



The potential of Natural Gas for U.S. transportation

Chrysler Group LLC
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DODGE

Jeep

CHRYSLER



Why compressed natural gas for transportation



- **A viable near/medium term option to lessen the transportation system dependence on crude oil:**
 - **Wider reserves**
 - **Better geopolitical distribution**

- **An intrinsically clean fuel:**
 - **Lowest carbon content and tailpipe CO₂ emissions among hydrocarbon fuels**
 - **Reduction of transportation greenhouse gas emissions**
 - **Significant contribution to air quality improvement**

- **A structurally cheaper solution:**
 - **Less expensive production, transportation and distribution**
 - **Technology is mature, available and low cost compared to other alternatives**

- **A strategic asset that supports progressive migration from fossil fuels to bio-methane and eventually Hydrogen from renewable sources**

Natural gas: reserves and geopolitical distribution



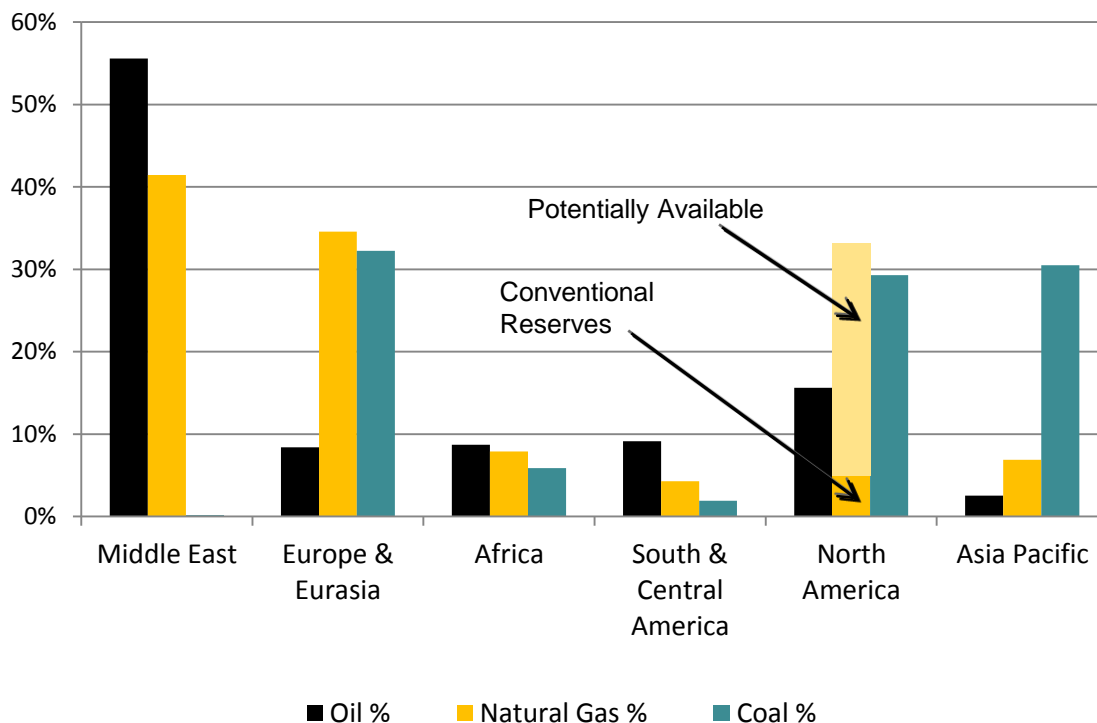
According to recent discoveries, North American natural gas is widely available and can reduce dependency on petroleum imported from the rest of the world

Worldwide reserves

	Reserve / Production
Oil	~ 45 years
Natural gas	~ 60 years with proved conventional reserves 100 to 150 years with shale basin reserves
Coal	~ 130 years

