

The Volkswagen Group's CNG Campaign

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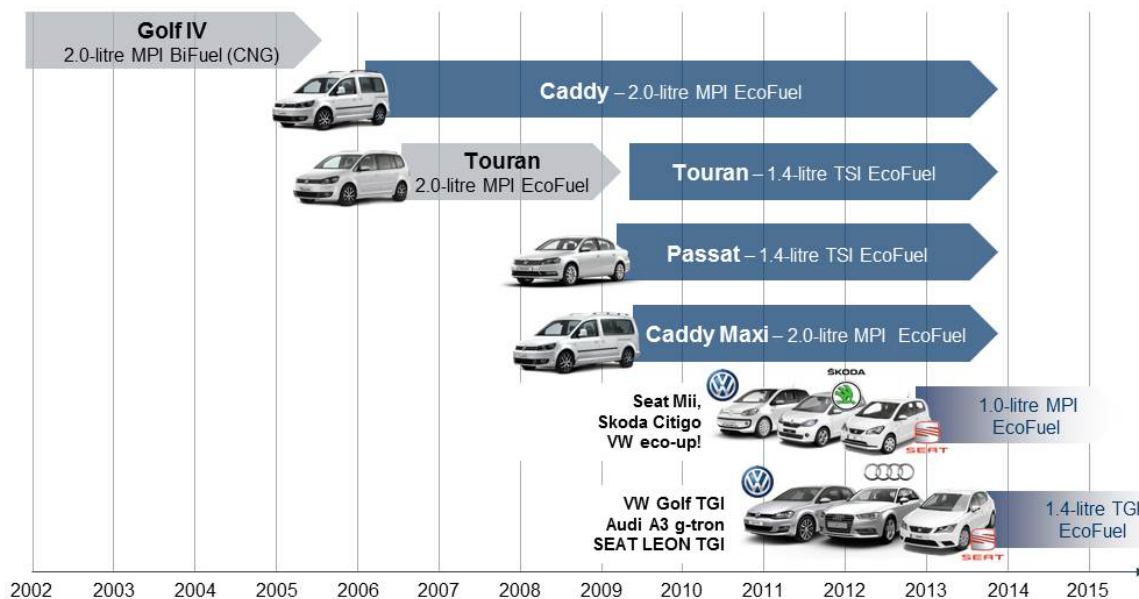


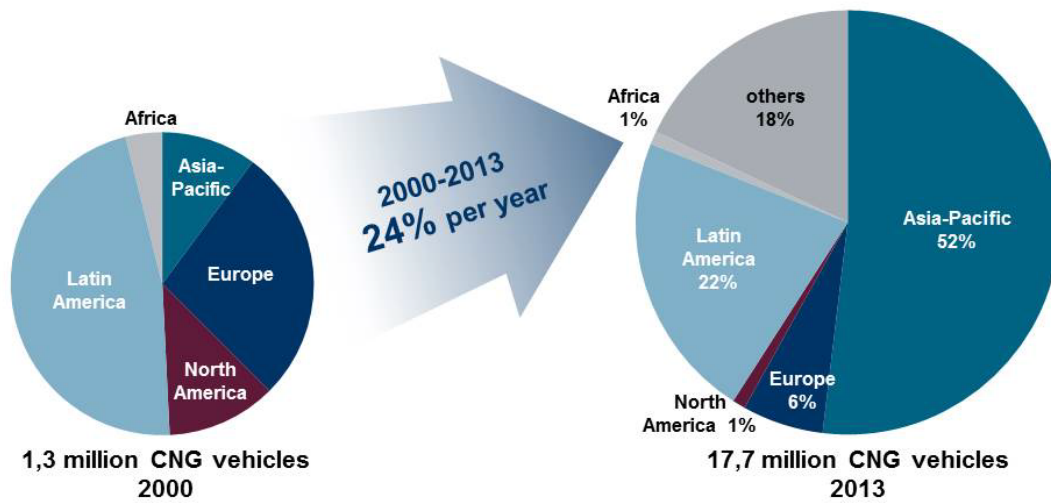
The CNG campaign in the Volkswagen Group

