Renewable LNG

Update on the world's largest landfill gas to LNG plant

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The Linde Group worldwide:
Global presence in more than 100 countries

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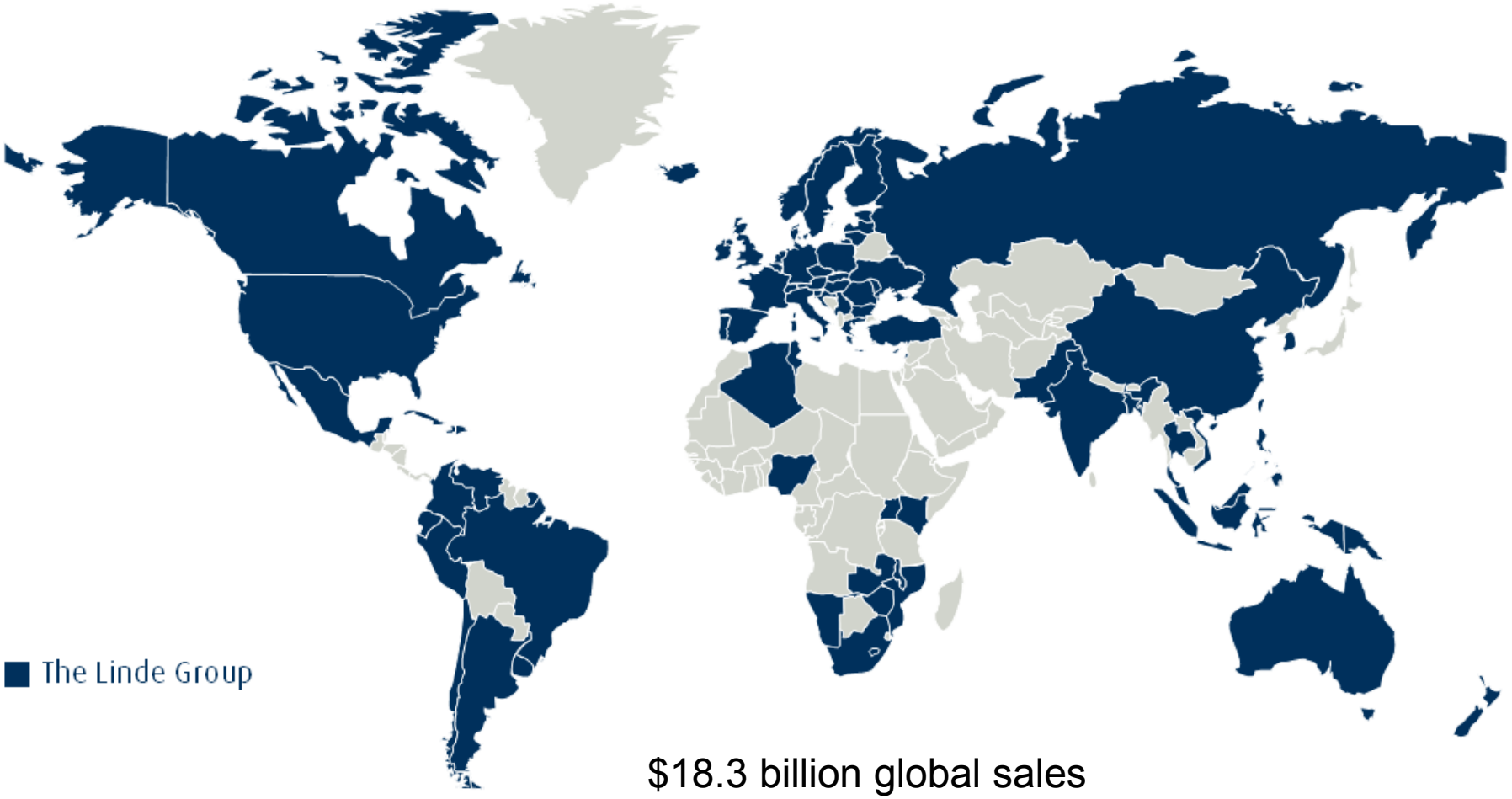

$18.3 billion global sales
A leading gases and engineering company

Linde North America Profile

$2.3 billion in gases sales revenue in North America in 2011

5,000 employees throughout the U.S., Canada and the Caribbean

Supplier of compressed and cryogenic gases and technology

- **Atmospheric gases – oxygen, nitrogen, argon**
- **Helium**
- **Hydrogen**
- **LNG and LPG**
- **Rare gases**

