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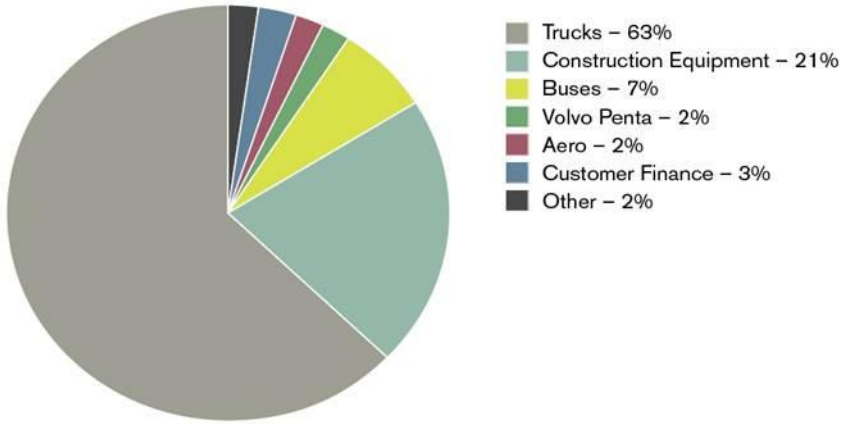
Volvo Group North America

Northeast Diesel Collaborative Partners Meeting
September 12, 2013

The Volvo Group

2012 SALES BY BUSINESS AREA – GLOBAL



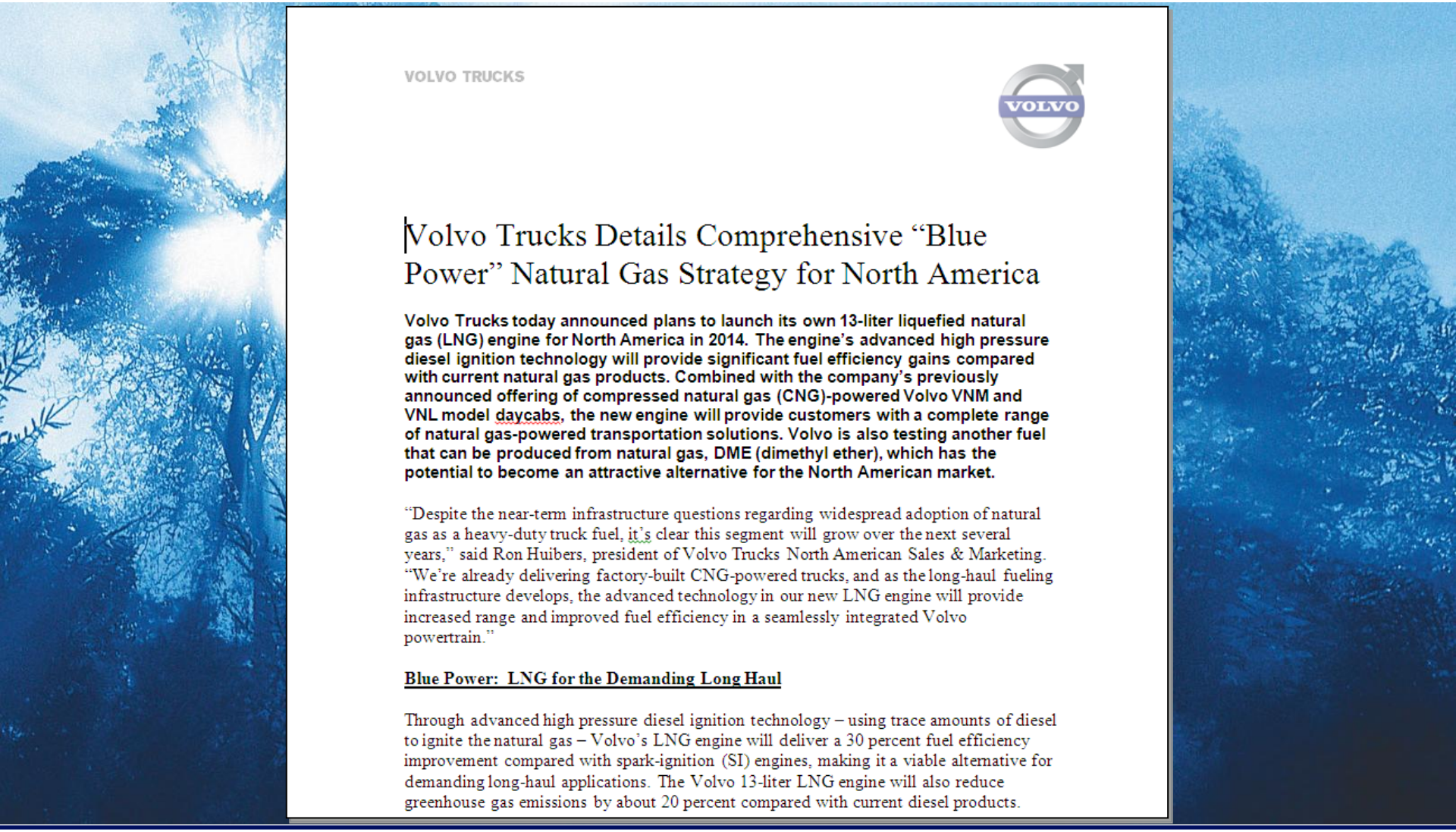
- **~$45 BUSD net sales**
- **One of the world's leading manufacturers of trucks, buses, construction equipment, and drive systems for marine and industrial applications**
- **115,000 employees worldwide, production in 19 countries, serving customers in 190 markets**
- **One of the world's largest manufacturers of heavy trucks and heavy-duty diesel engines**
- **In the US: 12,000 employees, six production facilities in five states**
- **The only heavy-duty truck manufacturing group that exclusively serves the U.S. market with domestically produced trucks**

Environmental Care

We know trucks are part of the problem; we accept responsibility to be part of the solution.