Data at current consumption rate

Geographical distribution of energy reserves



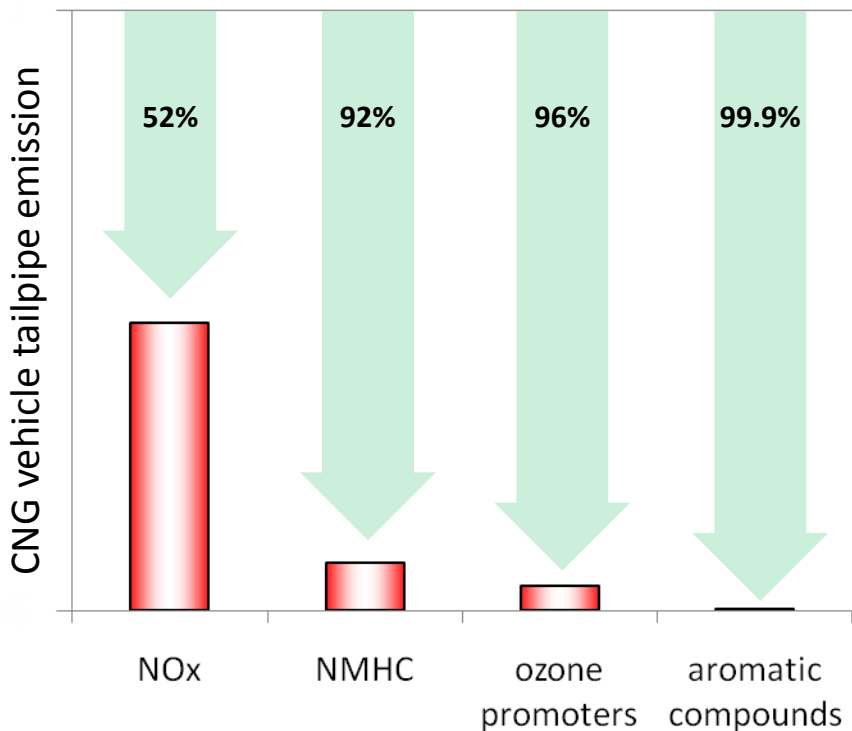
Natural gas: an intrinsically clean fuel