Plant engineering and supply

- **LNG**
- **Natural gas processing**
- **Petrochemicals**
- **Atmospheric gases**

Linde's alternative fuels portfolio

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Renewable liquefied natural gas production - Altamont, CA

Green hydrogen production - Magog, Quebec

Biogas fueling, LNG import terminal - Sweden

Hydrogen fueling for cars, buses & fork lift trucks

Project introduction

A Renewable Fuel Joint Venture Company

Linde and Waste Management 50/50 JV

Linde brings liquefaction, purification, operations, and logistics expertise

WM brings landfill management and gas collection expertise

JV part of WM comprehensive focus on the environment

Increase renewable energy production

Increase recycling

Improve fleet fuel efficiency

Altamont Landfill & Resource Recovery Facility

Located near Livermore, CA

7,000 tpd refuse from the Bay Area

Existing 8.5 MW electric generation

Altamont landfill gas to LNG pro

The largest of its kind in the world

WASTE MANAGEMENT

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A Renewable Fuel Joint Venture Company

LNG production plant

- 13,000 gpd LNG capacity
- Mixed refrigerant liquefaction process
- Purification: compression, chilling, adsorption & membranes
  - Designed to remove all potential contaminants

Environmental benefits

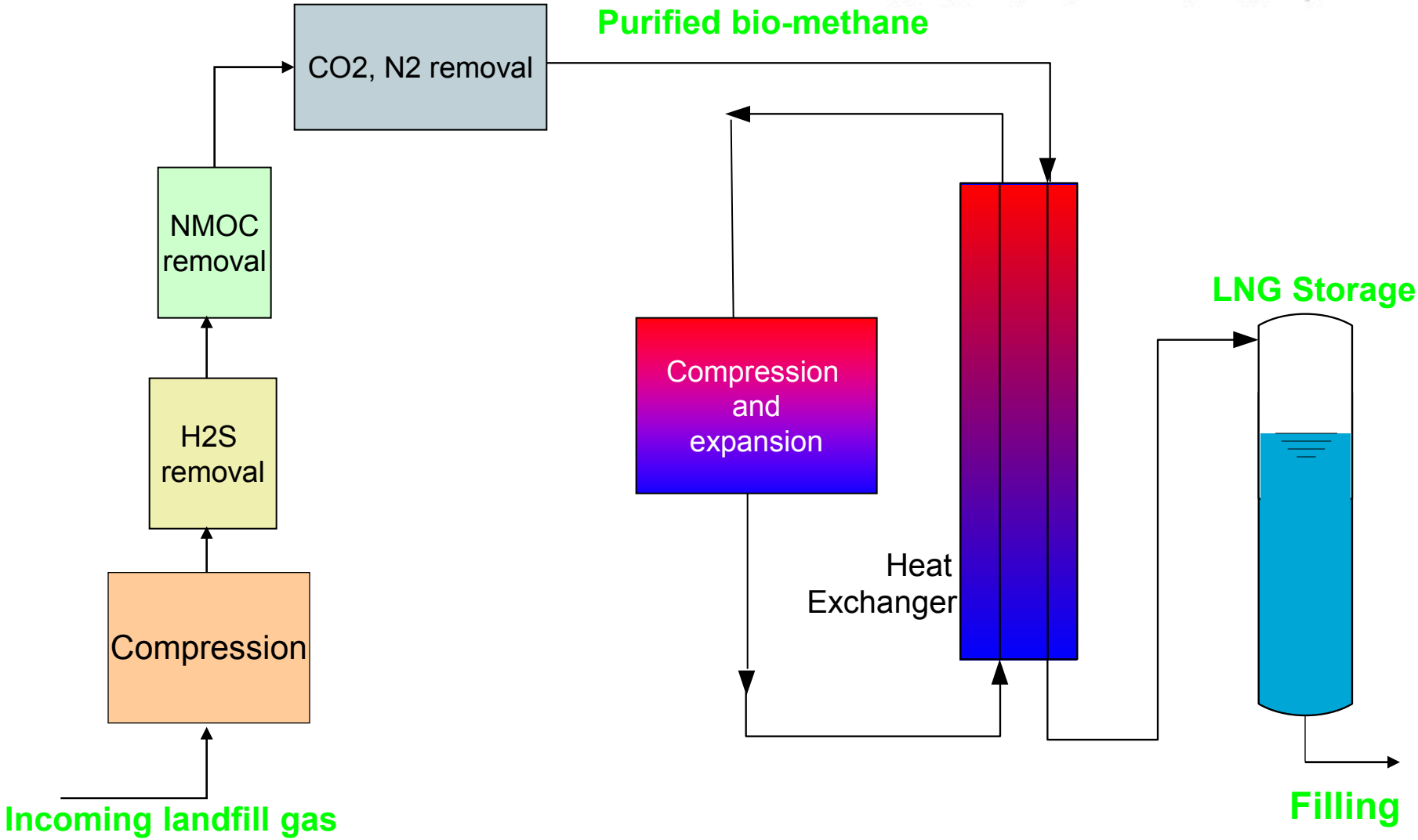
- Reduces nearly 30,000 tons CO2 annually
- Uses renewable feedgas and electricity
- Supplies 300 WM refuse trucks

