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PSA hybrid HDi Technologies

Joseph Beretta[1],Vincent Basso[2]

1PSA Peugeot Citroën, Paris Grande Armée, France, e-mail : joseph. beretta@mpsa.com
[2]PSA Peugeot Citroën, Velizy, France,

Abstract

Diesel hybrid technology is a key focus of PSA Peugeot Citroën's environmental strategy, and developing and industrializing this technology is a major challenge for the carmaker. PSA Peugeot Citroën has presented a new diesel-electric hybrid technology, the "HYbrid4" all-wheel drive train that will be fitted on certain distinctive mid-sized and executive Peugeot and Citroën models scheduled for market launch in 2011. Unveiled at the Paris Motor Show on the Peugeot Prologue and the Citroën Hypnos concept car, HYbrid4 offers an unrivalled combination of driving performance and fuel efficiency. The Peugeot Prologue family car, for example, consumes only 4.1 liters/100 km and emits 109 g/km of CO2, with the power train delivering a full 200hp.

The HYdrid4's architecture optimizes the performance of the diesel-electric drive train with a rear-mounted electric motor that drives the rear wheels, while the diesel engine runs the front wheels, providing a whole new type of all-wheel drive.

Keywords: *HEV (hybrid electric vehicle)-parallel HEV-diesel engine-passenger car-*

1 Introduction

Research and innovation constitute a major priority for PSA Peugeot Citroën. The Group continues its efforts in this domain essentially on environment and safety. To integrate better car into its environment, PSA Peugeot Citroën proposes solutions reducing CO2's emissions and assuring a high level of safety.

PSA Peugeot Citroën has identified three key ideas that underpin its contribution to sustainable development:
Introduce useful technological innovations,
Meet all economic, social and environmental responsibilities,
Maintain relations, based on ethical values and trust-based dialogue, with all partners.
PSA Peugeot Citroën has identified challenges that illustrate the responsibility of both vehicle manufacturers and the community to current and future generations:

- the greenhouse effect (environmentally-friendly innovation)
- The road safety,
- Urban mobility

PSA Peugeot Citroën: Europe's leading manufacturer of low-consumption vehicles in France with an average of 140 g/km in terms of CO^2 emissions for vehicle sales in 2007 (source ADEME). In Europe, the Group has sold one million vehicles emitting less than 140g/km of

CO², which more than 750,000 emit less than 130 g/km and 500,000 emit less than 120 g/km.

Research and innovation is focused on: Developing new vehicle concepts, notably by forging hybrid concepts and components and by re-thinking vehicle architecture.
the greenhouse effect is a priority for PSA Peugeot Citroën that has already led to substantial progress in the field of engines (HDi diesel engines, new families of gasoline engines) and which opens new roads of research for commercial development on new technologies (fuel cells, hybrids, Stop & Start, bio fuels).

2 Stop & Start (STT)

Our target is to market a lot of petrol and diesel vehicles fitted with Stop & Start systems by 2011. This system is already available for Citroën C2 and C3.
Stop & Start technology reduces fuel consumption by 8 to 15% in city driving, depending on the density of the traffic. STT, already diffused in great mass-production with benefit on Fuel & CO2 savings, better driving comfort.
For example, when vehicle is stopped with the ICE on standby you have no vibrations, no exterior noise and you reduce interior noise. The use of alternator instead of starter will guaranty an instant vehicle restart with silent and fast engine start.
The STT have also interesting performance ratio to regard cost/environment.
You could see on the following figures The CO2 benefit in real use and the technical view of 2° STT generation. You could save 15% of fuel in traffic jam.

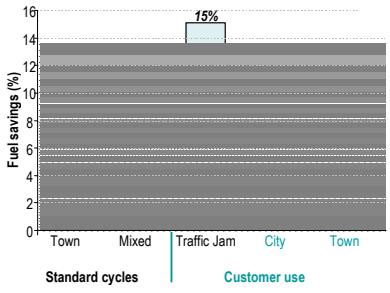

Figure1: STT fuel saving

This 2nd STT generation is fully integrate all the control algorithm are include in control engine ECU, sensor are link on can bus and power electronic include in starter generator.

