What Is Natural Gas?

• A combustible, gaseous mixture of simple hydrocarbon compounds, primarily methane

• Usually extracted from gas and oil wells. Smaller amounts are derived from supplemental sources such as landfill gas and coal-derived gas. Large deposits exist in more than half of the 50 states.

• Classified as an alternative fuel by the Energy Policy Act of 1992

• Accounts for 24% of U.S. energy use and 2.2% of energy used for U.S. transportation

Source: Transportation Energy Data Book, Figure 2.1 and Table and 2.2
Natural Gas Vehicles

158,000 natural gas vehicles on U.S. roads in 2004

- 80K in private (fleets and consumers)
- 82K in state fleets
- 7K in federal fleets

Source: EIA, Alternatives to Traditional Transportation Fuels, 2004
Natural Gas Fueling Stations

More than 750 natural gas fueling stations in the United States:

• 35 LNG
• 727 CNG
• 354 Public
• 408 Private

Source: DOE AFDC, July 2007
Types of Natural Gas for Vehicles

**Compressed natural gas (CNG):**

Generally used in vehicles at 3000-3600 psi (household natural gas pipe pressure is ~1-2 psi)

**Liquefied natural gas (LNG):**

Made by lowering the temperature of CNG until it becomes a liquid

<table>
<thead>
<tr>
<th>Equivalent Energy Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 gal. gasoline</td>
</tr>
<tr>
<td>125 scf CNG</td>
</tr>
<tr>
<td>1.5 gal. LNG</td>
</tr>
</tbody>
</table>
Why Use Natural Gas Vehicles (NGVs)?

• Increased Energy Security
  – Natural gas is a domestically available fuel

• Public Health and Environment Protection
  – 60-90% less smog-producing pollutants
  – 30-40% less greenhouse gas emissions

Source: fueleconomy.gov
Why Use NGVs?

- Pathway to Hydrogen and Fuel Cells – NGV and infrastructure development can facilitate transition to hydrogen fuel cell vehicles.
  - Natural gas on site could be used to produce $\text{H}_2$ through reforming.
  - Natural gas–hydrogen blends in NGVs reduce $\text{NO}_x$ emissions even further.
  - Lessons learned from developing natural gas technologies may aid transition to hydrogen.
Light Duty NGVs

- Use CNG
- Limited to one model (Honda Civic) for OEM vehicles
- EPA certified conversions available from a variety of companies
Heavy Duty NGVs

- May use LNG or CNG
- Larger engines typically use LNG
- OEM engines available from Cummins-Westport
- EPA certified re-power engines and conversions available from a variety of companies
Natural Gas Transit Buses

• Most established natural gas niche market
• Annual consumption (2004): 110 million diesel gallon equivalent of CNG
• 15% of transit vehicles in 2007 powered by natural gas

Source: USDOT-FTA Alternative Fuels Study, December 2006 and APTA 2007 Vehicle Survey
Other Heavy Duty NGVs

- Shuttle buses
- Trolleys
- Street sweepers
- Delivery trucks
- Refuse haulers
- Utility trucks
Natural Gas Guides

• Heavy Vehicle and Engine Resource Guide
  - www.afdc.doe.gov/pdfs/hvrg.pdf

• Available Natural Gas Vehicles and Engines
Implementation Challenges for Natural Gas

• **Vehicle Price** – Natural gas vehicles cost more because of onboard fuel storage and engine modifications.
  – NGV prices range from $4000 for LDV to $35,000 for transit bus to over $50,000 for specialty HDV

• **Fuel Availability** – Refueling is less readily available outside of California; most fleets build their own infrastructure.
Implementation Challenges for NG

• **Operating Costs** – Results vary by fleet.
  – Washington Metro Area Transit Authority study of 40 ft. transit buses showed increased operating costs of 3 to 8 cents per mile.
  – UPS study of delivery trucks showed increased operating costs of 19% for CNG in one fleet and decreased CNG operating costs, when compared to diesel, of 2% in a second fleet.

• **Vehicle and Engine Availability**
  – There is limited availability of OEM engines and vehicles.

Federal Tax Incentives for NGVs

- **Vehicle Tax Credits**
  (for new or retrofits)
  - Light Duty (up to 8,500 lb): up to $4,000
  - Medium Duty (up to 14,000 lb): up to $8,000
  - Medium-Heavy Duty (up to 26,000 lb): up to $20,000
  - Heavy Duty (more than 26,000 lb): up to $32,000
Federal Tax Incentives for Fuel and Infrastructure

- Fuel Excise Tax Credits
  - Fifty cents per gallon equivalent of CNG or LNG

- Infrastructure Tax Credit
  - 30% of cost of infrastructure
    - Up to $30,000 per commercial project
    - Up to $1,000 for home refueling appliance.
For More Information

• Alternative Fuels Data Center

• Clean Vehicle Education Foundation
  – www.cleanvehicle.org/index.shtml

• NGV America
  – www.ngvc.org