

An Overview of International Development Programs for Gas Fuelled Vehicles

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What caused the demise of CNG in New Zealand?

- Inferior quality conversions – power loss, hard starting.
- Reduction in petrol price.
- Change of government process for grants.
- Lack of involvement of vehicle manufacturers.

Since the 90's vehicle manufacturers have been offering an increasing number of OEM gas fuelled vehicles.....



Volvo Bi-fuel 850 introduced in 1995.

Currently sells S80, S70, V70 (pictured) and S60 models in bi-fuel.

140bhp on either fuel.

250 - 300 km range on gas.

Honda Civic GX

**First OEM dedicated CNG
passenger car**



1998 for fleets.
2005 for public.
Multipoint gas injection.
12.5:1 CR.
+/- 320 km range.
ACEEE “Greenest
vehicle” 2003 - 2008.

Honda Civic GX evolution

Year	Capacity cc	Power kW	Fuel Cons ml/GGE	Technology
1998	1590	84?	28 City 34 Hway	Based on std VTEC engine Improved O2 sensors
2001	1668	73	30 City 34 Hway	
2006	1799	84	28 City 39 Hway	Variable length inlet manifold Delayed inlet valve closure i-VTEC

“Mercedes-Benz Celebrates Milestone with Citaro G CNG”

August 2010



CNG version of Citaro available since 1998.
240kW M 447(h)LAG engine.
EEV (Euro 5+) emissions compliant.

Gas vehicles now come in all sizes!

CNG Tricycle (China)

150cc single cylinder engine, 9.5kW,
22L CNG tank, 60km/h, Euro 2 compliant



VW Caddy (2009)

Biomethane or CNG

80kW (same as diesel version but with
50% less CO emissions)



and bigger ones!!

M-B NGT Sprinter (2010)

1.8L supercharged, 115kW on both gas and petrol, range 200 - 450km on gas, 1200km both fuels, Euro 5 compliant



Scania L94UB

Scania OSC9 GO1 engine, 9L, 191kW



and even bigger ones!!!

Mack TerraPro (2010)

Cummins Westport ISL G engine 320bhp
Refuse and construction applications



Peterbilt 384NG (2009)

Cummins Westport ISL G engine 320bhp



and ones that don't go on the road !!!!!

Svensk Biogas Train



Commissioned 2005.
2 Volvo engines,
210kW each.
Top speed 130km/h.
600km range.
1.08M€ development
cost.

OEMs offering gas vehicles

- Opel
- Volvo
- Mercedes
- Renault
- Fiat/IVECO
- Ford
- GM
- VW
- Honda
- Mack
- Scania
- Renault
- Peterbilt
- Kenworth
- Nissan
- MAN
- Dongfeng
- Tata

Gas engine technology evolution

- Early HD automotive gas engines used stationary gas engine technology – gas carburetors, ignition systems.
- Lean burn operation with oxidation catalyst to reduce CO and HC. Relied on lean mixture to minimise NOx.
- Suffered from inability to maintain desired A/F ratio with variations in gas composition, altitude etc.

Gas engine technology evolution

- Introduction of electronic control of fuel metering, ignition timing etc in 90s provided much more accurate control.
- New generation engines operate at stoichiometric conditions to allow use of 3 way catalyst to control CO, HC and NOx.
- With EGR, these engines can meet EPA 2010 and Euro 5 requirements.
- Latest engines can operate efficiently under a much wider range of operating conditions and gas compositions.

Cummins Westport engine evolution

Engine	Date	Technology	Emissions compliant
L10G	1989	Mechanical, lean burn, open loop, no cat	CARB
B5.9G	1995	Electronic closed loop, lean burn, oxidation cat	Euro 3
C Gas Plus	2001	Electronic closed loop, lean burn, oxidation cat	Euro 4
B Gas Plus	2002	Electronic closed loop, lean burn, oxidation cat	EPA 2007, Euro 5, EEV
ISL G	2007	Stoichiometric, cooled EGR, 3-way cat	EPA2010, Euro 5, EEV

Current automotive gas engines

Cummins Westport ISL G

8.9L , 280 - 320bhp



MAN E2866/2867

12L, 180kW N/A stoich+3
way cat

228kW turbo lean burn



New gas engine developments

Scania OC9 G04/05



9.3L. 5 cylinder.

Turbo lean burn technology.

199 - 224kW.

