



U.S. Department of Energy
Energy Efficiency
and Renewable Energy



Natural Gas as a Transportation Fuel

Benefits, Challenges, and Implementation





What Is Natural Gas?

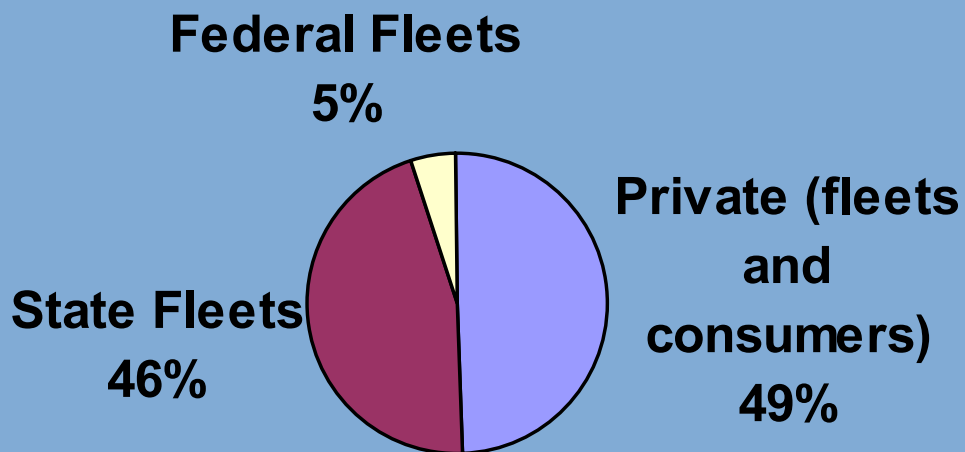
- A combustible, gaseous mixture of simple hydrocarbon compounds, primarily methane
- Usually extracted from gas and oil wells. Smaller amounts are derived from supplemental sources such as landfill gas and coal-derived gas. Large deposits exist in more than half of the 50 states.
- Classified as an 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



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

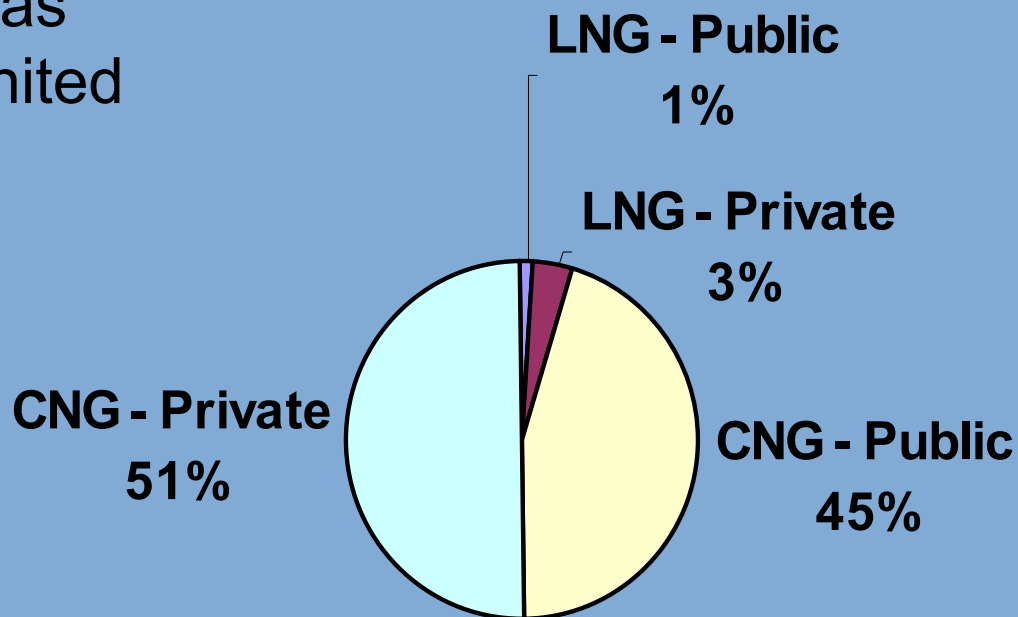




Natural Gas Fueling Stations

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

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





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



Equivalent Energy Content	
1 gal. gasoline	1 gal. diesel
125 scf CNG	139 scf CNG
1.5 gal. LNG	1.7 gal. LNG



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



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 H₂ through reforming.
 - Natural gas–hydrogen blends in NGVs reduce 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





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
- www.cleanvehicle.org/Available-NGVs-and-Engines.pdf



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.

Source: Washington Metropolitan Area Transit Authority: Compressed Natural Gas Transit Bus Evaluation <http://www.nrel.gov/vehiclesandfuels/ngvtf/pdfs/37626.pdf>) and UPS CNG Truck Fleet, Final Report, <http://www.nrel.gov/vehiclesandfuels/fleetttest/pdfs/31227.pdf>



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
 - www.eere.energy.gov/afdc/afv/gas_vehicles.html
 - www.eere.energy.gov/afdc/altfuel/natural_gas.html
- Clean Vehicle Education Foundation
 - www.cleanvehicle.org/index.shtml
- NGV America
 - www.ngvc.org