PRESS KIT

25 February,2013


# RENAULT'S 2014 POWER-UNIT CONSOLIDATES THE BRAND'S TECHNOLOGICAL LEAD AS POWER SUPPLIER TO THE FIA FORMULA ONE WORLD CHAMPIONSHIP

**The new regulations that the FIA (Fédération Internationale de l'Automobile) is due to introduce in 2014 will see Formula 1 enter a new era. Motor racing's premier series is on the threshold of one of the biggest technological changes in its history.**

**The objective of this metamorphosis is to ensure closer ties between the research and development carried out in F1, the concerns of everyday motorists and the new challenges faced on economic and environmental fronts, without detracting from the quality of the show or the level of competition.**

**This major technological revolution is a fresh challenge for Renault Sport F1's experts, who are developing a brand new electrified 1.6 V6 Turbo powerplant (known as a 'power unit'), which combines a significantly downsized internal combustion engine with an energy recovery system that feeds two electric motors.**

**The change fits perfectly with Renault's powertrain strategy, which is founded on:**

- **An unmatched commitment to electric motors,**
- **Ongoing improvements to the efficiency of its internal combustion engines with a view to achieving spectacular fuel consumption and $CO_2$ emissions gains.**

**Renault will defend its status as motor racing's technological leader to benefit its range of road cars. The creative thinking and passion for innovation of everyone at Renault will be major assets as it prepares for this new era.**

*"Renault's continued involvement in Formula 1 serves to showcase our technological expertise on the racetrack and also contributes to the progress of our road vehicles. In each of these areas that entails delivering the ideal balance between performance, fuel consumption and reliability.*
*For more than 35 years, F1 has helped Renault to develop its expertise in fields such as downsizing, friction reduction and cooling. With the new regulations, the use of electrical power stands to take on an increasingly important role in the development of powertrains, and that fits perfectly with Renault's strategic commitment to electric vehicles."*
*Carlos Ghosn (Chairman and CEO, Renault)*

# 01

# A REVOLUTION FOR F1 : A TECHNOLOGICAL CHALLENGE TO GET WELL AND TRULY INTO THE THIRD MILLENIUM

**“If they are to come true, dreams need technology.” Rob White, Deputy General Manager (Technical), Renault Sport F1**

**F1 is about to undergo one of the most important transformations in its history. After a seven-year period during which engine specifications were frozen, the new regulations due to come into effect in 2014 will see engine makers play a central role in the cars’ overall performance. By placing engines at the very heart of the sport once again, motor racing’s blue riband competition will stand out more than ever as a showcase for cutting edge technology.**

## WHAT WILL CHANGE

The gauntlet the FIA has thrown down to F1's engine makers for 2014 is to reduce the quantity of fuel needed for a Grand Prix by almost 40 percent, yet still maintain the same level of performance and power outputs (i.e. around 750 horsepower) as today. This change to the ground rules is poised to spark a major technological metamorphosis and a whole new challenge for the sport's engine experts.

The discussions that took place to prepare the new regulations led to the choice of a new engine technical definition.

The countdown to 2014 is already well under way as the engineers turn their attention to the development of what is termed a 'power unit' that combines a downsized turbocharged engine with two electric motors to recover braking and exhaust heat energy.

- Downsized internal combustion engine
  - Switch from a V8 to a V6 architecture
  - Cubic capacity reduced by one-third from 2.4 to 1.6 litres
  - Turbocharging (single-stage compressor), plus engine torque capped at 15,000rpm for a power output of approximately 550 horsepower
- New ‘Energy Recovery System’ (ERS): kinetic energy (ERS-K) and exhaust heat energy (ERS-H) is recovered by two electric motor-generator units named MGU-H and MGU-K.

## THE NEW RESTRICTIONS SPECIFIED BY THE 2014 FIA REGULATIONS

### A double-restriction concerning fuel

- The amount of fuel that can be used during races has been reduced : the maximum quantity of fuel that may be carried by the car during a race will be reduced to 140 litres. Energy management will become a major factor of race strategies.
- Fuel flow reduced : the maximum fuel flow rate will be reduced to 140 litres/hour, making optimisation of every gram of fuel vital for cars to go as fast as possible on a given quantity of fuel.