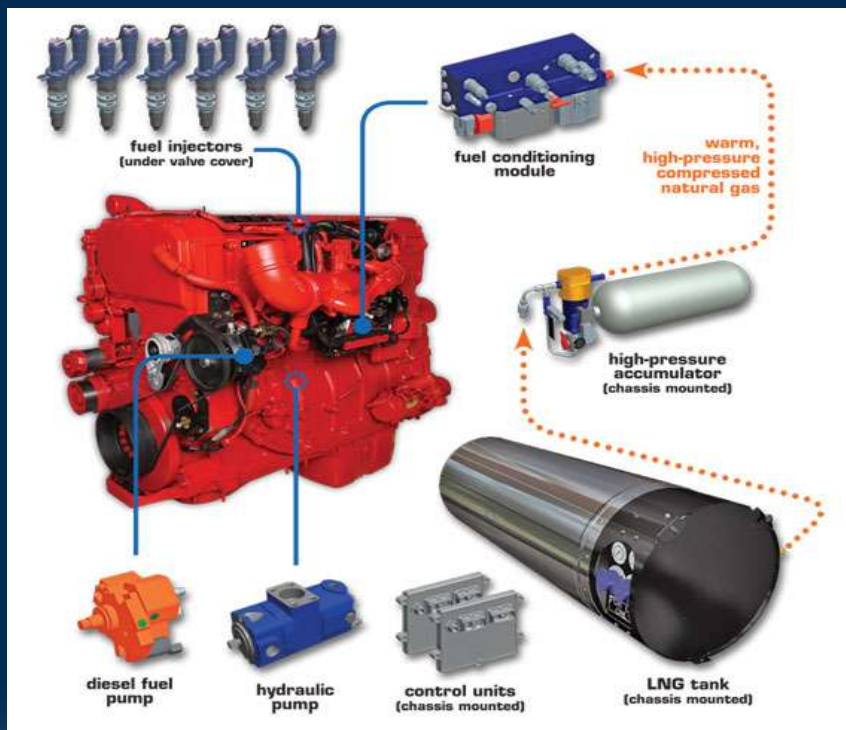
Scania engine management system controls a Bosch slave system.

Automatically adapts to gas quality.

Intended for trucks, with 640L gas capacity, and city buses, with 1,280L gas capacity.

New engine developments

Westport GX 15L



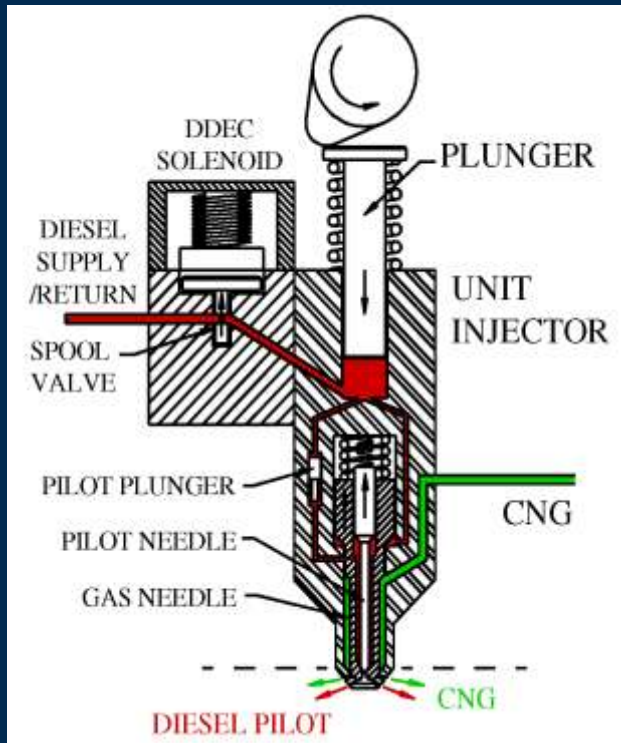
Diesel Dual Fuel (DDF) engine based on Cummins ISX.

Proprietary dual fuel injectors.

400 and 450bhp.

EPA and CARB 2010 compliant.

Westport HPDI injector



Single injector with both diesel and CNG feeds.

Diesel injected first with CNG injected a few degrees later.

Vehicle design for gas

Mercedes-Benz 170 NGT

86kW on both gas and petrol.
1000km range.

5 CNG cylinders located to minimise
loss of luggage space.



Motorsport (rallying)

OMV CNG Rally Team



Competing in CNG vehicles since 2006.

Ran Subaru Impreza and Mitsubishi Evo IX in 2009.

2nd in Austrian Rally Championship in 2009.

Motorsport (circuit racing)

“Volkswagen brings Biomethane Power to Race of Champions”

27/28 Nov 2010



VW Scirocco Cup Car.
330bhp turbocharged
direct gas injection.

Class winner at
Nürburgring 24h 2009
and 2010.

Winner of STCC team
championship 2010.