CO2 reduction for Transportation Systems
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Politecnico di Torino – Torino – ITALY
Conference
ATA ASSOCIAZIONE TECNICA DELL'AUTOMOBILE
SAE TORINO An SAE International Section

CNG 2.0

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CRF
FCA FIAT CHRYSLER AUTOMOBILES

Our position

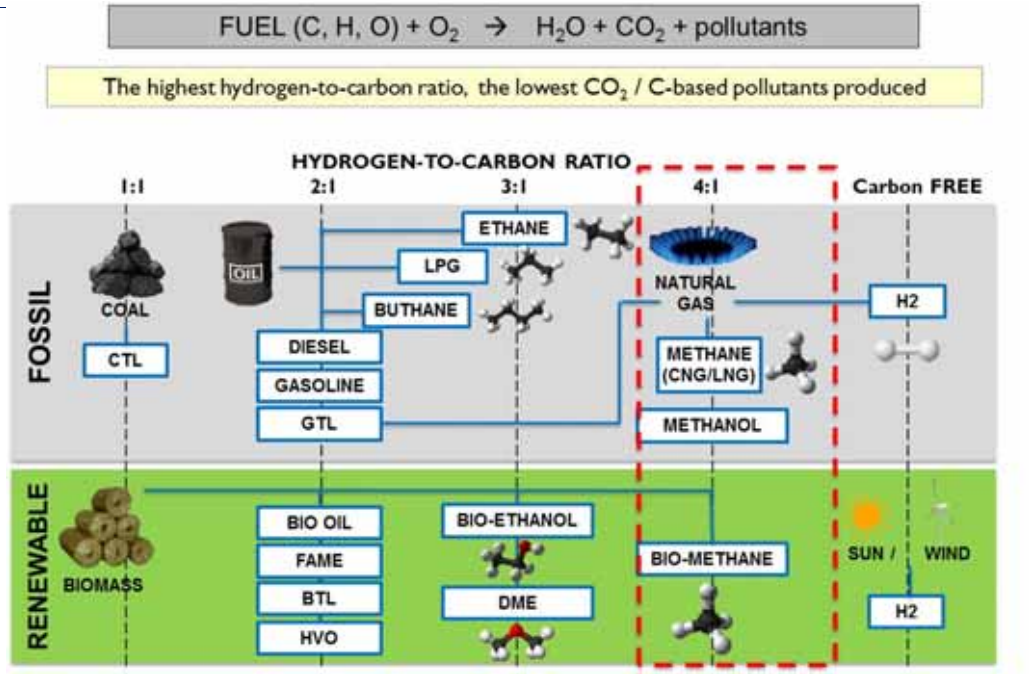
Natural Gas is a key fuel source for **sustainable mobility**

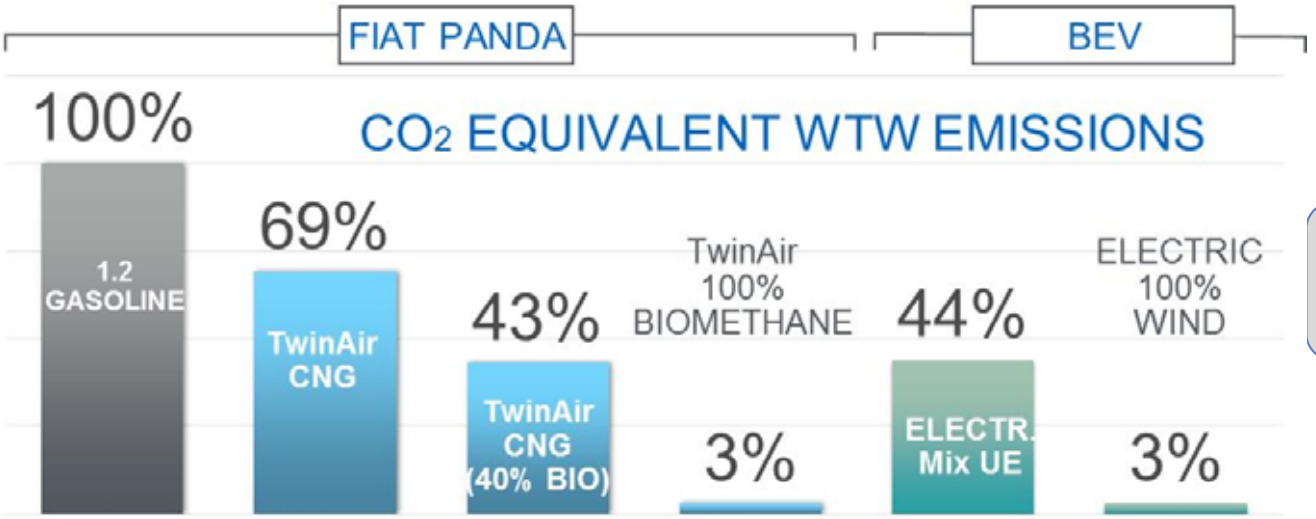
CNG represents the most efficient, **affordable** and immediately available choice for resolving pollution problems in urban areas and reducing CO2 emissions