Financials

- $15.5 m total capital
- About $2 m in funding from multiple agencies:
  - CIWMB, CARB, CEC, SCAQMD

Plant Schematic

A Renewable Fuel Joint Venture Company



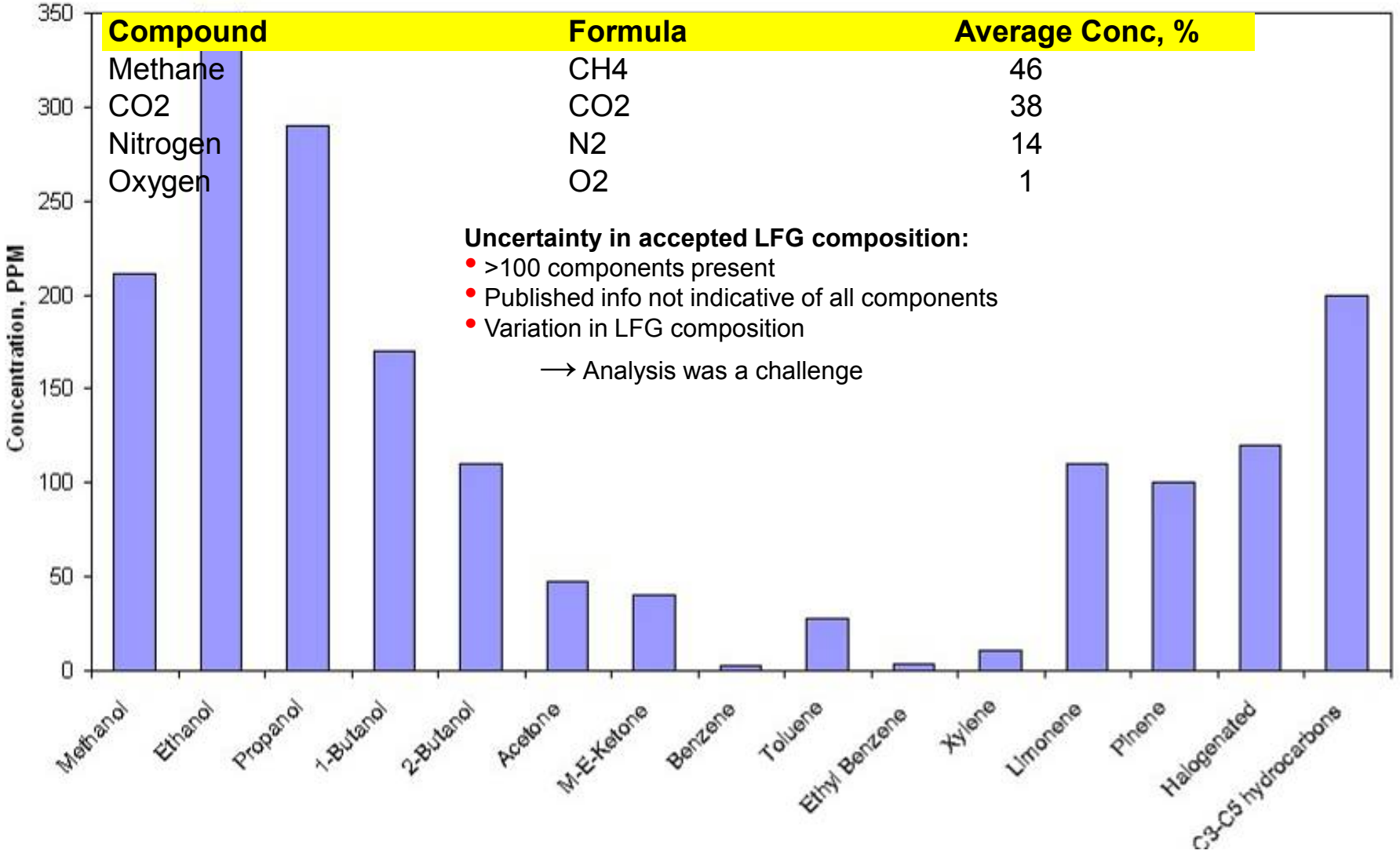
LFG Constituent & Contaminant Summary

Compound	Formula	Average Conc, %
Methane	CH4	46
CO2	CO2	38
Nitrogen	N2	14
Oxygen	O2	1

