Advanced Combustion Process for Passenger Car Gas Engines

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Advanced Combustion Process for Passenger Car Gas Engines

And the Role of Methane as a Transport Fuel

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Content

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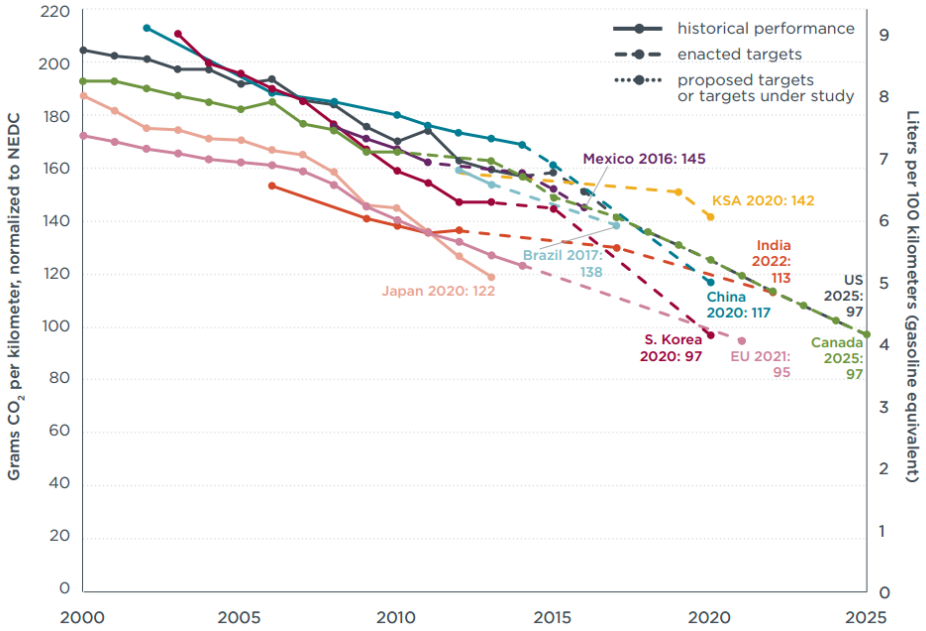
- Methane as a vehicle fuel – CO_2 legislation, consequences for CNG
- R&D on CNG engines for passenger cars: example of a running project
- Conclusions

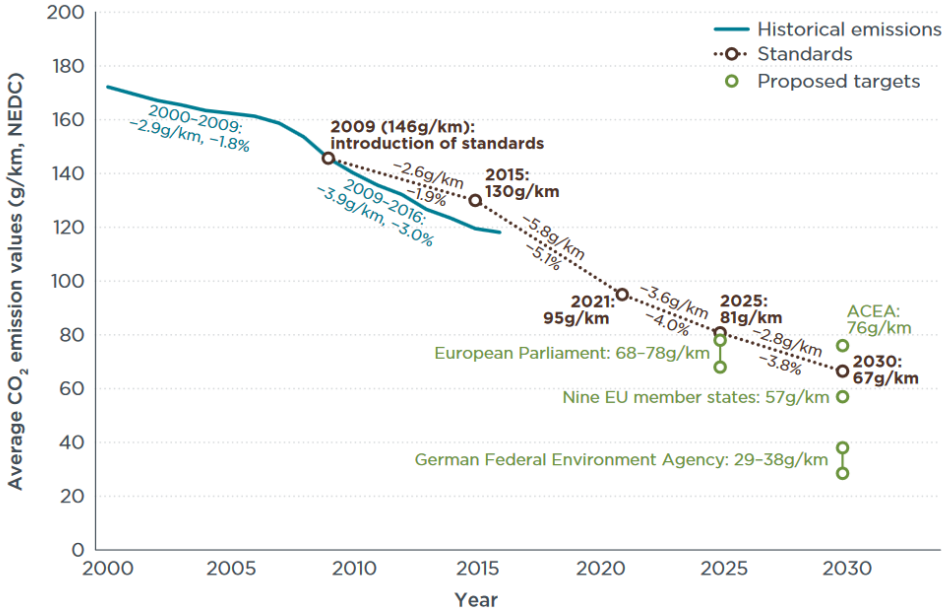
Situation: CO_2 Limits are Drastically Tightened Worldwide



