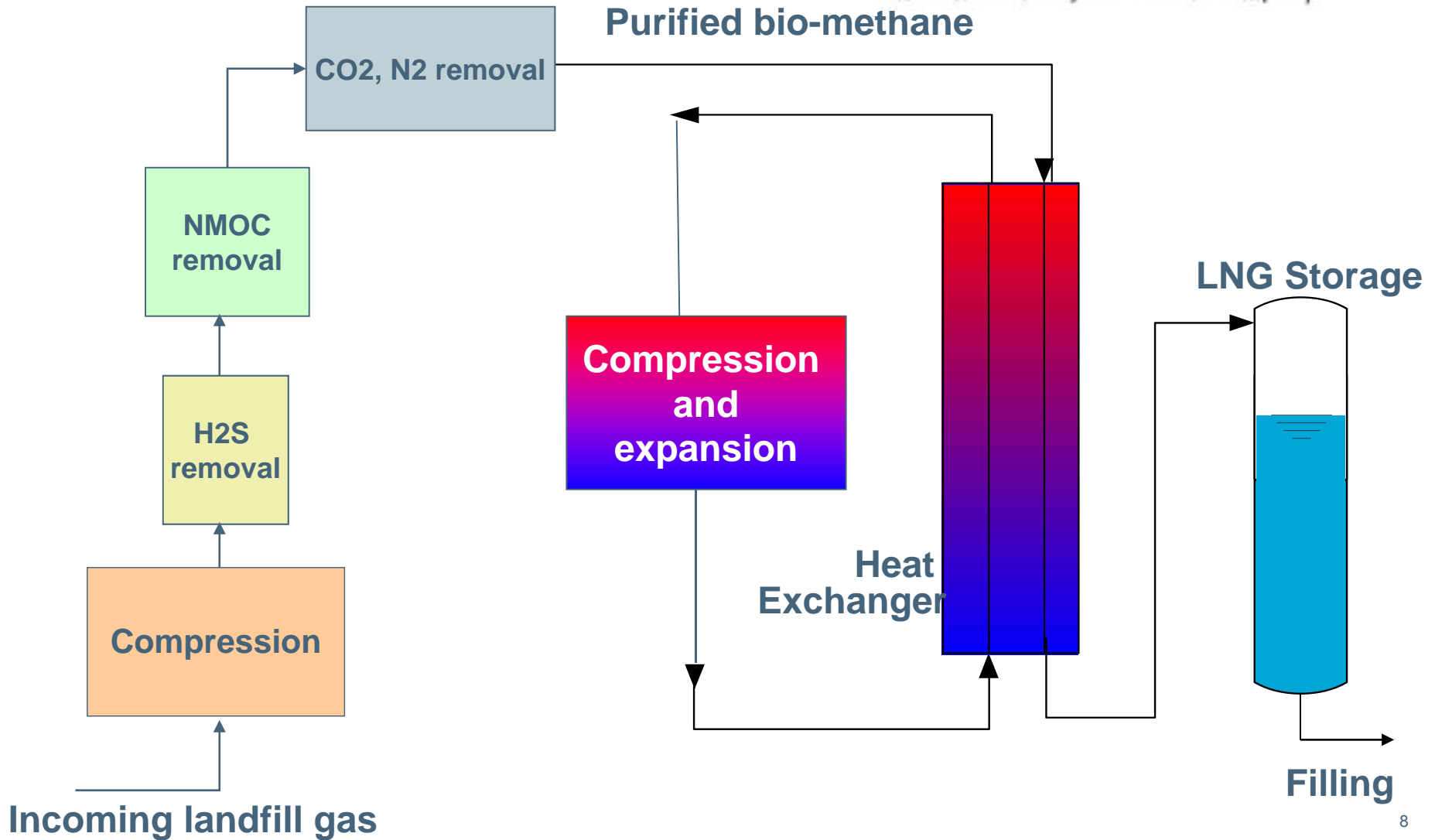


Purification system and flare

Plant Schematic



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Successful Commissioning



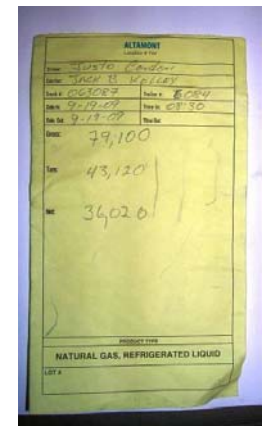
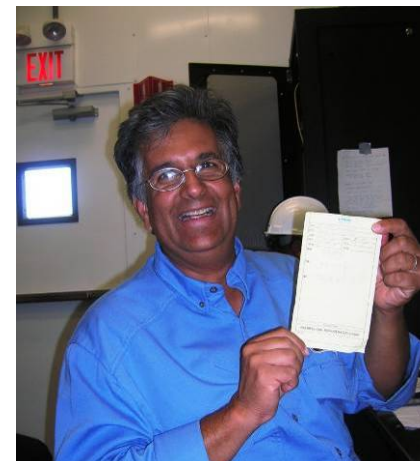
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Key dates:

- July 6, 2009 Flare commissioning began
- August 3 Landfill gas introduced to purification system
- September 16 Gas introduced to liquefier
- September 19 First LNG trailer loaded
- October 14 Unattended plant operation
- Feb. 16, 2010 Reached 1/2 million gallons
- May 10 Performance test completed

Performance through July 2010

- >1.7 m gallons LNG produced
- Maximum sustained production: 14,000 gpd
- Plant operates unattended nights and weekends
- Uptime last 4 months is 86%
- Plant efficiency is better than expected



TECHNICAL CHALLENGES

- Aligning multiple purification unit operations
 - Going from 48% CH₄ → 96%+ CH₄
- Reducing CO₂ from ~35% to < 50 ppm
- Variable NMOC species and amounts
- Efficiently removing sulfur and CO₂, N₂ removal as a side product



SOLUTIONS

- Robust design and commissioning plans
- Polishing using Molecular Gate adsorbent
- Multi-stage design
- Gas Technology Institute design and heat exchanger developments by Linde Engineering



Conclusions



A Renewable Fuel Joint Venture Company

- **Biogas to transportation fuels is technically and economically challenging**
 - *But it CAN be done*
- **Significant progress was made in moving the technology forward**
- **Economic challenges remain**
 - Improve capital and operating efficiencies for future plants
 - Current low natural gas prices
 - Uncertain market valuation for renewable aspect of product
- **Some government support is required to**
 - Reduce risks
 - Enable acceleration of technology and market development

Thank-you

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