From ’90s, FCA continues to invest time and resources in developing the **CNG technology** leading the European market with a large portfolio of **vehicles** and **engines**

CNG sustainability

Oil independence & decarbonisation





Well to wheel approach

CNG affordability

The lowest cost of ownership & the right driving range

Continuous growth of refueling stations and vehicle demand

FCA – Natural Gas experience

19-years consolidated experience (700.000 units sold, >50% market share)

FCA CNG line-up

PANDA
0.9 TWINAIR
TURBO 80 hp
CO_2 = 85 g/km

PUNTO
1.4 FIRE
70 hp
CO_2 = 115 g/km

500L
0.9 TWINAIR
TURBO 80 hp
CO_2 = 95/105 g/km

500L Living
0.9 TWINAIR
TURBO 80 hp
CO_2 = 95/105 g/km

QUBO
1.4 FIRE
70 hp
CO_2 = 119 g/km

DOBLÒ
1.4 T-JET
120 hp
CO_2 = 134 g/km

natural power

YPSILON
0.9 TWINAIR
TURBO 80 hp
CO_2 = 86 g/km

PANDA VAN
0.9 TWINAIR
TURBO 80 hp
CO_2 = 85 g/km

FIORINO
1.4 FIRE 70 hp
CO_2 = 119 g/km

DOBLÒ CARGO
1.4 T-JET
120 hp
CO_2 = 134 g/km

DUCATO
3.0 TURBO
136 hp
CO_2 = 234 g/km

DUCATO PANORAMA
3.0 TURBO
136 hp
CO_2 = 234 g/km

Full Natural Gas engine porfolio

3.0 TURBO

136HP
350NM

0.9 TWINAIR TURBO

80HP
140NM

1.4 FIRE

70HP
105NM

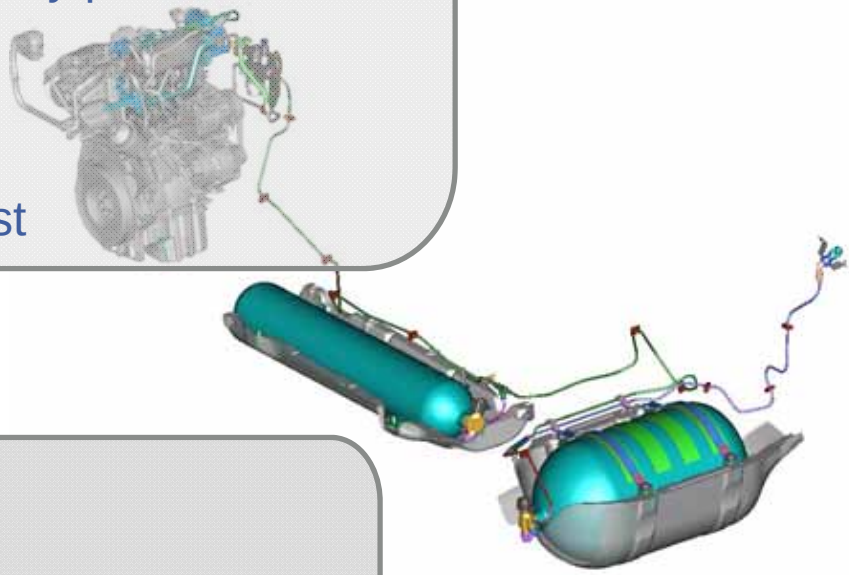
1.4 T-JET TURBO

120HP
200NM

Current CNG 1.0 technology

Powertrain

- ❑ Combustion → Otto cycle
- ❑ A/F ratio → stoichiometric operation in all conditions
- ❑ Ignition → positive with spark plug/coil
- ❑ Injection → port fuel multipoint sequentially phased
- ❑ Boosting → turbocharger with WG
- ❑ Tailored materials → seat valves/valves
- ❑ Control → tailored strategies
- ❑ After treatment → tailored 3-way catalyst

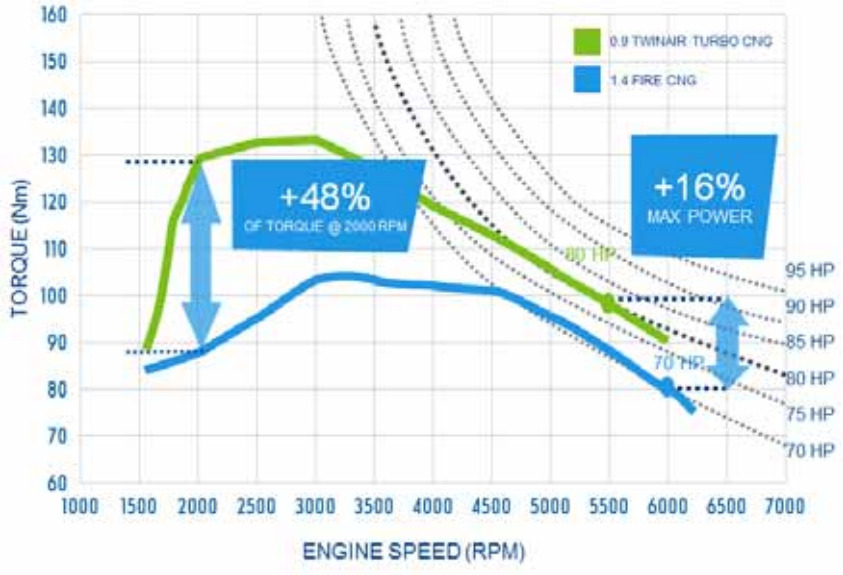


Fuel system

- ❑ Storage → steel tank @ 200 bar & safety devices
- ❑ Feeding → return less with pressure reducer
- ❑ Bifuel → gasoline as emergency mode

Benefits of current CNG technology

- Performance improved thanks to boosting system
- Reliability and maintenance equivalent to gasoline engines
- Outstanding CO2 emissions already compliant with 2020 targets
- Fuel tank installation to achieve at least 300 km of CNG driving range plus full gasoline range
- Unchanged trunk volume vs. gasoline version
- Safety devices at top level