EU has the bigest ambition worldwide

Source: ICCT briefing, CO_2 emissions from new passenger cars in the EU: Car manufacturers' performance in 2014

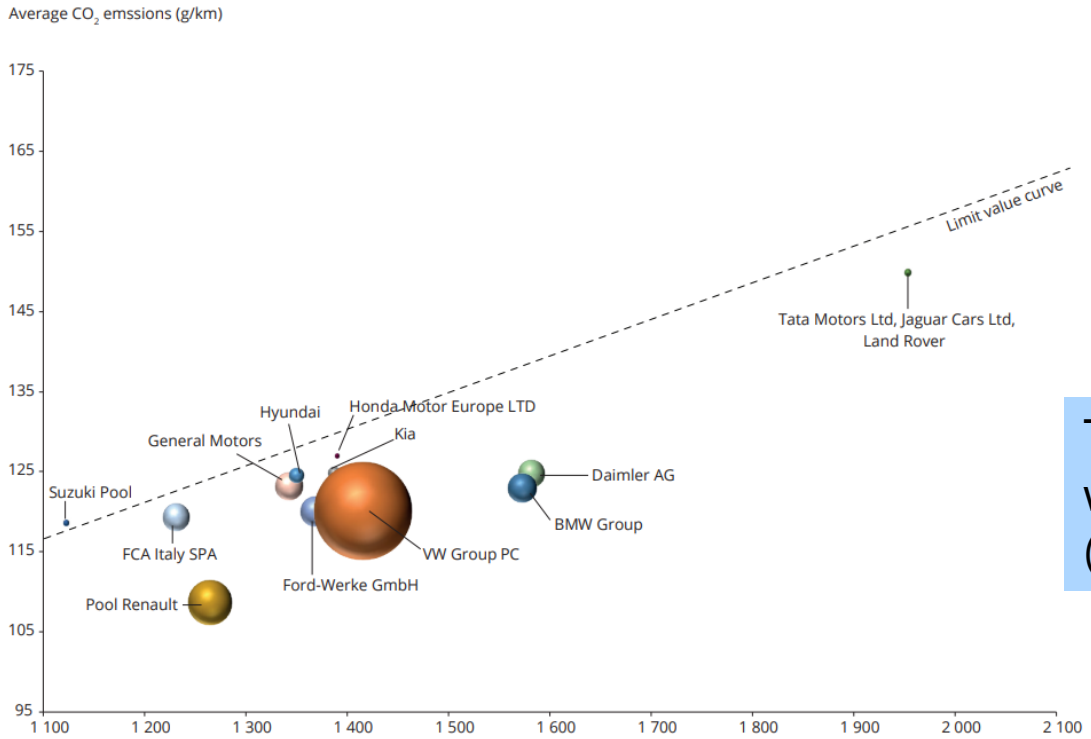
EU Legislation:
95 g/km per 2021, 67 g/km per 2030 proposed



Situation post-2021 is yet unclear, political debates are ongoing

Source: ICCT briefing, The European Commission regulatory proposal for post-2020 CO2 targets for cars and vans: A summary and evaluation