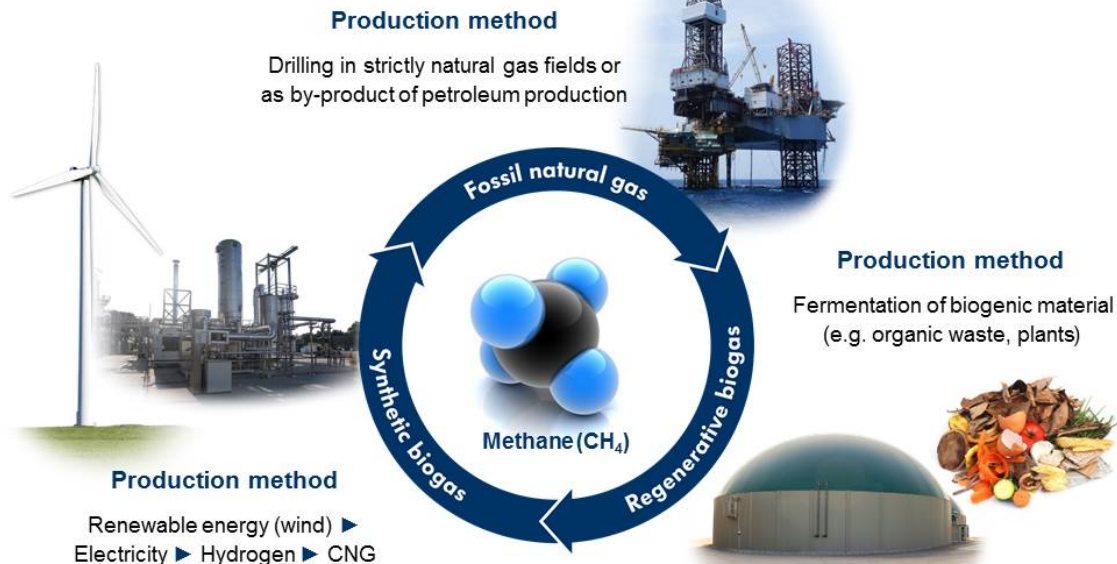
Dr. Heinz-Jakob Neußer

Member of the Board of Management Volkswagen Brand
Head of Group Powertrain Development Volkswagen Group

More than ten years of natural gas vehicles in the Volkswagen Group



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AKTIENGESELLSCHAFT**CNG – worldwide growth of Natural Gas Vehicles****» CNG vehicles – annual growth rate of 24%**Sources: NGV global
<http://ngvaeurope.eu/worldwide-ngv-statistics>VOLKSWAGEN
AKTIENGESELLSCHAFT**CNG – innovative and environmentally friendly**

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AKTIENGESELLSCHAFT**CNG – different sources, uniform quality**VOLKSWAGEN
AKTIENGESELLSCHAFT**CNG – lower CO₂ emissions**

Gasoline C₈H₁₈ (ISO-Octane)

$$2 \text{ C}_8\text{H}_{18} + 25 \text{ O}_2 \rightarrow 16 \text{ CO}_2 + 18 \text{ H}_2\text{O}$$

1 kg gasoline generates 3.1 kg CO₂ heating value 41.0 MJ/kg

CNG CH₄ (Methane)

$$\text{CH}_4 + 2 \text{ O}_2 \rightarrow \text{CO}_2 + 2 \text{ H}_2\text{O}$$

1 kg methane generates 2.75 kg CO₂ heating value 47.7 MJ/kg

Methane (CH₄)