CNG 2.0 powertrain technology

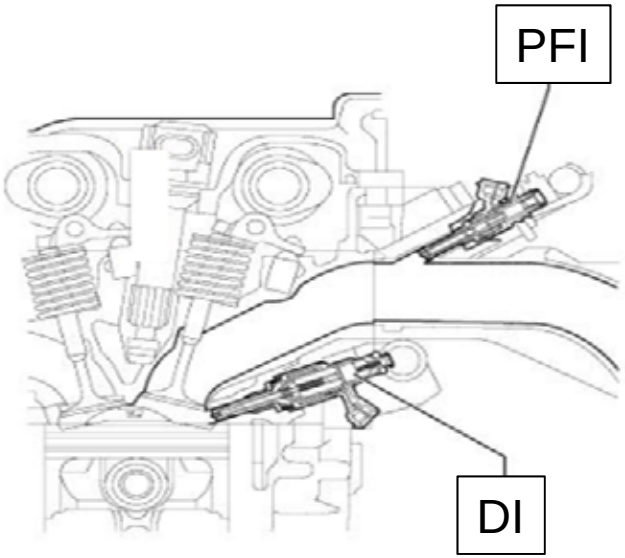
Current CNG technology is mature

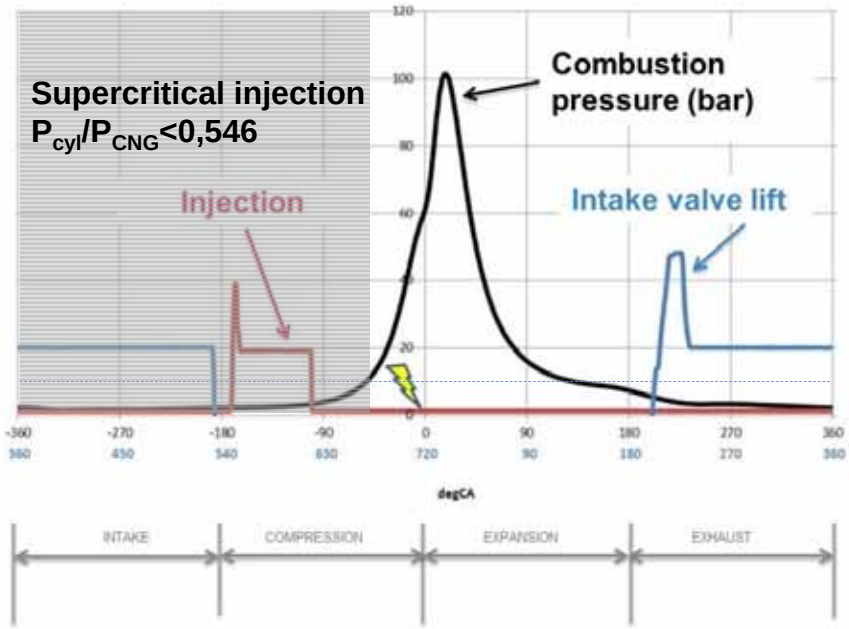
but

our goal is to develop a smart & affordable technology exploiting all CNG benefits without drawbacks:

- remove performance gap → gasoline-like target
- avoid installation impact → GDI (gasoline direct injection) compatible
- improve engine efficiency → post 2020 CO2 challenge

CNG DI (Direct Injection) concept



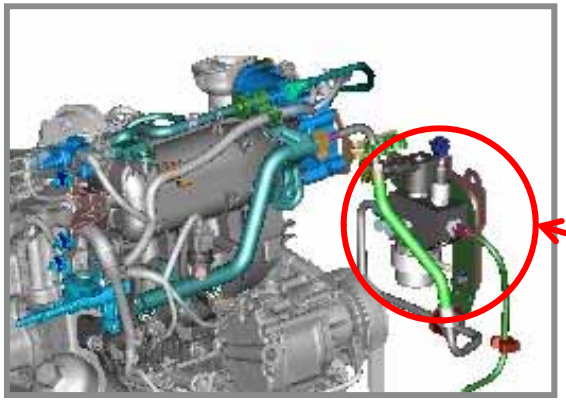


Low pressure injection after intake valve closing (DI)
to remove volumetric efficiency losses due to gaseous injection (PFI)