Local air quality

- ✓ Reduced SMOG forming emissions
- ✓ Practically zero evaporative emissions

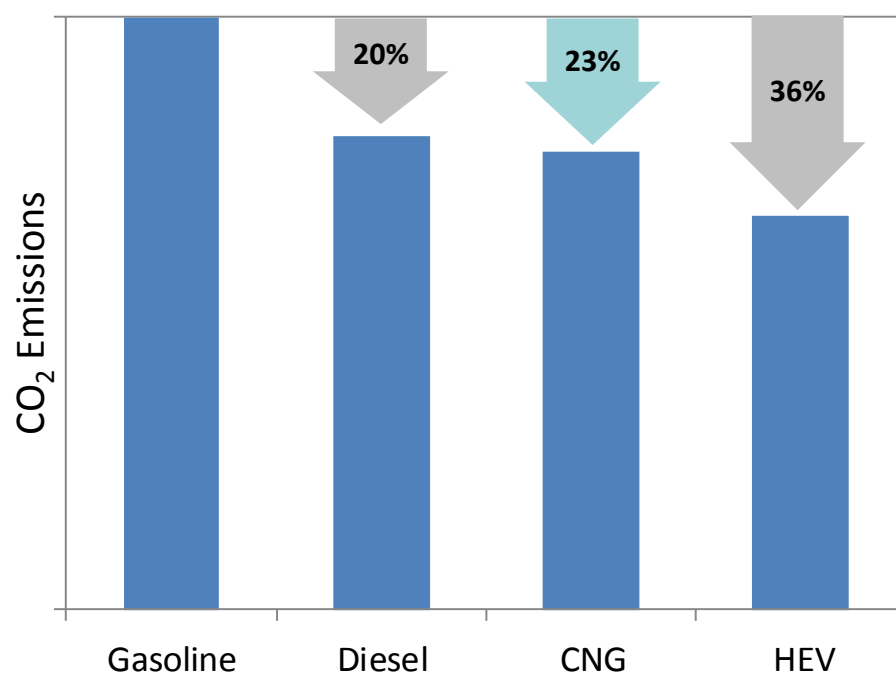
Baseline: Conventional Gasoline



CO₂ emissions*

- ✓ Low carbon content fuel
- ✓ No refining or distillation required

Baseline: D Segment Conventional Gasoline



Source: Chrysler Group, results are for a typical vehicle

* Green house gas CO₂ equivalent emissions based on EPA combined cycle

Natural gas vehicle technology

Engine modifications required for natural gas



Simple technology change

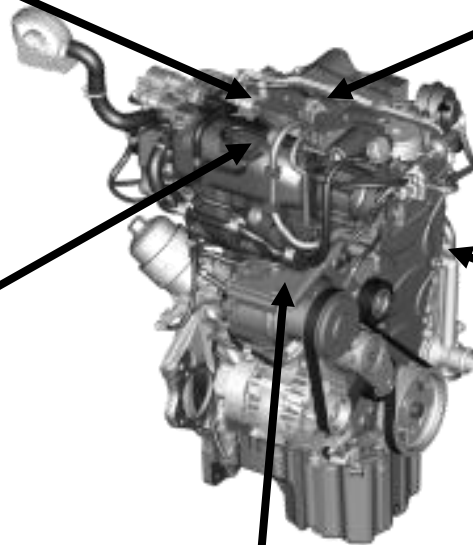
Specific spark plug

Dedicated geometry and material for valve and valve seat

Multipoint sequential injection with dedicated intake manifold

3-Way catalyst system

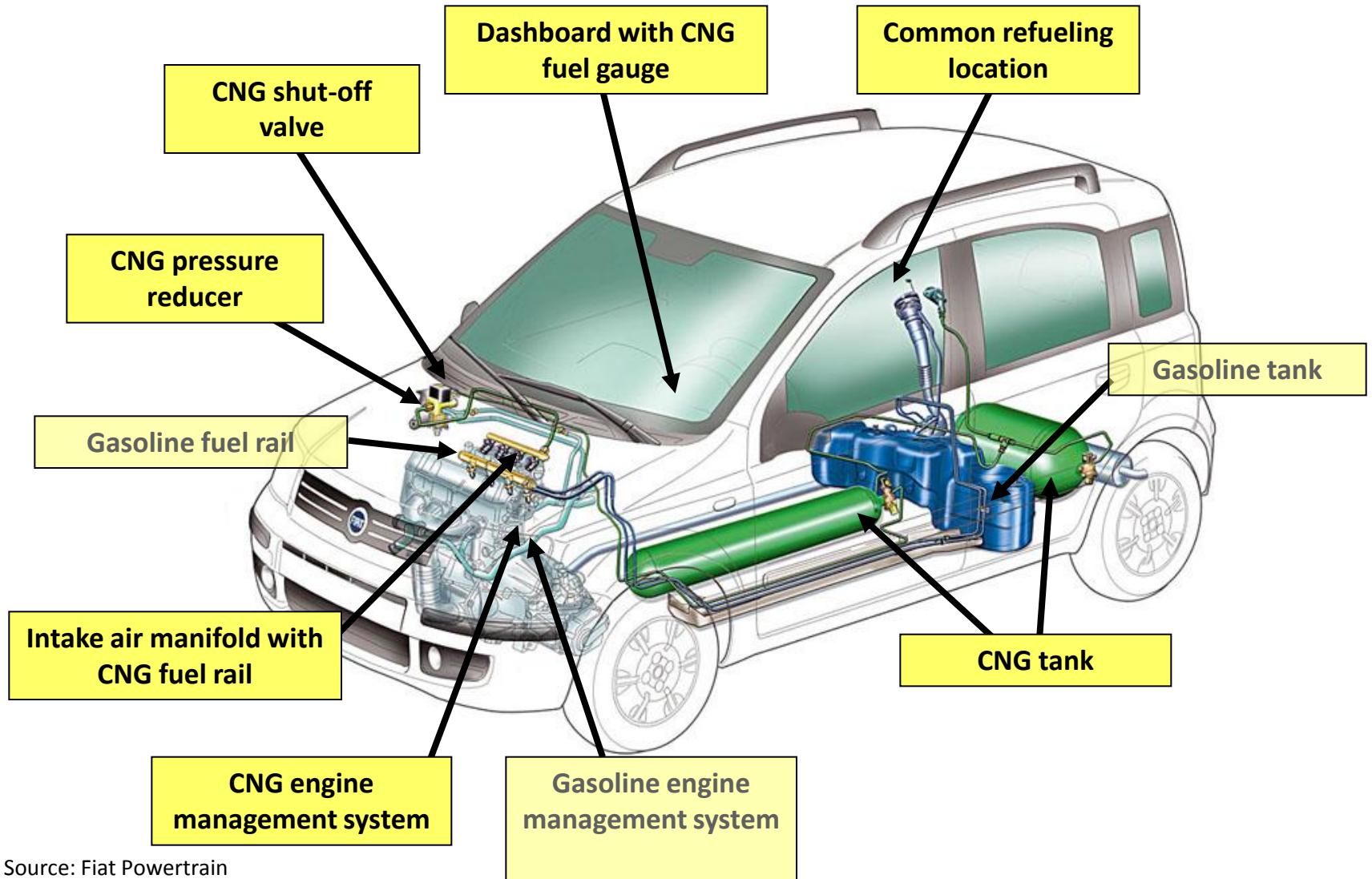
Dedicated controls strategy and calibration, with stoichiometric operation under all conditions