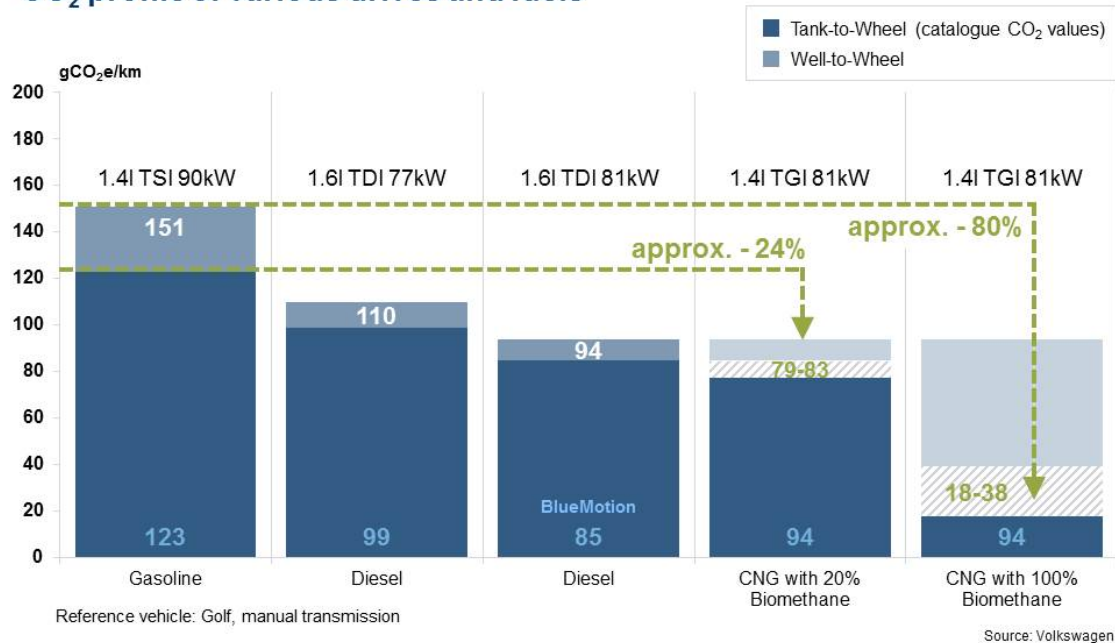
-25% CO₂

Potential reduction in CO₂ emissions in consideration of the heating value

» CNG: 25% CO₂ reduction compared to gasoline

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CO₂ profile of various drives and fuels



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CNG – properties

	CNG (CH ₄)	gasoline 95 RON	Effects
Density	0.73 kg/m ³	720 - 770 kg/m ³	- Requires storage under pressure - Low range
heating value	47.7 MJ/kg	41.0 MJ/kg	- CO ₂ advantage
Boiling point	-162 °C	25 - 210 °C	- No lubrication - No evaporation cooling
Ignition temperature	650 °C	400 °C	- Requires higher ignition voltage - Increased catalyst light off temperature
Octane rating	130	95	- Optimal efficiency of ignition timing - Increased peak pressures and combustion chamber temperatures

» The modification of engine hardware and application is necessary to exploit the advantages of chemical properties.

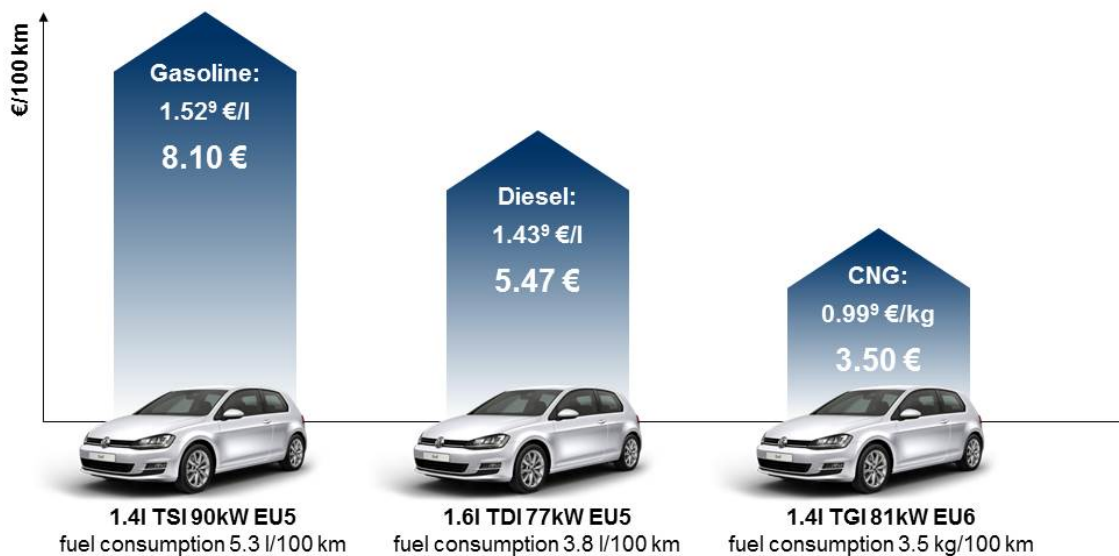
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CNG in motorsport – 24h Nürburgring