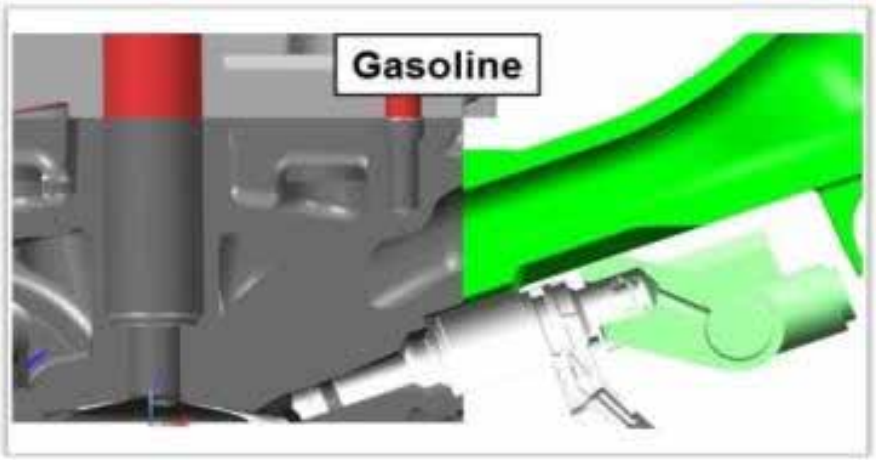
CNG DI: compatible with GDI engine

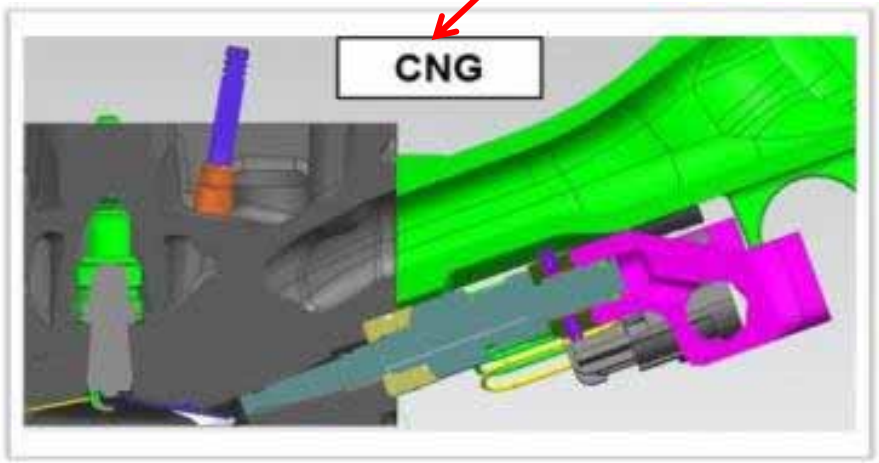
Easy adaptation of CNG DI system into GDI engine

Cylinder Head & Block:
- No modifications



Injection system CNG:
- DI CNG injectors, fuel rail and electronic pressure regulator