### A double restriction concerning the flow of electrical energy

- The amount of energy that can be recovered during each lap has been reduced
- The amount of energy that can be restored has also been reduced

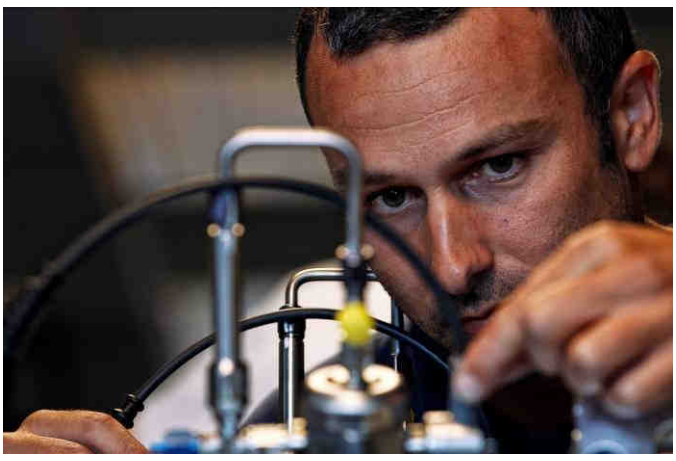
.

**Development costs have been limited and the number of engines each driver can use in the course of the season has been further capped:** five per driver in 2014, then four per driver from 2015 (compared to eight per driver at the moment). The technologies and materials employed must be similar to those used for production engines.

**Energy efficiency, the new aim in F1**

This step from a competition that has traditionally placed the emphasis on power with little consideration for fuel consumption to a new era focused on energy efficiency and reduced fuel consumption (for the same level of performance) is a real revolution for the world of F1.

As a pioneer of engine downsizing as long ago as the 1980s, Renault benefits from an extensive understanding of the turbocharged V6 architecture. Meanwhile, thanks to the electric vehicle programme it instigated in 2009, Renault also enjoys an edge in the field of electric motor technology. These are two indisputable trump cards as it prepares for the switch from normally-aspirated V8s to electrified V6 turbocharged power units.



# 02

# RENAULT, A MAJOR PLAYER IN F1'S CURRENT TECHNOLOGICAL METAMORPHOSIS

**From 2014, the powertrains used in Grand Prix racing are expected to deliver the same levels of performance as previously, while using 40 percent less fuel. These changes mean that Formula 1 will recover one of the ingredients that helped to forge its popularity, namely research by car manufacturers into increasingly competitive and more modern technologies, which explains Renault's commitment to this highly specific sport as a supplier of engines.**

***"Renault saw assuming the lead in the orientation of the new rules as an opportunity to lay down the foundations for the future – with engine technology at their heart. The reconciliation between F1 and the world of mass production is geared to the efficient use of energy, which itself will be dependent on engine technology." Jean-Michel Jalinier (President and Managing Director, Renault Sport F1)***

## Renault a technological leader on the race track

Having powered Red Bull Racing to three straight Drivers' and Constructors' world title doubles in 2010, 2011 and 2012, Renault is the only volume car manufacturer to have proved itself capable of competing on equal terms with, and defeating, the specialist carmakers on the race track, notching up a score of 11 Constructors' crowns (either as an engine supplier or as a team in its own right), 151 victories and 202 pole positions in the process.

Today, Renault stands out as one of the discipline's key players. Four teams have been using its engines* and, more than ever, its expertise as an engine manufacturer comes to the fore as it rises to the challenge of the 2014 regulations. The skills and talents of Renault Sport F1's engine specialists are being channelled towards this new mission and prototypes of the Renault power unit are already being run on the test benches at the factory in Viry-Châtillon.

*Infiniti Red Bull Racing, Lotus F1 Team, Williams F1 Team and Caterham F1 Team


**1980s : 1500cc**


**1990s : 3500 cc**
**2000s : 3000 cc**


**From 2006 : 2400cc**

In this technological race, Renault has always led the way, and its willingness to take risks and push back boundaries has frequently reaped dividends in the long-term. One need only think back to how Renault made turbo engines the norm in the 1980s. Then, in the 1990s, Renault introduced the V10 powerplant that won the championship six years in a row between 1992 and 1997. The noughties saw Renault innovate yet again with an open-angled V10 followed by a V8 (the RS27, which revved to almost 20,000rpm) which claimed the title out of the box in 2006.

## Renault, a major player in F1's transformation

Renault contributed significantly to the establishment of the new regulations through its participation in the different working groups set up by the FIA since 2009.

