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LPG and Natural Gas

# Emissions from road vehicles

TNO Automotive



M. van der Steen, Marketing Manager

## Contents

- TNO Automotive
- LPG and Natural Gas
- Pollutants
- Emissions from vehicles



Vehicle Emissions with LPG and Natural Gas



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Vehicle Emissions with LPG and Natural Gas

## TNO Automotive

- Part of  
*The Netherlands Organisation for Applied Scientific  
Research (TNO)*
- 5,400 Staff -  
350 in Automotive research
- 35 years experience with alternative fuels  
(LPG, CNG, Methanol, Ethanol, DME)



Vehicle Emissions with LPG and Natural Gas

## TNO Automotive and alternative fuels



Fuel System  
Development

Control System  
Development



Vehicle Development

Component testing  
Fuel Tanks (bonfire) Crash testing



SafetyStudies

- Infrastructure
- Parking Garages
- Tunnels

Concept and implementation  
studies

- Emissions
- Costs



Vehicle Emissions with LPG and Natural Gas

## Contents

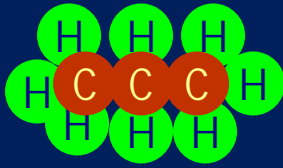
- TNO Automotive
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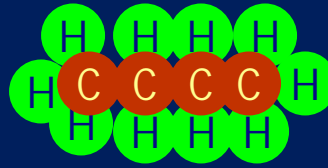
Vehicle Emissions with LPG and Natural Gas

## LPG Liquefied Petroleum Gas

- Mixture of Propane ( $C_3H_8$ ) and Butane ( $C_4H_{10}$ )
- By-product at crude oil refineries
- Associated gas with the exploitation of natural gas
- Is liquid under moderate pressure (7..8 bar)



*Propane*



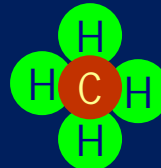
*Butane*

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Vehicle Emissions with LPG and Natural Gas

## CNG Compressed Natural Gas

- Mainly Methane ( $CH_4$ )
- Produced during the winning of crude oil or directly from natural gas fields
- Needs to be stored under high pressure (200 bar)
- Can be liquefied at very low temperatures (LNG)



*Methane*

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Vehicle Emissions with LPG and Natural Gas

## Gasoline and Diesel

- Mixture of (heavier) hydrocarbons ( $C_{4...20} H_{7...38}$ )
- Liquid fuels (evaporative range)
- Harmful constituents or combustion products
  - *Benzene, Toluene, Xylene*
  - Formaldehydes, Polycyclic Aromatic Hydrocarbons
  - Lead, Sulphur



Vehicle Emissions with LPG and Natural Gas

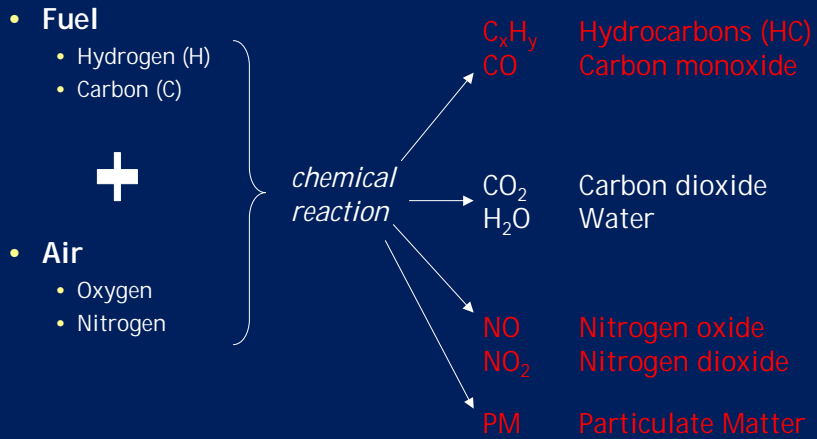
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Vehicle Emissions with LPG and Natural Gas

