Heavy Duty Transportation

By Region

- Russia/Caspian
- Mid East
- Africa
- India
- China
- Other AP
- Europe
- Latin America
- North America

By Fuel

- Gasoline
- Diesel
- Other
- Bio-Distillate

Efficiency Impact on Fuel Demand

- Operating Inefficiencies
- Truck Size
- Technology
- Growth
Relative Energy Density

Volumetric Energy
Relative to Diesel

- Diesel
- Gasoline
- LPG
- Ethanol
- LNG
- DME
- CNG
- Hydrogen
- Battery
Alternative Fuels for Heavy Duty Trucks

- **Bio-distillates (FAME, renewable diesel) are commercially available at scale**
  - May offer significant GHG reduction potential if from algae or cellulosic sources
  - Blendable/drop-in

- **CNG attractive for centrally fueled fleets and short-haul trucks**
  - Simpler after-treatment if SI
  - Lower GHG if from bio-methane but limited scale
  - Economics depends on the relative costs of the vehicle and fuel (varies by region)

- **Potential for LNG use in long-haul heavy duty trucking**
  - Boil-off, fugitive emissions need to be managed
  - Higher vehicle cost

- **Hydrogen offers lower GHG if sourced from fossil with CCS or non-fossil; significant infrastructure challenge**

- **DME has lower PM emissions; efficient synthesis from natural gas; can be sourced from bio materials**

- **Ethanol heavy duty truck engines are available; ethanol available commercially at scale**
  - Offers significant GHG reduction potential if production combined with CCS or if from cellulosic sources
Algae Biofuels

- very high biomass productivity
- year-round growth
- land and water unsuitable for crops

Area required to replace 10% of U.S. road transportation demand
North American Fleet Owner Survey

Source: Schoettle, Sivak, Tunnell, “A Survey of Fuel Economy and Fuel Usage by Heavy Duty Truck Fleets”, SWT-2016-12, University of Michigan Sustainable World Transportation
Closing

• Most of the heavy duty fuel demand is likely to remain diesel

• Of the lower GHG potential fuels –
  ▪ Bio-distillates from algae and cellulosic sources; further technology development needed; fuel cost
  ▪ Hydrogen if sourced from fossil with CCS or non-fossil; significant infrastructure challenge; fuel and vehicle cost
  ▪ Ethanol with CCS could have cost and scale advantages; further potential with cellulosic ethanol; bespoke engines
  ▪ Bio-methane and derivatives; insufficient scale/availability; fuel cost

• Fleet owners have a strong incentive to reduce fuel costs
  ▪ Fuel economy (driven by fuel cost reduction imperative) may be the most important factor in GHG emissions reduction from this sector
  ▪ Alternative fuels (and vehicles) need to compete on cost; payback period
  ▪ Fuel choices need to be acceptable to fleet owners

Source: NREL (2013)