Our Renewable LNG Experience

The Altamont landfill gas to LNG plant

May 2013
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Linde Gas
Linde’s profile

$20 billion in revenues
62,000 employees in over 100 countries
1,000 employees and N. America HQ in NJ
  - Industrial gases
  - Plant engineering and operations
  - Alternative energy and fuels
  - Strong focus on sustainability

Biogas-based fueling projects in N. America and Europe

Some Linde-built LNG plants
Why consider biogas?

• It’s available from
  - landfills
  - anaerobic digestion of animal and food waste, sewage, crop waste

• Can be upgraded to high purity bio-methane

• Very low greenhouse gas emissions

• Can displace 10-16 billion gasoline gallon-equivalents per year in the U.S.
  - GHG emission reductions equal to taking >90 million light-duty vehicles off the road
Altamont landfill gas to LNG

The largest project of its kind in the world
- 13,000 gpd design capacity
- Supplies over 300 WM refuse trucks

$15.5 million capital

$2 million government funding
- CIWMB, CARB, CEC, SCAQMD

Uses renewable feed gas and electricity

Reduces 30,000 tons/year CO2
The Altamont project partners manage the entire supply chain

Bio-methane Production  LNG Production and On-site Storage  Logistics/Distribution  Fueling  LNG Consumption
Key technical challenges and solutions

**TECHNICAL CHALLENGES**
- Aligning multiple purification unit operations
  - 50% CH4 → >96% CH4
  - CO2 from ~35% → <50 ppm
  - Variable NMOC species
- Efficiently liquefying natural gas on a small scale

**SOLUTIONS**
- Robust design & operations planning
- Multi-stage design
- Gas Technology Institute design
- Heat exchanger developments by Linde Engineering

CO2, N2 removal

Sulfur, CO2 removal
Key commercial challenges

DECLINE IN NATURAL GAS PRICES
• $8.00 when we invested
• Do customers value the “green-ness” of renewable LNG?

UNPREDICTABLE RIN VALUES
• Nice to have
• Does not justify large new investments
Thank-you

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