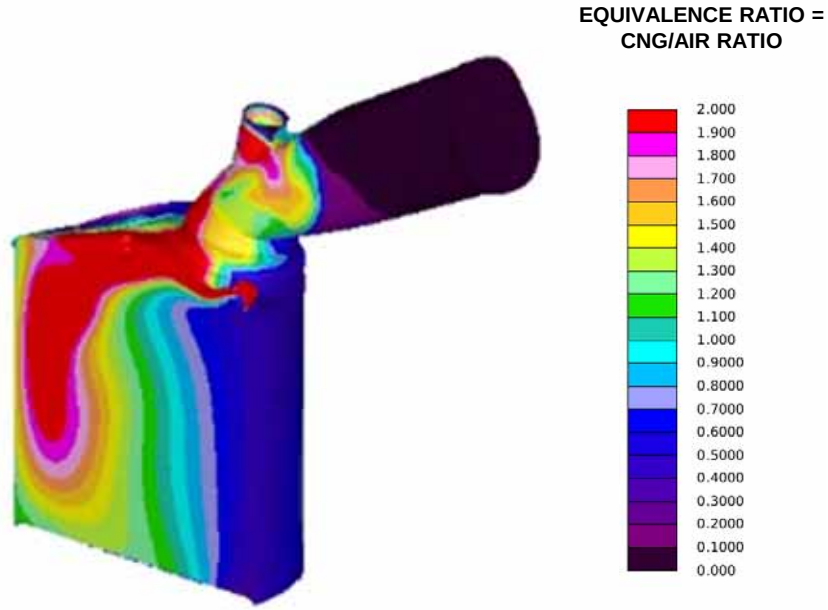


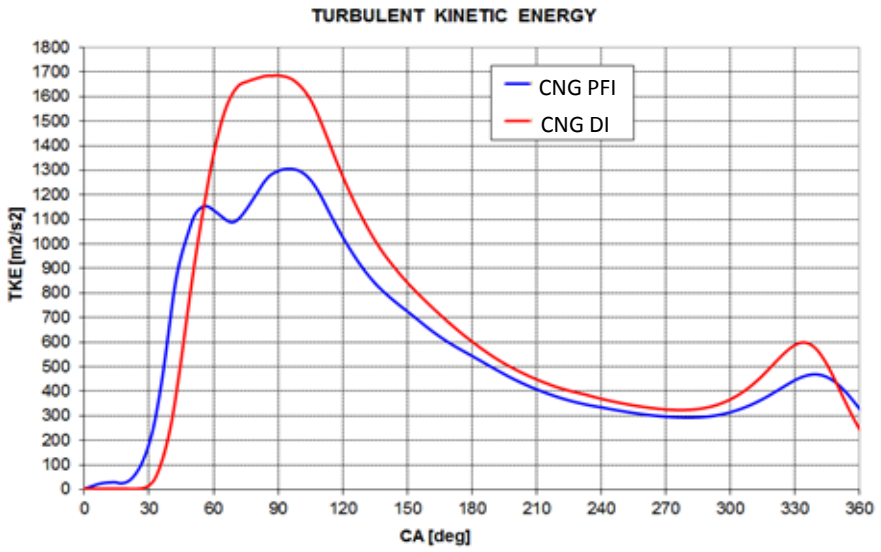


CNG DI improves engine efficiency (1/2)

1.4L 4cyl. 16v TC engine – 5000rpm full load

The side injection of CNG enables a good air/gas mixing close to spark plug before ignition……..



