Brittany Applestein Syz, Vice President Business Development and General Counsel
Dimethyl ether (DME)

- NO carbon-carbon = NO soot/particulate matter
- No sulfur, low $\text{NO}_x$
- Non-Toxic
- Similar to Propane
• Excellent fuel for compression ignition engines
  – High cetane
  – Power and Torque

• Competitive Pricing with Diesel
  – *Not* tied to the price of crude oil
  – Multiple feedstocks (biogas, natural gas) minimize price volatility
  – Simple distribution infrastructure
Oberon Fuels Overview

• Company Background
  – San Diego-based company
  – 1st to produce fuel-grade DME in North America

• Technology
  – Developed small-scale process that cost effectively converts methane and carbon dioxide to DME
  – Pilot plant online in southern California (Imperial Valley Region)
Plant 1a Online

- World’s 1st Commercial Catalytic DME Distillation Column
- 1st Fuel-grade DME in North America
- **Location:** Brawley, California
- Plant Capacity 60 Trucks
- Serve demonstrations and initial truck rollout
Cost-effectively converts methane and CO₂ to DME
Process by the Numbers

• Production: 10,000 DME gallons per day
  – PER DAY
    • 5,300 diesel gallon equivalents
    • 28 tons of DME
  – PER YEAR:
    • 1.8 million diesel gallon equivalents
    • 9,700 tons of DME

• Service ~125 trucks

• Natural Gas
  • 1.3 million standard cubic feet per day

• Biogas
  • 2.1 million standard cubic feet per day
  • 225 tons of food waste, 62 tons of fats & grease
Feedstocks: DME Production

Made from methane and CO$_2$ sources

- Natural Gas + CO$_2$
- Biogas
- High Solids
- Landfill
Feedstocks: Renewable Sources

- Cow Manure: 25 m³ per ton
- Pig Manure: 30
- Potato Waste: 29
- Chicken Manure: 80
- Brewery Waste: 120
- Green Clippings: 175
- Grass Silage: 185
- Corn Silage: 190
- Food Scraps: 265
- Bakery Waste: 714
- Fats & Grease: 961

Skid-mounted Fuel Production

April 15, 2013
Chicago, IL

May 17, 2013
Brawley, CA
Development

• Produced large-scale internationally
• History of DME Testing
  – Amoco led initial tests
  – Volvo bioDME project Sweden:
    • 10 trucks
• Why now?
  – Price of Natural Gas
  – Technology
  – Emissions
Sweden
1st BioDME plant
(2011)

China
11 mtpy capacity
30–50% in operation

India
265 ktpy planned

Uzbekistan
100 ktpy planned

Vietnam
Project announced

Indonesia
800 ktpy planned

Japan
80 ktpy operational

Papua New Guinea
200 ktpy planned (2016)

Trinidad & Tobago
100 KTA plant planned
Mitsubishi Corp. & Mitsubishi Gas Chemical

United States
12,000 liter/day modular plant producing (2013)

 Courtesy of the International DME Association
Oberon Process Advantage

- **Financing**
  - Capital expenditure in sync with market growth

- **Feedstocks**
  - Large supply of domestic natural gas
  - Renewable & wasted feedstocks (stranded gas, food waste, landfill gas, wastewater treatment)
  - *Feedstock flexibility = price stability*

- **Proprietary Process Design**
- **Footprint**
Oberon Fuels Project with Volvo Trucks and Safeway Receives Grant from San Joaquin Valley Air Pollution Control District for Production of First North American Fuel-grade DME

SAN DIEGO, June 6, 2013 /PRNewswire/ -- Oberon Fuels, the first company to bring dimethyl ether (DME), a clean burning diesel alternative to market, has received a $500,000 grant from the San Joaquin Valley Air Pollution Control District (SJVAPCD) to produce fuel-grade DME at its facilities in California. Working with its partners, Volvo Trucks in North America and Safeway, Inc., one of the largest food and drug retailers in North America, Oberon Fuels will provide DME produced from biogas for Safeway’s trucking operations.