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CNG – cost advantage

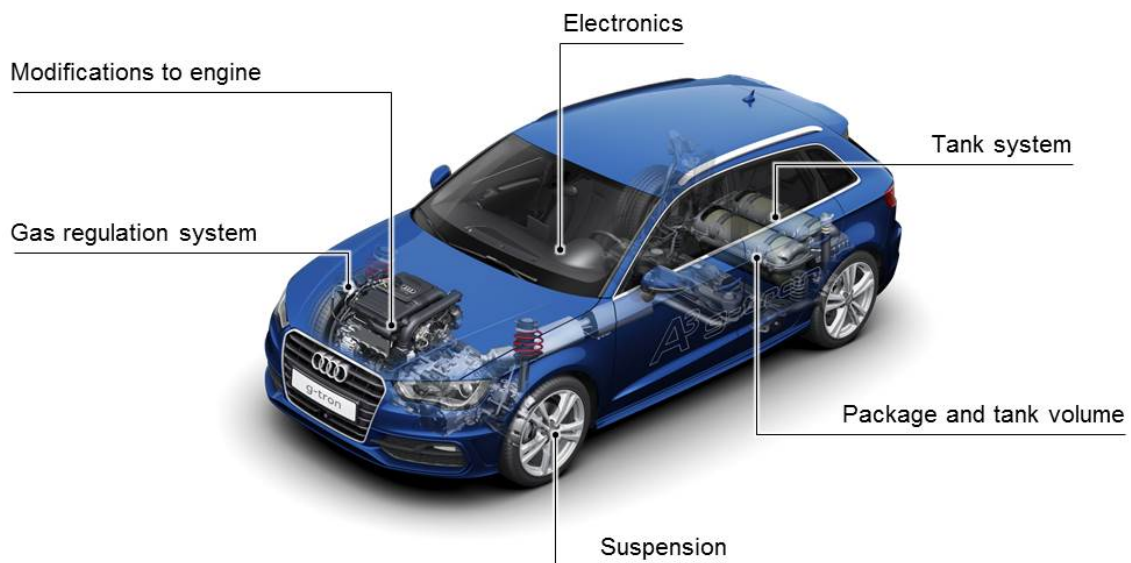


all variants manual transmission

(Germany, 27. Sep. 2013)

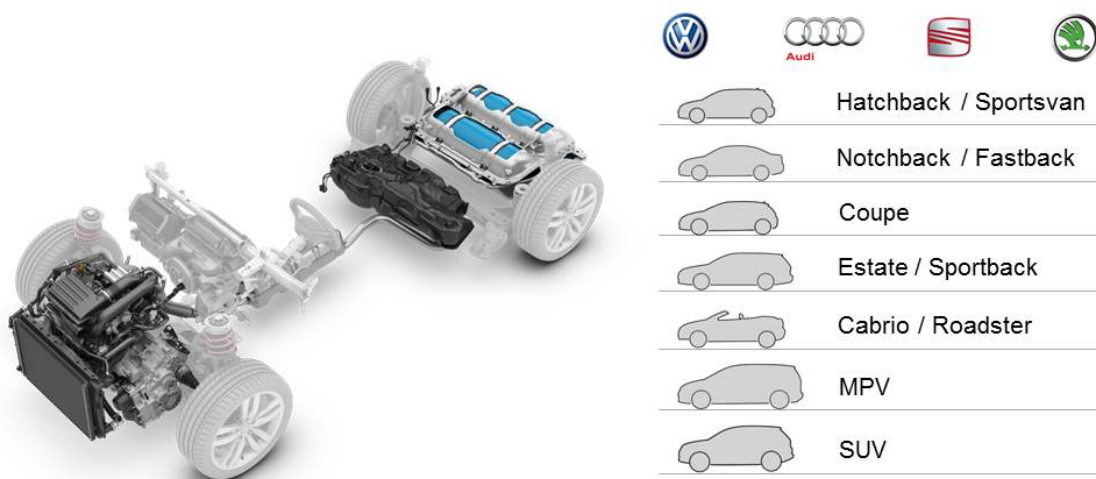
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CNG – Modifications to vehicle



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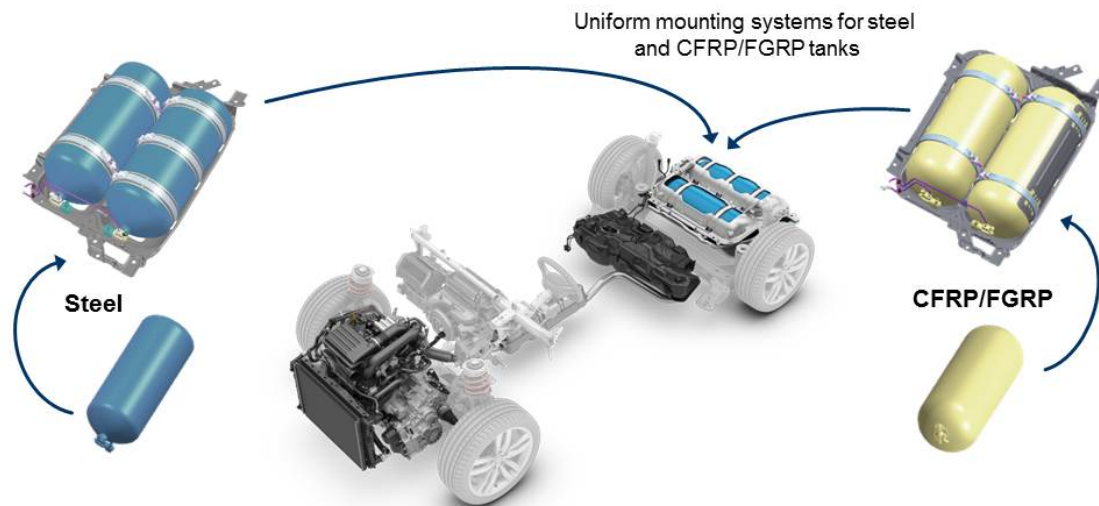
Possible applications of CNG in the MQB



» More than 40 models throughout the Group are based on the MQB.