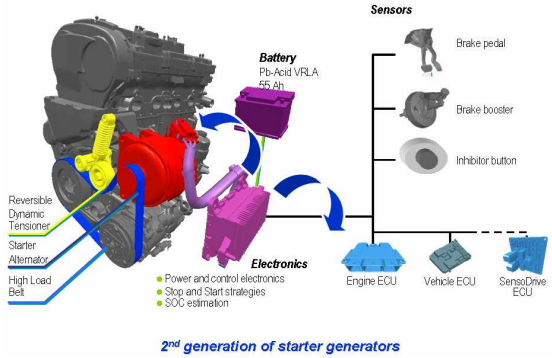

Figure2: STT component synoptic

3 Full hybrid

At the time of Mondial of Paris in October 2008, Peugeot and Citroen presented various variations of the full hybrid: HYbrid2, HYbrid3 and HYbrid4.
The Group continues its research into reducing CO² emissions, in particular in hybrid HDi which combines internal diesel combustion engines with electric drive solutions.
• PSA is indeed precursory in the field of the full hybrid Diesel. This leadership related to the capitalization of our work having made in Diesel engine and electric drive train permit to development better “own” technologies: This PSA parallel hybrid architecture makes it possible to design the electric part with just a few kW, contrary to hybrid on the market to day. If you look the optimum electric power to regard best fuel saving, is around 20kW.

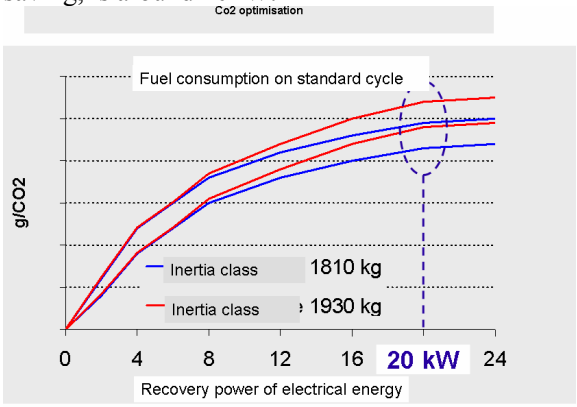

Figure3: Power of electrical motor

3.1 HYbrid2 hybrid HDI

In early 2006, PSA Peugeot Citroën presented two demonstration vehicles, each one fitted with a hybrid diesel-electric drive train, the 307 and C4 hybrid HDi. These vehicles represent a significant

step forwards in both technical and environmental terms. The performance of these vehicles marks a significant breakthrough in terms of fuel economy and CO2 emissions. Average consumption is 3.4l of diesel per 100 km for CO2 emissions of 90 g per km.

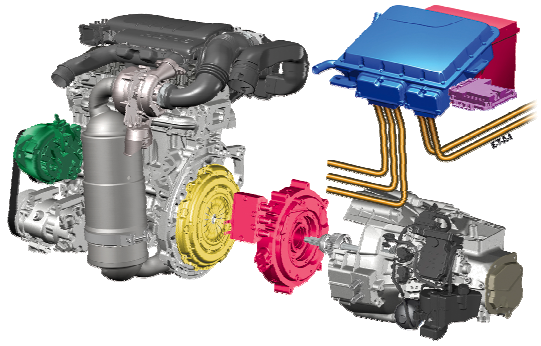

Figure4: Hybrid2 drive train

The Group's ecological policy has always consisted in offering technologies and vehicles that are accessible to the greatest number in order to produce a real environmental impact. PSA Peugeot Citroën is currently focusing on reducing the cost price of this technology.

Figure5: Hybrid2 concept cars

3.2 HYbrid4, hybrid HDI:

Now PSA Peugeot Citroën plans to bring new hybrid HDi vehicles concept to market from 2011, it is HYbrid4 technology. It was presented on "Prologue" Concept: new generation of Hybrid cross-over resulting from the interbreeding of several worlds. Anticipating the tendencies which take shape, “PROLOGUE” proposes new generation of hybrid HDI technology. This car of 147 kW (200 HP), has 109 gCO2/km in mixed cycle, even zero in full electric drive.

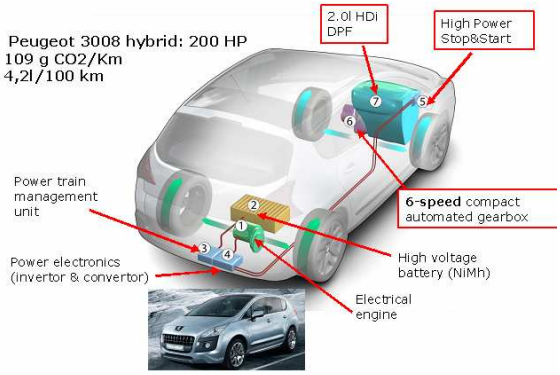

Figure6: Peugeot 3008 hybrid4

HYbrid 2 and HYbrid4: different architectures for different services

On HYbrid2, the electric machine is located between the engine and the transmission. This architecture, which was not retention device in production initially, made it possible to garner know-how in the field of the full hybrid.