Situation Today

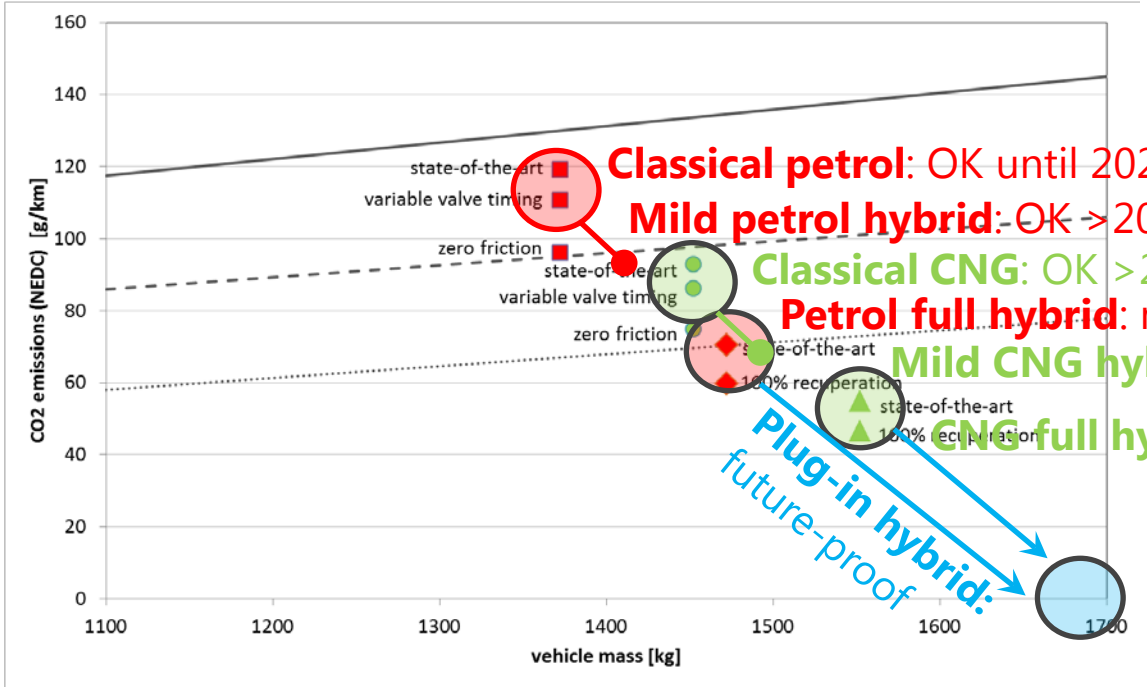


Note: The size of the bubble is proportional to the number of vehicles registered in the EU-28.

Today: CO_2 limits are achieved with mainly classical technology (petrol / diesel)

Source: EEA Report No 19/2017, Monitoring CO2 emissions from new passenger cars and vans in 2016

Which Technologies Can Comply With Future CO_2 Limits?



Classical petrol: OK until 2020

Mild petrol hybrid: ~~OK~~ >2021…?

Classical CNG: OK >2021…?

Petrol full hybrid: maybe future-proof

Mild CNG hybrid: OK >2030

CNG full hybrid: future-proof

Plug-in hybrid: future-proof

Battery-electric: future- proof with today's «no tailpile = no CO_2» rule

+ Biofuels / synfuels (biogas / power-to-gas) will be more important if the CO_2 benefits will be assigned to the vehicles

Source: own simulations

Today's CNG Passenger Cars

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- Good situation, major manufacturers offer an increasing number of modern CNG models
- In some countries, the gas industry has invested in filling station infrastructure but density is still low compared to petrol/diesel
- All CNG passenger cars have bivalent engines, e.g. they can operate on natural gas and petrol
  → The engines are not fully optimized for natural gas

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R&D On Future CNG Engines

Example of a Running Project

grant agreement No 652816

Project Goals GasOn (2015-2018)

- Post Euro-6 emission standards
- 20% CO_2 reduction (compared to best-in-class CNG technology of 2015)
- At least 600 km driving range

