Natural Gas Vehicles





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Agenda

Why natural gas?

- Types of Natural Gas Vehicles (NGVs)
- How do you fuel with Compressed Natural Gas (CNG)?
 - Current activity
 - Future
 - Challenges
 - Questions?

Black Hills Corporation

Based in Rapid City, SD, with corporate offices in Denver, CO, & Papillion, NE, the company serves 750,000 utility customers in Colorado, Iowa, Kansas, Montana, Nebraska, South Dakota and Wyoming. The company's non-regulated businesses generate wholesale electricity, produce natural gas, oil and coal, and provide appliance repair services.





Natural Gas: Clean, Abundant, Affordable and American Energy Alternative

- Natural gas is the **cleanest** commercially available fuel for transportation today, reducing GHG's between 20-29%
- Worldwide, natural gas reserves are greater than petroleum, with a supply now estimated @ 100+ years
- Natural gas **costs** 20-50% less per gallon equivalent than conventional gasoline at the pump, with over 1,100 CNG fueling stations in the U.S.
- 98 percent of all the natural gas consumed in America is produced in North America
- There are approximately **130,000** NGV's on U.S. roads today and over **13** million worldwide

NGVs Are a "Good Fit" for Many Fleet Applications

- Best applications:
 - High fuel use
 - Central fueling
 - Local routes/operating areas
- Federal/State/Local Government
 - 25,000+ light duty NGVs
- Refuse
 - 4,000+ trucks
- Transit
 - 11,000+ buses
 - 1 in 5 on order
- School Districts
 - 3,000+ buses
- "Short-Haul" Delivery
 - 17,000+ medium duty NGVs



Types of NGV Systems

- Dedicated powered <u>only</u> by natural gas
- Bi-fuel natural gas <u>or</u> gasoline
- Dual fuel natural gas <u>and</u> diesel

NGV SYSTEM LAYOUT Dream XXI P - Sequential Gas Injection System Intelligent & Innovative Technology



How do you fuel with CNG?

- Time-fill
- Fast-fill
 - Cascade, Buffer or Combination
- Gasoline Gallon Equivalents (GGEs)
 - Amount of CNG it takes to equal the energy content (in BTUs) of one liquid gallon of gasoline
 - \checkmark 1 GGE = 5.660 lbs of natural gas
 - \checkmark 127 scf of natural gas per GGE = 8 GGEs per Mcf of natural gas
- Diesel Gallon Equivalents (DGEs)
 - Amount of CNG it takes to equal the energy content (in BTUs) of one liquid gallon of diesel fuel
 - \checkmark 1 DGE = 6.360 lbs of natural gas
 - \checkmark 140 scf of natural gas per DGE = 7.2 DGEs per Mcf of natural gas

Combination Fast-fill







Home Refueling Appliance (time-fill)



CNG Station & NGV Conversion Costs

CNG station costs range from \$5K to \$2.5 million

- Time-fill, Fast-fill, Combo-fill
- Depends upon number of vehicles per day, vehicle fueling patterns, maximum daily flow, maximum hourly flow
- Modular approach adds capacity as fleet grows
- Average national pump prices < \$2.00/GGE</p>

NGV conversion costs range from \$10K to \$50K+

- Dedicated, bi-fuel or dual fuel
- EPA certified or approved kits and installers
- NFPA 52 and 30A





Future of NGVs

- Only 130K in U.S.; 13 million worldwide
- CNG & LNG fueling infrastructure
- Price of natural gas vs. diesel/gasoline
- Fracking & the EPA
- OEMs vs. conversion shops
- Over-the-road trucking industry
- Home fueling appliances

CNG Stations Nationwide winnipeg Vancouver Map Satellite North Washington Prince New Dakota Montana Brunswick Edwar Minnesota Island Nova Montreal Maine Scotia South Wisconsin Dakota Toronto Michigan Oregon Vermont Idaho Wyoming New York. New Chicago Hampshire lowa Nebraska Pennsylvania Illipois . Ohio Massachusetts New York United States Indiana Nevada **Bhode Island** San l tah Colorado West Connecticut Kansas Francisco Missouri Virginia Kentucky Catifornia Virginia New Jersey . North



Liquefied Natural Gas

LNG

- Natural gas cooled to -260 degrees F
- 1/600th the volume of gaseous natural gas
- Vaporized to gaseous form for use
- Costly to produce (liquefy) but easy to transport
- Stored in specialized tanks with insulated walls
- Kept in liquid form by autorefrigeration



Westport Cummins **12L Dedicated CNG Engine**



Introducing the 2013 ISX12 G, a 12 litre natural gas engine for heavy duty truck and refuse applications:

- 320-400 hp / 1150-1450 lb-ft torque
- Maintenance-free aftertreatment
- Wide OEM availability





- 26 million trucks in U.S., including three million Class 8 OTR
- 165 million gallons of diesel fuel used daily
- 871 million metric tons of GHG emissions annually



Home Fueling Appliances

- PHILL @ \$6,000
- Whirlpool @ \$2,000
- GE @ \$500





Challenges to NGV's

- Initial conversions costs of \$10K \$50K
- Limited availability of CNG fueling stations
- Cost of CNG fueling stations (\$5K \$2.5MM)
- Lack of federal & state grants/incentives/funding
- High pressure fuel tank in vehicle
- Paradigm shift as a transportation fuel
- Crude oil & gasoline costs historic fluctuation
- NGV industry is still in its infancy
- Is natural gas really "safe"?

LNG issues

Why natural gas vehicles today?



"We need a bridge...to replace foreign oil with American natural gas for cars and trucks. It's cleaner, it's cheaper, it's abundant and it's ours. It buys us one thing money can't buy: time, time to develop the renewable fuels that will break our dependency on foreign oil."

-- T. Boone Pickens

















































Natural Gas – The Vehicle Fuel that's good for America!

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