View from the Bridge
Commercial Vehicle Perspective

DEER 2012

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Volvo Group Truck Technology
The Volvo Group is one of the world’s leading manufacturers of trucks, buses and construction equipment, drive systems for marine and industrial applications and aerospace components.
Light-Duty vs Heavy-Duty Technology

Heavy trucks are not big cars

• **Personal** – Emotional, pleasure
  • Most fuel is used to **move the vehicle**
    Typically 1.6 passengers & light cargo.
  • Heavily used in **urban** areas.
  • **Spark** ignited **stoichiometric** engines.
  • Key Emerging Opportunities
    • Hybrid
    • Electrification
    • SI engine efficiency or dieselization
    • Ethanol
    • Hydrogen?
    • Reduced weight & Down-sizing

• **Commercial** – business, profit
  • Most fuel is used to **move cargo** volume and/or weight
  • Heavily used on open **highways**.
  • **Compression** ignited **lean burn** engines
  • Key Emerging Opportunities
    • Integrated aerodynamics
    • Exhaust energy recovery
    • Logistics and vehicle management
    • Bio, renewable, synthetic diesel
    • Natural gas
    • Longer, heavier- increased capacity
"There are two kinds of forecasters: those who don't know, and those who don't know they don't know."

"There are two kinds of forecasts: Wrong and Lucky"
Volvo Materials Planner
HD/MD Truck Fuel Consumption Shares

Annual Vehicle Miles Traveled for Heavy-Duty Vehicles

NATIONAL PETROLEUM COUNCIL
Advancing Technology for America’s Transportation Future
Class 7-8 Sales Projection

Class 7&8 Combination Market Shares of New Diesel and Natural Gas Trucks – Reference Oil Price Case

NATIONAL PETROLEUM COUNCIL
Advancing Technology for America's Transportation Future
Heavy-Duty Truck Energy Use by Fuel Type

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MAKE MINE NATURAL GAS, LIQUEFIED NOT COMPRESSED.
“Diesel engines will remain the powertrain of choice for (heavy duty) vehicles for decades to come because of their power and efficiency. There are, however, opportunities to improve the technology. Significant fuel economy improvements in diesel powered trucks are possible. Indeed, the fuel economy (mpg) for new Class 7&8 HD vehicles, which consume more than 70% of the fuel in the trucking fleet, could be doubled.”
Class 8 Ton-MPG - A Prospective Scenario Via Vehicle Efficiency Gains and VMT Reductions

- Engine gains yield ~1%/year.
- Double the 1980 to 1999 average.
- Includes VMT Reductions by hauling more freight per truck and use of intermodal.
- 65% Ton-MPG improvement yields 40% fuel savings - L/ton-km.

Trailer and Fleet Operations (Trailers and Fleet Operations).
Truck Technologies (Truck Technologies).
Engine Technologies (Engine Technologies).
It is unlikely that conventional on-road diesels can go much beyond 50% brake thermal efficiency. Further improvement will require innovative thermodynamic cycles and engine geometry.
Turbo-Compounding:
Essentially a turbine engine added to the diesel

2 - 4% Fuel Efficiency Benefit in Long-haul Application
Rankine Waste Heat Recovery System:
Essentially a steam cycle engine added to the diesel

Expect 4-5% improved efficiency at US road load conditions.

Maximum efficiency benefit is limited by low temperature heat rejection capability.

Note: complexity, packaging and weight.
Propulsion System – not Engine

... powertrain experts agree that IC engines have to be looked at more as “propulsion systems” rather than freestanding components. That way powertrain teams increasingly can solve problems by looking at the entire transmission and driveline, rather than only the engine.

2012 CAR Management Briefing Seminars
Aug. 8, 2012 Drew Winter, WardsAuto
Why is complete vehicle integration so important?
Total Vehicle System Design

Accessory Power Reduction

>22% overall drag reduction
~12% reduction in power demand at 65 MPH

Lightweight intelligent efficient drivetrain

Vehicle Aerodynamic Drag Reduction

Lightweight Chassis and Cab Materials
Engine Efficiency Impact of Integration

1. Cruise operating point 2010 Baseline
   - Volvo XE13 & Mack Super Econodyne – Down-speeded engine, enabled by integrated AMT & high torque yields 3% FE

Typical Diesel Engine Map

- Lines of constant power
- Typical Diesel Engine Map

1-2: chassis & trailer improvements reduce load
2-3: downspeeding improves efficiency
3-4: downsizing increases percent load

RESULT:
- Small improvement in engine brake specific efficiency
- Major improvement in vehicle fuel consumption
Total Vehicle System Design

Using system engineering, an integrated vehicle design will yield major improvements in features and fuel economy.
Longer Combination Trucks

Single Biggest Potential Efficiency Gain via Lower VMT

Fuel saving for longer US combinations (with volume limited freight - per ATRI study)

Sweden and Finland allowing rigs up to 25.25 m vs 18.75 m in rest of EU (14-20% less fuel)
US limits trailers to 53’ (16.2 m)

Quote – Ontario, Canada Ministry of Transport
LCVs are a win-win-win. They are good for the economy, good for the environment and improve highway safety. They can move goods at a lower cost and with fewer greenhouse gas emissions than single-trailer trucks and, under carefully controlled conditions, more safely.
And just when we thought it was safe to rest on our achievements in diesel emissions: A new California ‘Vision for the Future’

What are the Solutions?

- Large trucks
  - Double fuel economy
  - Decrease NOx standard for new truck engines to ~0.05 g/bhp-hr by 2020
  - Widespread use of drop-in biodiesel (low carbon)
  - Introduction of advanced powerplants such as hybrids and fuel cells
  - Improved goods movement
Conclusions

• Significant potential improvements are possible but market is complex with multiple players requiring coordinated approach.
• Engine and vehicle technologies are already quite advanced, but many available efficiency features are only slowly gaining acceptance (especially for trailers)
  – There are no feasible single technology options with huge benefits
  – Economic barriers (efficiency feature cost vs. fuel cost)
  – Regulatory barriers (length, weight, safety)
  – Infrastructure barriers (alternative fuels, congestion, truck stops, IT, docks, terminals, etc.)
• Efficiency needs to be measured in terms of moving freight, not moving trucks.
• We lack a comprehensive freight policy
  – Fuel supply/cost, fuel & vehicle taxes, fuel alternatives, infrastructure, intermodal, metropolitan freight delivery, size/weight consistency, speed, safety, data collection and analysis
• Freight growth will continue to outpace efficiency improvements without clear policy direction and coordination between vehicle manufacturers, carriers, fuel suppliers, shippers, and policy makers.
Thank you for your attention