Source: Fiat Powertrain

Example of bi-fuel passenger car

Fiat Panda



Source: Fiat Powertrain

Examples of bi-fuel passenger cars



Punto Evo 1.4 8V

Rated power - CNG mode	70 HP (51kW)
CO2 emissions - CNG mode	115 g/km (185 g/mi)
Range - CNG mode	310 km (193 mi)
Full range	1000 km (621 mi)

Grande Punto 1.4 8V

Rated power - CNG mode	70 HP (51kW)
CO2 emissions - CNG mode	115 g/km (185 g/mi)
Range - CNG mode	310 km (193 mi)
Full range	1000 km (621 mi)



Panda Panda 1.2 8V

Rated power - CNG mode	52 HP (38kW)
CO2 emissions - CNG mode	113 g/km (182 g/mi)
Range - CNG mode	270 km (168 mi)
Full range	750 km (466 mi)

Qubo 1.4 8V

Rated power - CNG mode	70 HP (51kW)
CO2 emissions - CNG mode	119 g/km (192 g/mi)
Range - CNG mode	300 km (186 mi)
Full range	940 km (584 mi)

Nuovo Doblò 1.4 16V T-jet

Rated power - CNG mode	120 HP (88kW)
CO2 emissions - CNG mode	134 g/km (216 g/mi)
Range - CNG mode	325 km (202 mi)
Full range	625 km (388 mi)

Source: Fiat Powertrain

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The Italian experience:

- ❑ **Government support**
- ❑ **Product**
- ❑ **Infrastructure**

Italian experience:



- ❑ **Compressed natural gas vehicles introduced in Italy in 1936, widely developed during World War II, and continued thereafter as a cheap aftermarket option.**
- ❑ **In 1995 Fiat Group, after a thorough investigation of various alternative fuels, focused on the development of compressed natural gas technology. The first passenger car was produced in 1997 and the first bus in 1998.**
- ❑ **The successful market and political acceptance of the new compressed natural gas technology led in 2001 to the definition of an agreement among government, oil & gas companies and Fiat Group in order to foster the deployment of compressed natural gas vehicles in Italy (First National Natural Gas Plan).**
- ❑ **From 2001 to 2009 compressed natural gas passenger car sales grew from 20k to 130k per year, the refueling stations from 300 to 800, Fiat Group introduced 9 car models and a full line of medium / heavy compressed natural gas engines.**
- ❑ **A new “Natural Gas plan” for a 3 years timeframe is currently under discussion in Italy.**

First Italian “Natural Gas plan”: key actions



Government support

- ❑ Taxation of compressed natural gas for transportation at a constant favorable level (ecological fuel)
- ❑ Incentives to offset the added cost of the compressed natural gas fuel system
- ❑ Subsidies for new refueling stations with a financial contribution up to 40% of the total cost
- ❑ Simplified procedures/regulations for the location and operation of new refueling stations

Oil and gas companies involvement

- ❑ Investment in new refueling stations, to double their number in the timeframe of the plan

FIAT Group product range

- ❑ Increased offering of compressed natural gas cars & light commercial vehicles (at least 5 new models) and of medium / heavy duty compressed natural gas engines for buses / trucks
- ❑ Development of innovative compressed natural gas powertrain technologies to further reduce fuel consumption and CO₂ emissions

Compressed natural gas technology: well-developed and industrialized



- ❑ Fiat Group sales of compressed natural gas vehicles (1997 – Apr. 2010)
 - > 400,000 passenger cars & LDVs with a European market share > 80 %
 - > 15,000 buses & garbage trucks with European market share > 50% (Italy, France, Spain, Greece)
 - > 2,000 engines for buses of external customers (Europe, China, Far East, Latin America)

Passenger Cars



Delivery Van



Heavy-Duty trucks



City Buses



1997

2007

2009

2010

Source: Fiat Powertrain

History of compressed natural gas for transportation: the market take-off (2001 – 2009)