Seven Alternative Fuel Vehicles

Blue Power Strategy



VOLVO TRUCKS

Volvo Trucks Details Comprehensive "Blue Power" Natural Gas Strategy for North America

Volvo Trucks today announced plans to launch its own 13-liter liquefied natural gas (LNG) engine for North America in 2014. The engine's advanced high pressure diesel ignition technology will provide significant fuel efficiency gains compared with current natural gas products. Combined with the company's previously announced offering of compressed natural gas (CNG)-powered Volvo VNM and VNL model daycabs, the new engine will provide customers with a complete range of natural gas-powered transportation solutions. Volvo is also testing another fuel that can be produced from natural gas, DME (dimethyl ether), which has the potential to become an attractive alternative for the North American market.

"Despite the near-term infrastructure questions regarding widespread adoption of natural gas as a heavy-duty truck fuel, it's clear this segment will grow over the next several years," said Ron Huibers, president of Volvo Trucks North American Sales & Marketing. "We're already delivering factory-built CNG-powered trucks, and as the long-haul fueling infrastructure develops, the advanced technology in our new LNG engine will provide increased range and improved fuel efficiency in a seamlessly integrated Volvo powertrain."

Blue Power: LNG for the Demanding Long Haul

Through advanced high pressure diesel ignition technology – using trace amounts of diesel to ignite the natural gas – Volvo's LNG engine will deliver a 30 percent fuel efficiency improvement compared with spark-ignition (SI) engines, making it a viable alternative for demanding long-haul applications. The Volvo 13-liter LNG engine will also reduce greenhouse gas emissions by about 20 percent compared with current diesel products.

Blue Power Strategy

Volvo VN Series
Spark Ignition Engine

Volvo D13-LNG
Compression Ignition Engine

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VOLVO

Demo Project
10 Trucks
1 Million km

Feedstock: Black liquor from paper mill **Output: 4 tons Bio-DME/day**










DME: What's Changing?

- **Higher cost of diesel since 2008**
- **Abundance of natural gas at low cost in U.S.**
  - Readily available feedstock for DME
  - DME from NG: cost effective vs. diesel
- **DME as transport fuel in ongoing field test**
  - Bio-DME produced from paper mill residue
  - DME infrastructure with four filling stations
  - Field test at customers with 10 class eight trucks
- **Increasing interest from fuel suppliers**

DME and On-Site Fueling

- Simple delivery
- Low power fuel dispenser
- Low vapor pressure
- Safe, inexpensive storage

- DME can be stored indefinitely at ambient temperatures
- DME fills at relatively low pressure
- DME filling requires only a small amount of energy

DME: Why?

- **Excellent diesel cycle fuel (high cetane)**
- **Easy to store and transport (liquefies at low pressure; no venting)**
- **Clean (near-zero soot) combustion (no DPF)**
- **Cost-effective**
- **High well-to-wheel efficiency**
- **Low global warming potential (GWP = 1.2 @ 20 yr; 0.3 @100 yr)**
- **Synthesis from variety of bio-based feedstocks**
  - High biomass-to-fuel conversion efficiency
- **Synthesis from natural gas**
- **Power density for long-haul**
- **Non-toxic**

What is Electromobility?

- **Concepts, technologies and infrastructure relating to vehicles powered by electric drivelines using energy supplied fully or partly by the grid**
- **Includes plug-in hybrid vehicles, battery powered vehicles and vehicles and systems designed for the continuous transfer of electrical energy**

Research & Development Trends
Hybrids Maturing –Intermediate Solution

- **Plug-in hybrids are on the door step**
  - Requires **higher electric drive power**
  - Requires **much larger batteries**
  - Requires **charging systems**, both off and onboard
- **Benefits of electromobility in the heavy-duty sector**
  - Use of **clear, defined infrastructure**
  - Operate **in specific areas**
  - Usually **parked in the same place** when not in service
  - Most **technology already exists,** mainly need to solve economic issues
- **Electric roads the key to an electromobility future**
  - An **infrastructural paradigm shift**
  - Minor additional onboard equipment compared to plug-in

Electric Road Systems
Continual power supply for vehicles?

- **Battery technology not adequate for long distance, heavy trucks**
- **Could highways be electrified?**
- **Catenary systems for city buses are not new**
- **Various methods for wayside charging are currently being explored:**
  - Overhead lines
  - Conductive
  - Inductive

ERS test road, at a Volvo test facility

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