Horizon2020 Project GAS ON grant agreement No 652816

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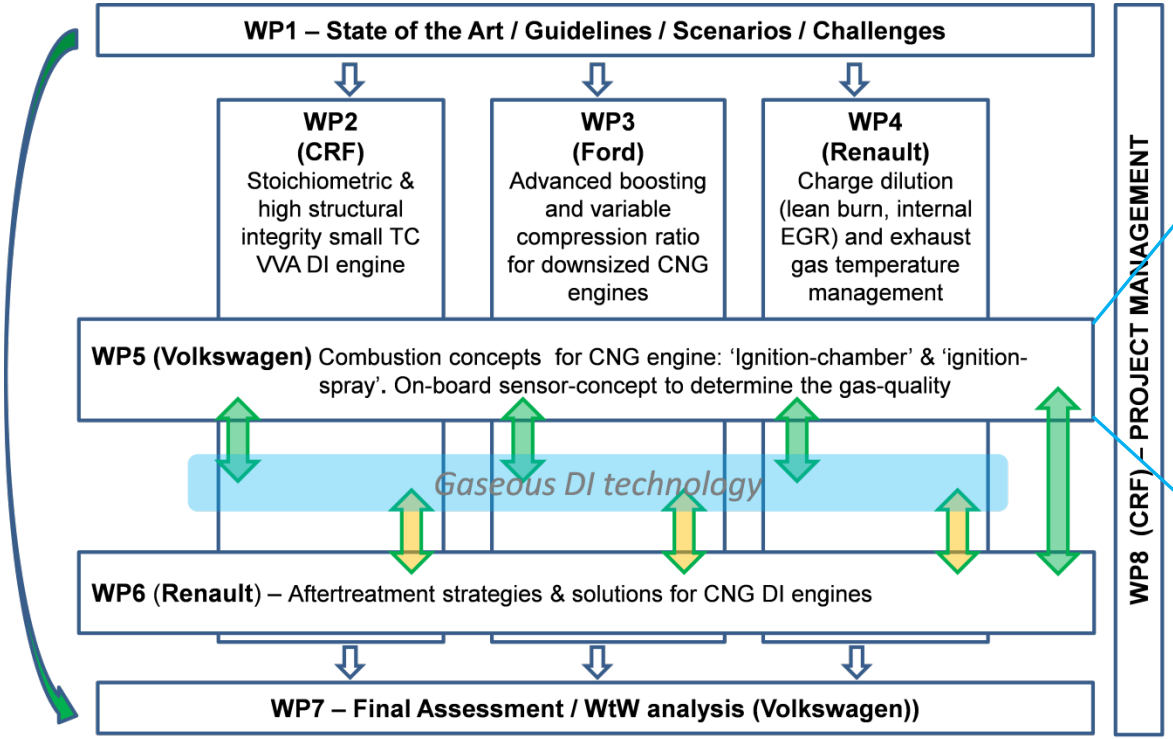

Focus of GasOn Work Package 5

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- R&D on technology, for decidaded (monofuel) CNG engines for passenger cars
- CNG is very knock resistant (compared with petrol) and can burn at much higher cylinder pressures (≈ 170 bar peak) than petrol engines (≈ 120 bar peak)
- CNG is harder to ignite than petrol
- Goal: Diesel-like efficiencies → diesel like combustion
- Method: Diesel basis engine (=high peak pressures) adapted mixture formation / ignition / combustion