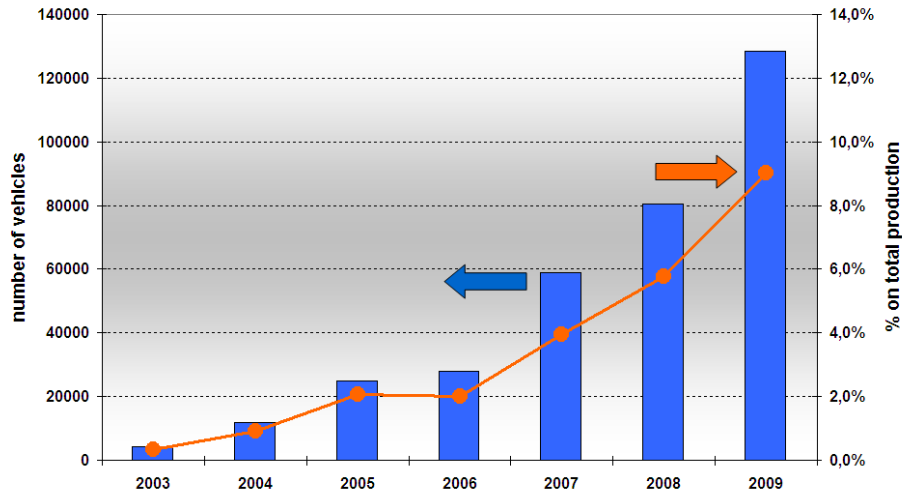
Main factors for rapid growth of the CNG vehicle market in Italy:

- ❑ Competitive fuel price compared to conventional fuels
- ❑ Government incentives allowing final customer to buy a CNG vehicle at a competitive price
- ❑ Availability of CNG vehicle with a range suitable to typical urban mission

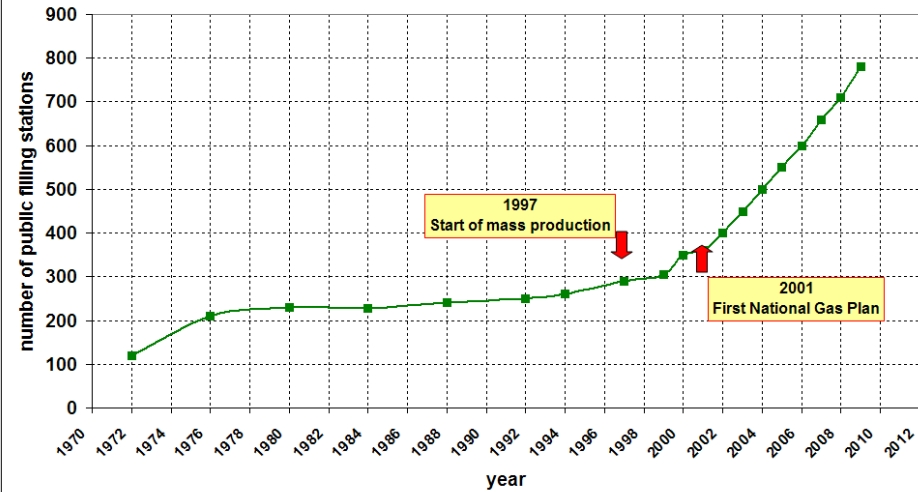
Existing Challenges:

- ❑ Number and distribution of the refueling stations

FGA CNG vehicles production



Evolution of the CNG distribution network in Italy



Source: Centro Ricerche Fiat - CRF

New Italian “Natural Gas Plan”



The new plan is mainly structured along the same lines as the first plan, with the following improvements:

- ❑ Incentives for new refueling stations will be more focused on the development of the network in the regions with lower concentration, in big cities and along highways
- ❑ Home and private fleet refueling stations will be promoted
- ❑ Production of bio-methane to be distributed through the existing compressed natural gas pipeline network will be incentivized (European Directive on Renewable Sources)
- ❑ Local use of methane – hydrogen mixtures will be promoted on selected fleets