(Logo: http://photos.prnewswire.com/prnh/20130412/LA94212LOGO)

The approved project focuses on using DME as a near-zero emission solution for heavy-duty trucking. Oberon Fuels has developed a patented, skid-mounted, modular design for DME production. This small-scale process enables the development of regional fuel markets that
DME Infrastructure: Hub & Spoke Model

DME Centrally Produced

10,000 gallons per day
Fuels 100-150 trucks per day

DME Delivered to Customers

On-site Fueling at Customer Terminal
Brittany Applestein Syz
VP Business Development/General Counsel
brittany@oberonfuels.com
(858) 900-2624

www.oberonfuels.com
Management Team

• Neil Senturia, CEO
  – 25+ years experience with diverse entrepreneurial endeavors
  – Led 7 technology companies, selling them to Cisco, Lockheed Martin, Kofax, and ViaSat

• Rebecca Boudreaux, Ph.D., President
  – Management and Board experience with early-stage biotech, materials, and high tech companies
  – B.S. (U. Southern Miss.), M.S. & Ph.D. Polymer Science & Eng. (UMass), Co-inventor on 12 patents and applications

• Elliot Hicks, COO
  – Senior management positions in several technology startups (LEDs, solar cells, online media, software)
  – B.S., Mech. Eng. (MIT), MBA (SDSU)

• Brittany Applestein Syz, VP Business Dev. & General Counsel
  – 8 years as transactional attorney and Founder of 2 start-ups
  – B.A. (Harvard University), M.A. Env. Economics (London School of Economics), J.D. UC Hastings College of the Law.
Scientific Advisory Board

• Theo H. Fleisch, Ph.D.,
  – Under his leadership at Amoco, DME was identified and developed as a new clean fuel. Internationally-recognized expert in gas conversion to liquid fuels.

• André Boehman, Ph.D.

• Ravi Randhava
  – Co-founder of Unitel Technologies, an engineering firm with a track record for designing operational DME plants.

• Richard K. Herz, Ph.D.,
  – UCSD Professor Chem. Eng. Expert in heterogeneous catalysis

• Frits Dautzenberg, Ph.D.
  – Shell, Catalytica, ABB Lummus
# DME Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Propane</th>
<th>Methanol</th>
<th>DME</th>
<th>Diesel Oil</th>
<th>Methane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point (°C)</td>
<td>-42</td>
<td>64.6</td>
<td>-25.1</td>
<td>180-360</td>
<td>-161.5</td>
</tr>
<tr>
<td>Vapor Pressure @ 20°C, bar</td>
<td>8.4</td>
<td>--</td>
<td>5.1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Liquid Density @ 20°C, gm/cm³</td>
<td>0.509</td>
<td>0.79</td>
<td>0.67</td>
<td>0.84</td>
<td>--</td>
</tr>
<tr>
<td>Sp. Gravity of gas (vs. Air)</td>
<td>1.52</td>
<td>--</td>
<td>1.69</td>
<td>--</td>
<td>0.55</td>
</tr>
<tr>
<td>Flammability Limits in Air, vol.%</td>
<td>2.1-0.4</td>
<td>5.5-36</td>
<td>3.4-17</td>
<td>0.6-7.5</td>
<td>5-15</td>
</tr>
<tr>
<td>Wobbe Index, kJ/m³</td>
<td>69,560*</td>
<td>--</td>
<td>46,198</td>
<td>--</td>
<td>48,530</td>
</tr>
<tr>
<td>Cetane Number</td>
<td>5</td>
<td>5</td>
<td>55-60</td>
<td>40-55</td>
<td>0</td>
</tr>
<tr>
<td>Calorific value, LHV, Kcal/kg</td>
<td>11,100</td>
<td>4,800</td>
<td>6,900</td>
<td>10,200</td>
<td>12,000</td>
</tr>
<tr>
<td>Calorific value, LHV, Kcal/nm³</td>
<td>21,800</td>
<td>--</td>
<td>14,200</td>
<td>--</td>
<td>8,600</td>
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