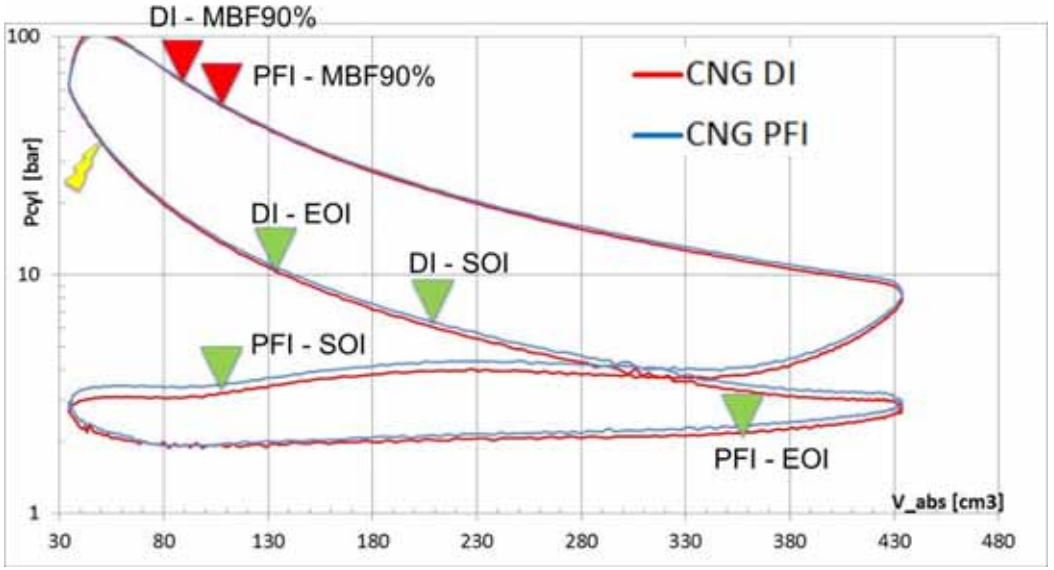


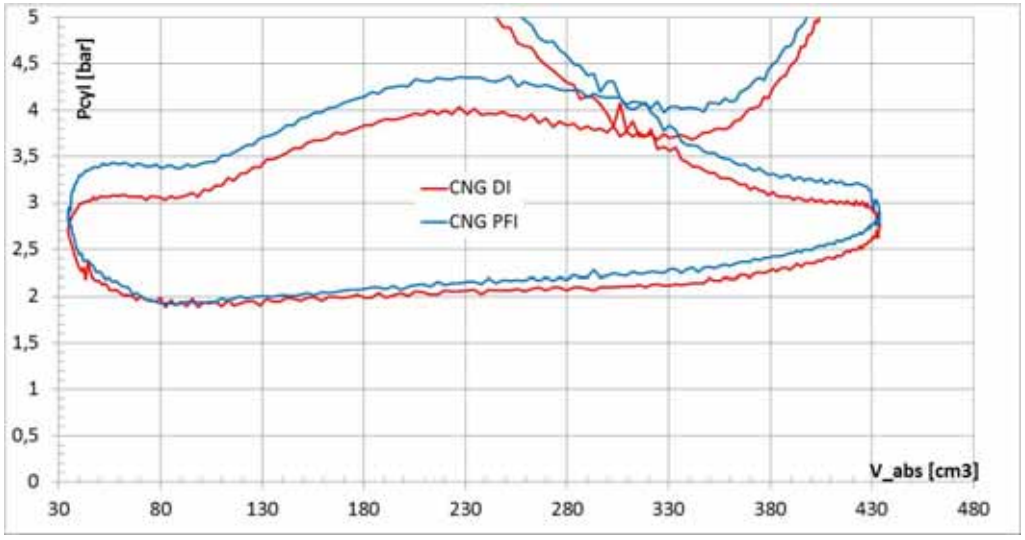
…….and influences tumble motion enhancing combustion speed

CNG DI improves engine efficiency (2/2)

1.4L 4cyl. 16v TC engine 5000rpm full load

Faster combustion leads to an exhaust gas temperature & pressure reduction





- The lower exhaust gas temp./press. reduces pumping work
- The lower pumping work enhances fuel efficiency & reduces CO2 emissions

CNG DI: EU large collaborative project

Gas-Only Internal Combustion Engines

Contract number: 652816 - **1st of May 2015 / 31st of October 2018**
Topic: H2020 GV-3-2014 Future natural gas powertrains and components for cars and vans

http://www.gason.eu/

GasOn project: objectives

In order to exploit the main benefits of CNG-powered engines, the aim is to develop CNG-only (monofuel) engines able to comply with:

- post Euro 6 noxious emissions
- 2020+ CO_2 emissions targets
- new homologation cycle and real driving conditions

with simultaneous improvement of engine efficiency & performance, adopting:

- innovative injection, ignition and boosting system concepts
- advanced exhaust gas aftertreatment system