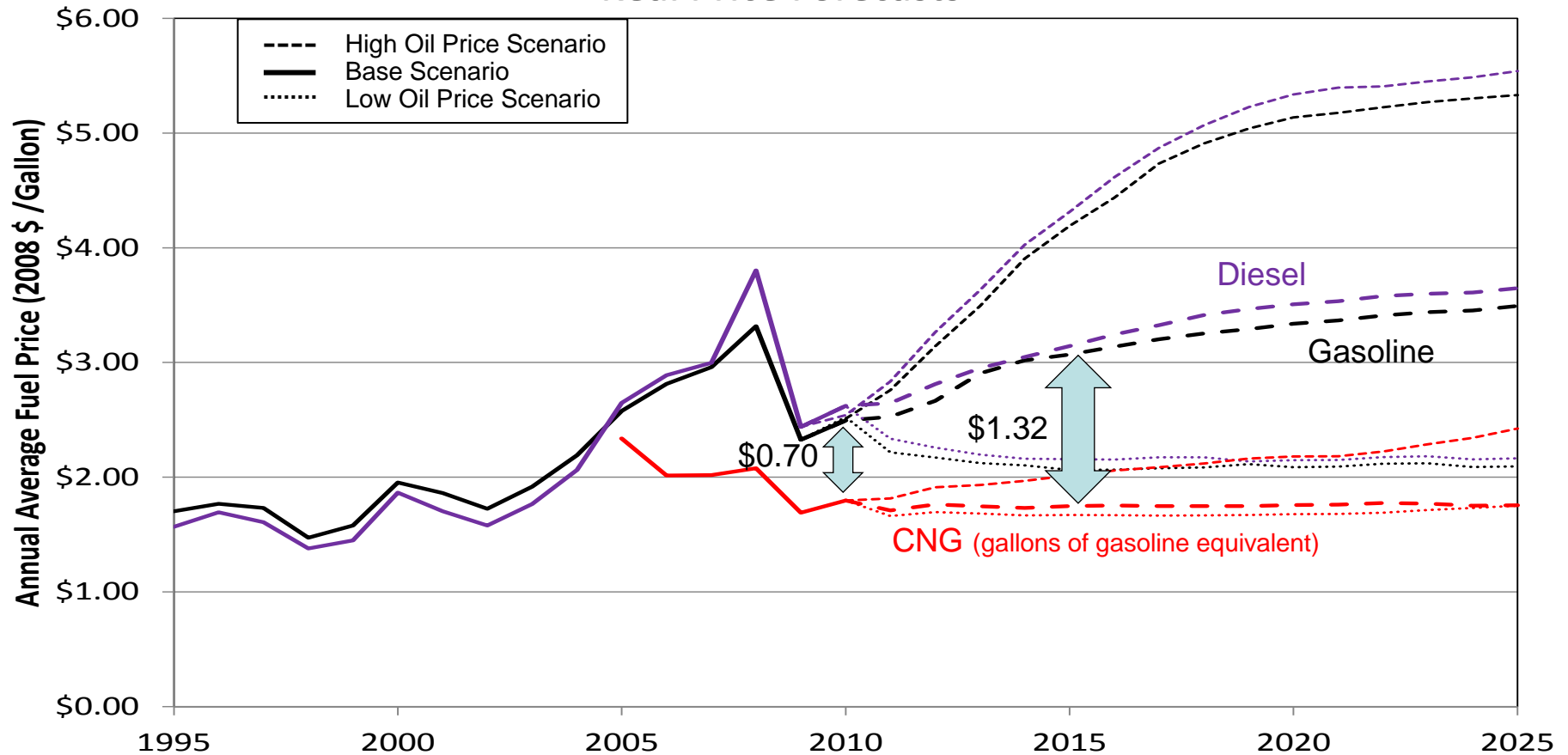
Natural gas potential in the U.S.

Fuel price forecast



- Current CNG fuel price spread of 70¢ per gasoline gallon equivalent (GGE) provides reasonable payback for many fleet operators.
- Expected doubling (\$1.32 per GGE) by 2015 will make CNG even more attractive.

U.S. Historical and 2010 Energy Outlook Real Price Forecasts



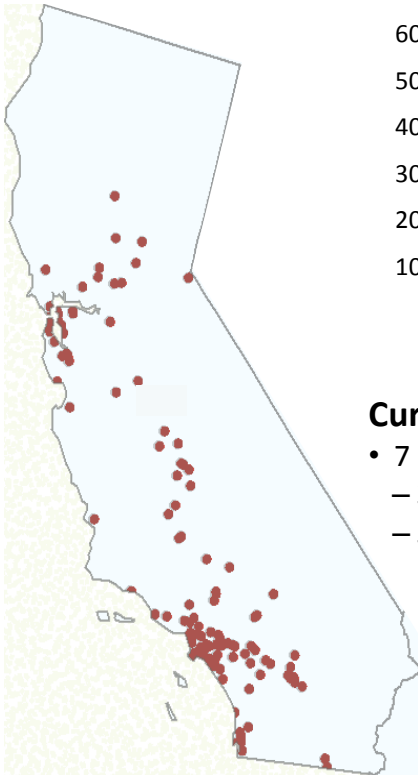
U.S. compressed natural gas fueling infrastructure