## Combustion of Hydrocarbons

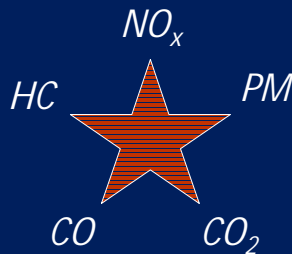


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Vehicle Emissions with LPG and Natural Gas

## Unfavorable effects

- Health effects
- Environmental effects



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Vehicle Emissions with LPG and Natural Gas

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## Pollutants / Emissions

Name	Harmful effect
Nitrogen Oxides (NO <sub>x</sub> )	Irritation of the respiratory organs - Poisonous
Hydrocarbons (HC)	Irritation of the respiratory organs - Some are carcinogenic
Carbon monoxide (CO)	Extremely poisonous
Carbon dioxide (CO <sub>2</sub> )	Non - toxic, but contributes to greenhouse effect
Particulates (PM)	potentially carcinogenic



Vehicle Emissions with LPG and Natural Gas

## Environmental effects

- Acid Rain Nitrogen oxides
- Summer smog Photochemical reaction of hydrocarbons and nitrogen oxides
- Winter smog Particulates
- Greenhouse effect Carbon dioxide, nitrogen oxide, hydrocarbons



Vehicle Emissions with LPG and Natural Gas

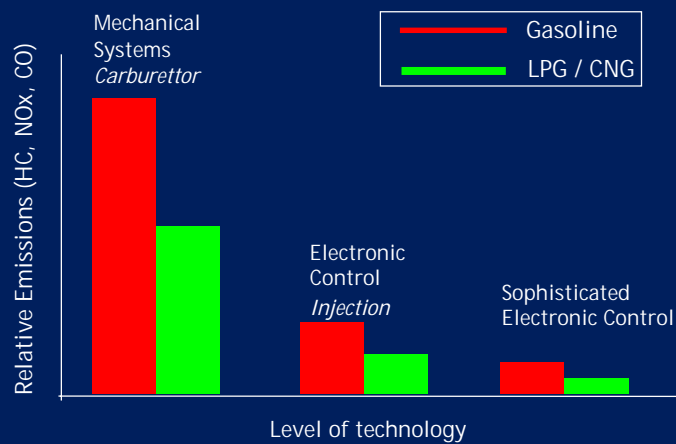
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Vehicle Emissions with LPG and Natural Gas

## Emission performance of gaseous fuels (passenger cars)

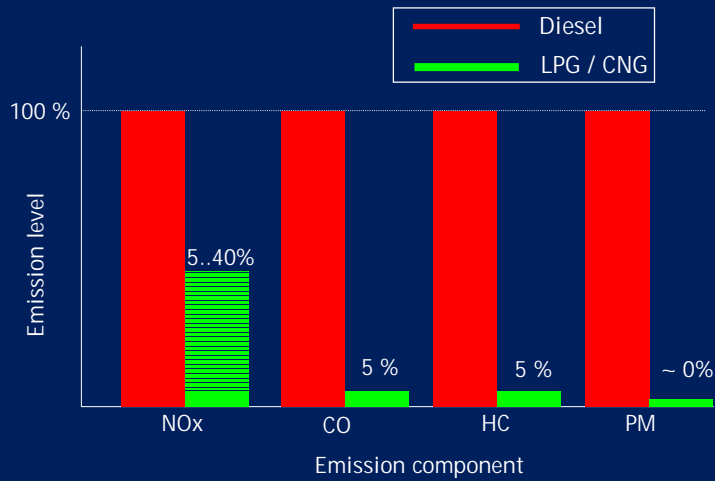


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Vehicle Emissions with LPG and Natural Gas

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## Emission performance of gaseous fuels (heavy-duty vehicles)



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Vehicle Emissions with LPG and Natural Gas

## Conclusions

- Pollution from road-vehicles (passenger cars and heavy-duty vehicles) contribute to negative health and environmental effects
- LPG and natural gas are viable alternative fuels for internal combustion engines
- The application of alternative (gaseous) fuels can significantly help to reduce pollution from road-vehicles

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Vehicle Emissions with LPG and Natural Gas