- detecting gas-quality and composition

GasOn project: objectives towards CNG 2.0

GHG Reduction Technology	Enabling Technology	Estimated GHG Reduction Range on NEDC cycle		
		WP2 (CRF)	WP3 (Ford)	WP4 (RSA)
Downsizing and Extennal EGR benefit	Advanced Boosting	6 … 8%	10…12 %	5 … 8%
	CNG Direct Injection (CNG DI)			
Compression Ratio Increase	High Peak Pressure Capable Engine Architecture	3… 4%	1… 3%	3 … 4 %
	Variable compression ratio (VCR)	na		na
Dethrottling and/or advanced air management	Advanced Variable Valve Actuation	3…6%	2 … 3%	4 … 5%
	Charge Dilution	na	na	
CNG system weight reduction with downspeeding and further vehicle measures	Light Weight CNG Tank System	3 … 4%	5 … 7%	4 .. 6 %
	Downspeeding with longer final drive to trade performance (gained by weight reduction) against fuel economy			
	Vehicle frictions/aerodynamics	na	na	
TOTAL (Reference: 2014 Best in class CNG vehicles)		16 … 22 %	18 … 25 %	16 … 22 %

CNG 2.0 means tailored technologies (engine, fuel system and storage) all together to achieve outstanding target: **-20% CO_2** vs. current CNG solutions.

MAKING THE WORLD'S ROADS GREENER

THANK YOU FOR YOUR ATTENTION