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Technical components of gas storage system within the MQB



» 15 kg gas storage for up to 430 km range. Total range over 1.400 km.

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CNG modifications to EA211 1,4I TSI

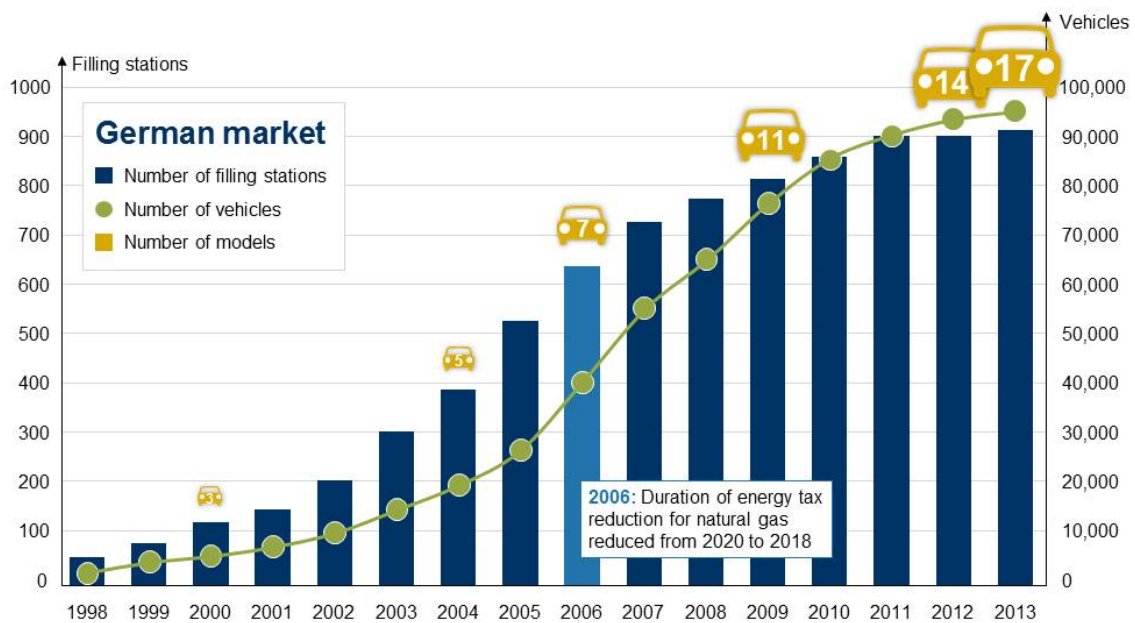


Cylinder head/valve train
Cranktrain assembly
Injection system
Ignition system
Turbocharger
Catalytic converter
Coolant Circuit

» CNG capability was planned for during the initial development of the EA211.

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Numbers of natural-gas vehicles and filling stations, 2001 – 2013

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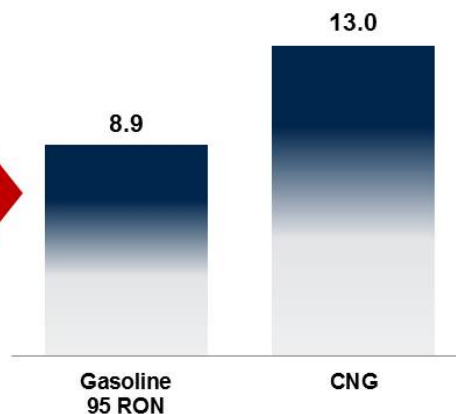
Prices of energy equivalents based on gasoline 95 RON

Current gas
station prices

Price in €/l



Energy content per litre or kilogram (kWh)

Objective for
price displayPrice in €/l_{GE}

(Germany, 27. Sep. 2013)

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CNG – Fields of action



» Cooperative efforts are necessary to increase the CNG market share.

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Outlook – CNG systems



» Acceptance of CNG is growing worldwide.

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Outlook – The CNG campaign in the Volkswagen Group