Uncertainty in accepted LFG composition:

- >100 components present
- Published info not indicative of all components
- Variation in LFG composition

→ Analysis was a challenge



Successful Commissioning & On-going Operations

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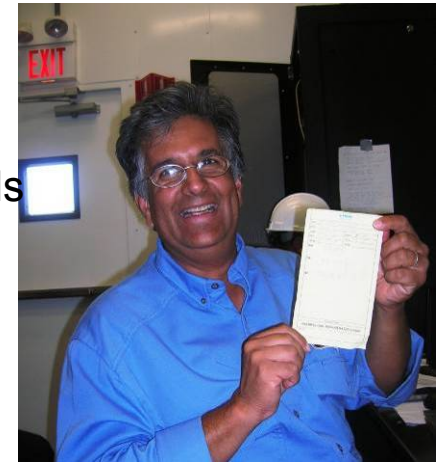
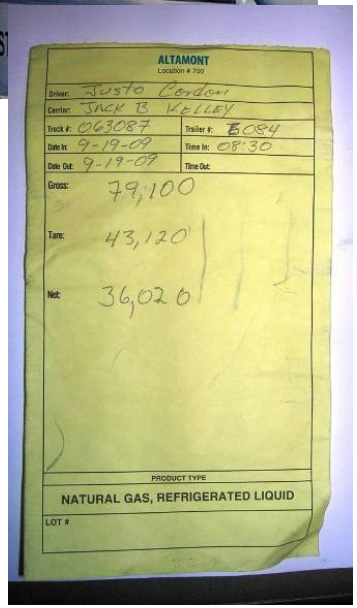
- Key dates:
  - July 6: Flare commissioning began
  - August 3: Landfill gas introduced to purification system
  - September 16: Methane introduced to liquefier
  - September 19: First LNG trailer loaded
  - October 14: Unattended plant operation
  - February 16: Half million gallons produced

1st trailer loading – Sept 19, 2010





- Performance Update
  - Maximum sustained production: 14,300 gpd
  - Plant operates unattended nights and weekends

Challenges and Solutions

CHALLENGES	SOLUTIONS
Aligning operation of multiple unit operations in purification system Going from 48% CH4 → 96%+ CH4	Robust design and commissioning plans
Reducing CO2 from ~35% to < 50 ppm	Polishing using Molecular Gate adsorbent
Multiple NMOC species and amounts	Multi-stage design to handle varying levels.
Efficiently liquefying natural gas on a small scale	Mixed refrigerant liquefier based on Gas Technology Institute design and heat exchanger developed by Linde Engineering

Awards for the Altamont project

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EPA Landfill Methane Outreach Project of the Year

EPA

East Bay (CA) Clean Cities Clean Air Champion Award

Clean Cities

U.S. Department of Energy

Climate Change Business Journal Business Achievement Award

CLIMATE CHANGE BUSINESS JOURNAL

2010 – Compressed Gas Association Environmental Recognition Program Aw

Status Update

A Renewable Fuel Joint Venture Company

Second site identified by JV & awarded $11MM in funding from CEC - Simi Valley, CA

Would utilize advanced purification system

Would have capacity of 18k gpd of RLNG

Evaluating commercial viability in context of low natural gas prices

Develop mechanisms to “de-risk” RINs, low carbon credits, etc.

Conclusions

A Renewable Fuel Joint Venture Company

Biogas to transportation fuels is technically and economically challenging

- *But it can be done!!*

Significant progress made in moving the technology forward

- Commissioning successfully completed
- Reliable performance and operation proven
- Improvements to purification system will enhance performance/reduce costs

Economic challenges remain

- Improve capital and operating efficiencies for future plants
- Current low natural gas prices
- Minimal & uncertain market valuation for renewable aspect of product

Continued government support is required to

- Reduce risks
- Enable acceleration of technology and market development
- De-risk renewable credits

Thank-you

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