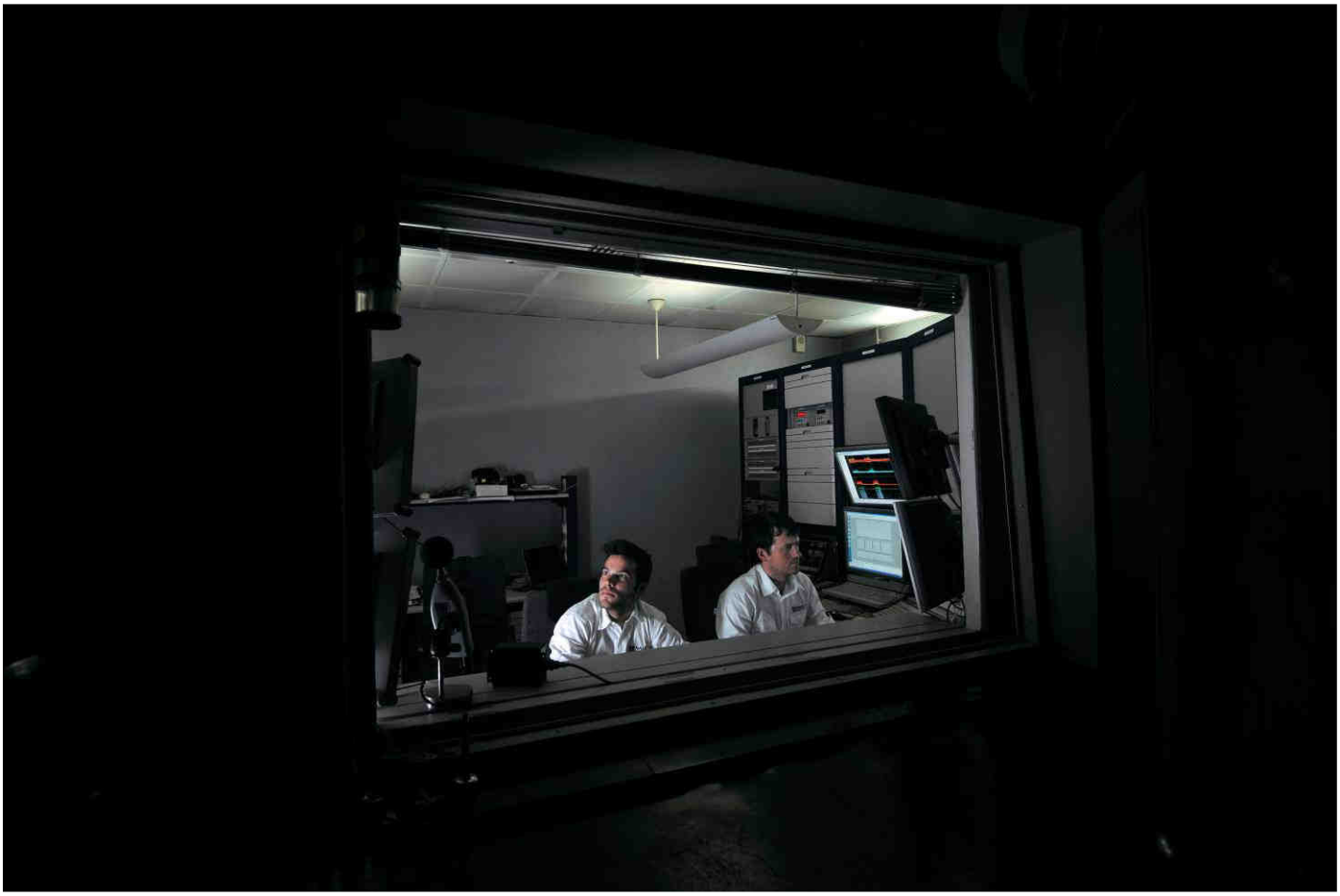
*"At the time, there was a perceived distance and lack of consistency between the technology employed in F1 and that used for mass production vehicles, from both the economic and environmental angles. It was therefore necessary for F1 to undergo a significant change in order to reconcile these two realities." Rob White, Technical Director, Renault Sport F1.*

In order to continue competing in F1, Renault was adamant that the discipline should recover the reputation it enjoyed as a technological pioneer before the engine freeze regulations came into force in 2007. During these group consultations, Renault proposed that the race engines' specification should be based on 'road relevant' criteria, with energy efficiency as the number one priority. The watchwords of this shift towards engines that are also closer to the technology used by mass production vehicles were downsizing, supercharging, an upper limit on engine speeds and the controlling of costs to stay close to production technologies. Energy efficiency emerged naturally as the key consideration.

**The four cornerstones put forward by Renault to the FIA:**

- Road relevant: F1 needed to be closer to mass production vehicles and become a technological bridgehead => INNOVATION
- A more entertaining show: more overtaking was needed to make the sport more entertaining ==> the performance level of F1 cars therefore needed to be maintained, along with overtaking opportunities ==> PERFORMANCE
- Energy efficiency: taking environmental realities into account by reducing energy consumption and $CO_2$ emissions has become vital ==> ENERGY CONSUMPTION AND MANAGEMENT
- Keeping costs under control: the 2014 power unit must continue the existing cost-cutting trend seen in F1, notably by reducing the number of engines a driver can use in the course of a season to just five and, eventually, four (as opposed to eight at the moment) ==> RELIABILITY AND ROBUSTNESS

In addition to being among the first ones to propose the concept of downsized engines to the FIA, Renault actively campaigned for the new regulations to incorporate more electrification, a technology of the future in which the company stands out as a pioneer in the realm of road vehicles and also one in which it has made significant progress in F1. The teams at Renault Sport F1 were between the first on the grid to introduce KERS in 2009. Their experience of energy management also led to Renault using their expertise to develop the motor for Twizy on the test benches at Viry-Châtillon.