Concept

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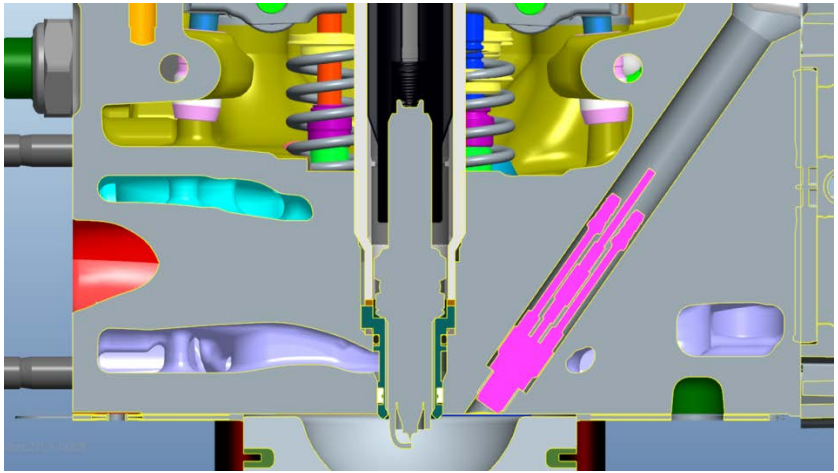
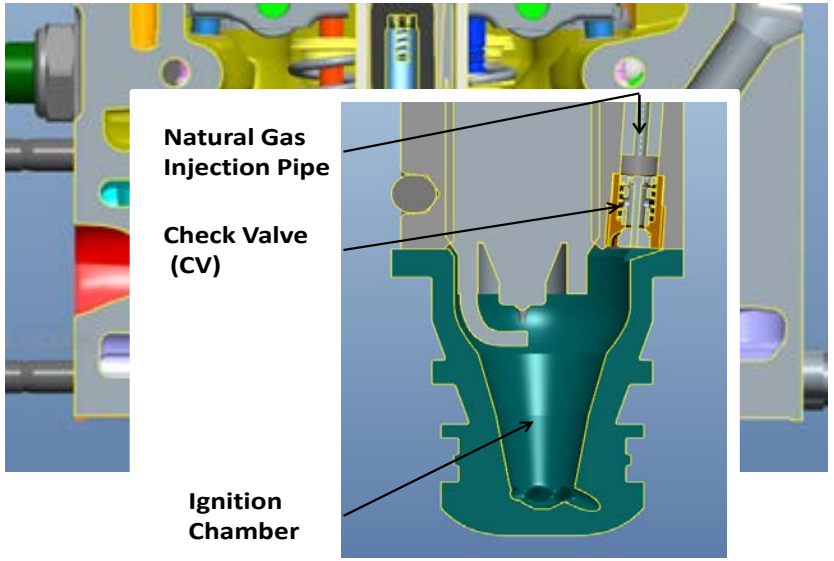
Classical Spark Plug Ignition



Prechamber Ignition



Goal: provide very high ignition energies to the main chamber for stable and fast combustion

Prechamber Details

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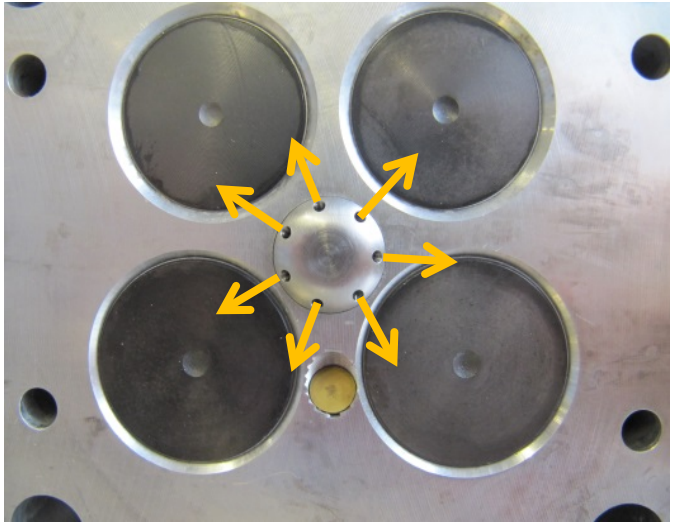
Prechamber lower part