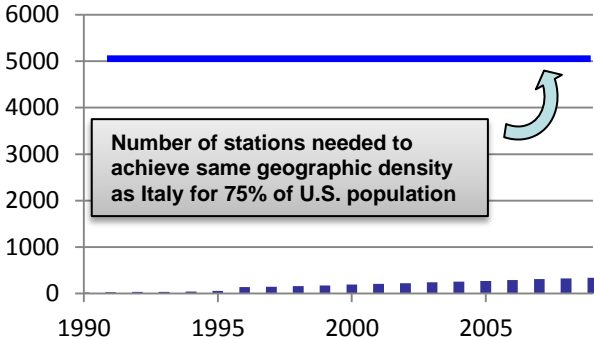
- ❑ Limited number of fueling stations
- ❑ 828 stations nationwide, 338 accessible to the public
- ❑ ~ 200,000 public gasoline stations (600 times the number of public CNG stations)
- ❑ California has the largest number of stations in the U.S., but still far less compared to Italy



Italy: ~ 800 public CNG stations
28 stations / 10,000 km²



California: 123 Public CNG stations
3 stations / 10,000 km²



Current infrastructure doesn't meet needs

- 7 % annual growth rate over the last ten years
 - 3,000 Stations needed to reach 50% of pop.
 - 5,000 Stations needed to reach 75% of pop.

Home Refueling: a solution to limited infrastructure

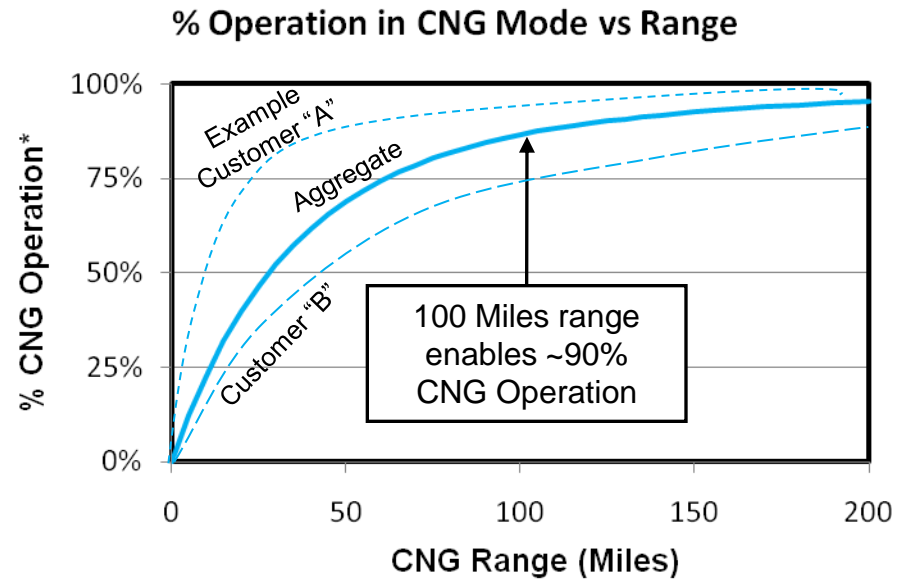


- ❑ A bi-fuel CNG vehicle with home refueling offers an alternative solution to limited infrastructure
- ❑ Cost of the home refueling unit and customer acceptance are the main issues

Home refueling technology is available

- Retail price ~\$5K (at low volume)
 - ➔ Could be largely offset by tax refunds
- Simple and easy to use
- Can refuel ~½ gallon (GGE) per hour
 - ➔ 100 – 200 miles range in an overnight fill

Home Refueling Appliance



* Source: CARB Utility Function for PHEVs

Key enablers for CNG expansion in the U.S.



- ❑ **Expanded government support**
 - **Incentives for bi-fuel vehicles to help offset system cost**
 - **Subsidies for infrastructure (public stations & home refueling)**
 - **Policy to sustain favorable CNG fuel price**
 - **R&D funding for CNG technology development**

- ❑ **Energy industry commitment to increase number of public refueling stations**

- ❑ **Auto industry commitment to expand offerings of CNG vehicles**