On HYbrid4, the electric motor is located on the REAR axle, thus making it possible to obtain the same motricity than all wheel drive vehicle. This architecture will be marketed since 2011 on several vehicles Peugeot and Citroen. This specific parallel hybrid are more potentiality that classic parallel hybrid. This architecture will be considered like à mild series parallel hybrid; the alternator could refill the battery during vehicle operation. The advantages of this architecture are not just for customer. Putting the electric drive at the rear gives more freedom for thermal engine. The hood doesn’t change and we could apply this electric power with a minimum of modification on different platforms; all is more flexible. We use a large part of standard PSA automotive components like engine, gearbox, stop and start system.

HYbrid4 combines:

- A 2-liter HDi diesel engine with FAP particulate filter.
- A high-power Stop & Start system.
- A six-speed compact automated gearbox.
- A high-torque, high-power electric motor mounted in the rear-axle.

Concept Citroën HYPNOS
Hypnos : Hybrid HDI 200 HP (147 kW)
4,5 l/100 km , 120 g CO2/km

Concept Prologe Peugeot
147 kW (200 HP), 109 gCO2/km

Figure7: Hybrid concept cars

PSA Peugeot Citroën work with Bosch for the electric drive train, it supply the rear-axle electric motor and high-voltage alternator and the power electronic to control them.
Bosch provides also an interface between the electric and electronic components for example the antiblock braking system and specific electronic stability program that enhances energy recovery.
We use Ni-MH power batteries at first, simply because they are readily available and proven to be robust enough to work in the automotive environment. This kind of battery don't stores as much energy as lithium-ion but for this kind of parallel hybrid its gives enough performances today; in the next future it will change for lithium technologies.
Finally HYbrid4 technology gives drivers the advantages of all-wheel drive, such as increased safety under conditions of reduced grip, without any of the usual drawbacks (increased weight and higher fuel consumption). Its hybrid4 offers all the benefits of a hybrid diesel-electric drive train by delivering exceptional performance:
- The drivability and efficiency of a diesel engine in highway driving, which exceed those of a gasoline engine.
- The quiet running, zero fuel consumption and zero emissions of an electric vehicle at low speeds, especially in city driving.
- Lively acceleration thanks to the power boost from the electric motor even at low diesel engine speeds.
- Energy recovery while decelerating or braking.
- Four-wheel drive.

4 Scooter HYbrid3

HYbrid3 is a transposition of HYbrid4 technology on a scooter with 3 road wheels. This concept has one thermal engine on rear wheel and an electric motor on each front wheel.

Figure8: Peugeot motor cycle Hybrid3 scooter

5 Conclusions

(1)

To propose:
"A more ecological vehicle for each",
This strategy will offer a large range of technological solutions, around 4 major axes.

Continue to improve the thermal diesel and gasoline engines.
By 2011, the introduction of a new family of small gasoline engines 3 cylinders will make it possible to reach, on a small urban vehicle, a level of CO2emissions less than 100g/km without additional technology.

Second generation of micro hybridization (stop and start) on all gasoline and diesel since 2010. This second generation appreciably improves the energy recovery of the vehicle when it slows down and allows up to 15% of profit in CO2 downtown. Taking into account the bulks envisaged, its cost will be accessible for the greatest number.

Technology full hybrid diesel in 2011. In this new technology, electric motor is positioned on the rear axle will add to it the possibility of a 4 WD mode. Introduced initially on "distinctive" Peugeot and Citroen vehicles in 2011, it will reduce strongly consumption and CO2 emissions. In the 2nd time, when the costs of hybridization approach the acceptable economic threshold for the majority of the customers, diesel hybrid technology will be deployed on large scale.

Preparation of future ZEV (Zero emission conveys) vehicles. Precursor of the electric-powered vehicle, with 10.000 cars sold between 1995 and 2005, PSA started again its work in this field. It thus wishes to be present on a market which will develop EV, initially, through fleets and car sharing. A partnership is singe with Mitsubishi on a small urban electric vehicle base on iMiev.

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Authors

Joseph BERETTA
Since 2006: energies, technologies and automotive emissions project manager. In charge to define in this field the technical group positions.
Before 2006 he was in charge on Electro mechanic, electrochemistry, Electronic and Systems research within the Directorate of Research and Automobile Innovation. During this time, he manages many research projects in the fields of: Fuel cell, Electric Drive, Batteries, mecatronic, onboard diagnosis and electronic systems.