Prechamber upper part



Performance in a Real Engine

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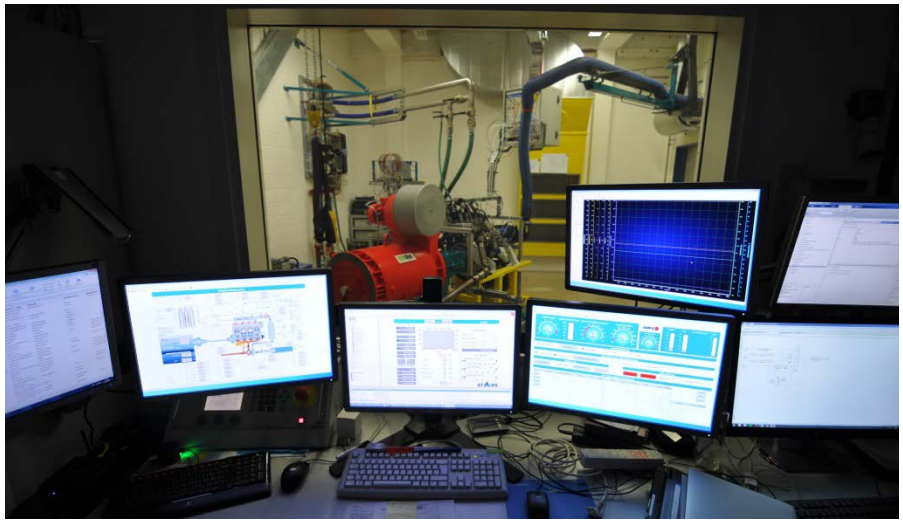
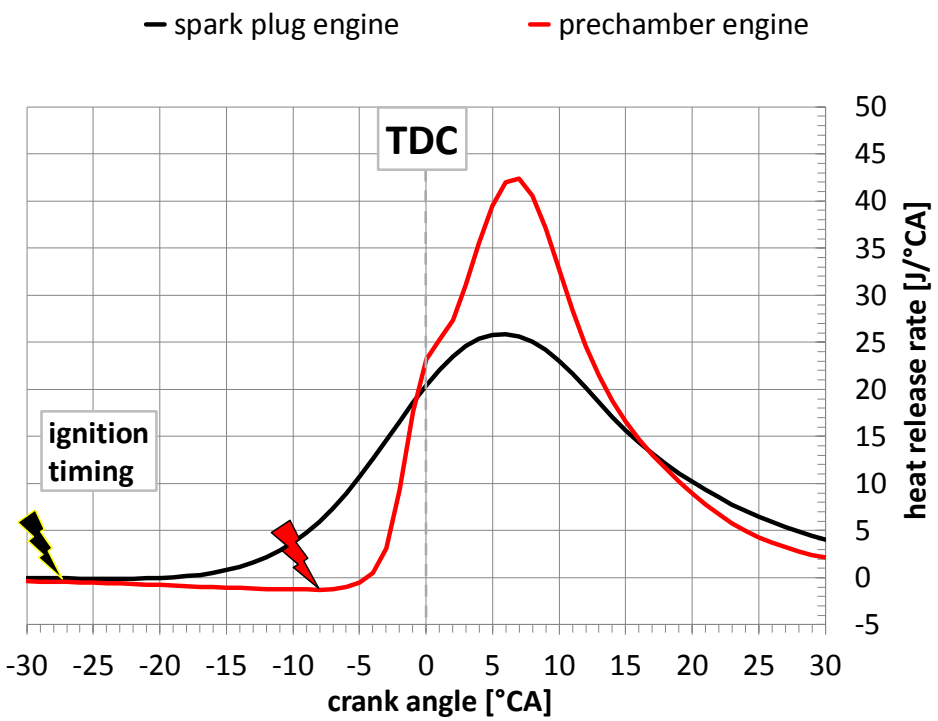


Effect of Prechamber: Extremely Fast Ignition



- Time from ignition to global heat release is massively shortened with a prechamber
- Combustion is much faster with a prechamber
- The project engine achieves efficiencies of more than 44% which is far above a classical petrol engine

Conclusions

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- CO_2 emission limits for vehciles are increasingly important, CNG is in a very good position – CNG cars, especially hybrid, are future-proof
- CNG has the advantage over petrol/diesel that it is 100% compatible with renewable methane from different sources (biogas, power-to-gas, etc.)
- Today's passenger cars CNG engines are petrol engines (slightly) adapted for CNG and achive petrol-like efficiencies
- Strong R&D is ongoing for future CNG engines, with contribustions of the Swiss research community and cooperation with leading automotive industries
- They will be fully optimized to CNG and achieve Diesel-engine-like efficiencies with considerably lower CO_2 emissions and basically «zero» pollutant emissions
- Vehicle ranges of >600 km and fast refilling times make CNG vehicles attractive, especially for high-mileage-drivers and fleet operators

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Thank you for your attention!

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