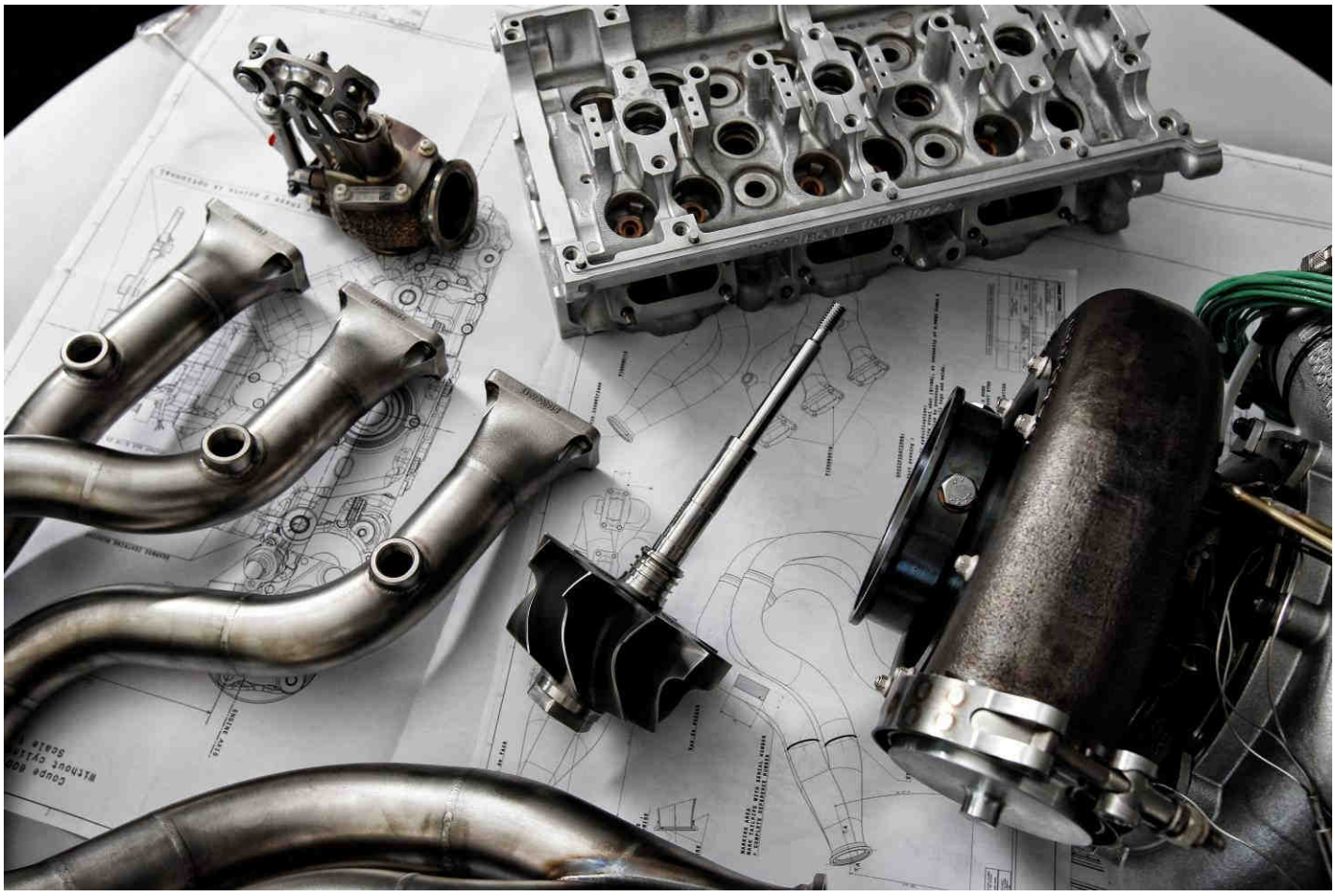


# 03

# FROM THE CURRENT V8 ENGINE TO THE 2014 POWER UNIT

**Formula 1 cars will consequently use so-called power units from 2014. These new power units will feature a combination of an internal combustion engine and two electric motors.**

***"The next F1 engine will be a turbocharged 1.6-litre V6 combined with a double energy recovery system. At Renault Sport F1, we fostered our knowledge of energy management through our first experience with KERS some years ago already. Thanks to this, the current step to electrification was relatively straightforward."*** **Pierre-Jean Tardy (2014 Power-Unit Project Manager)**

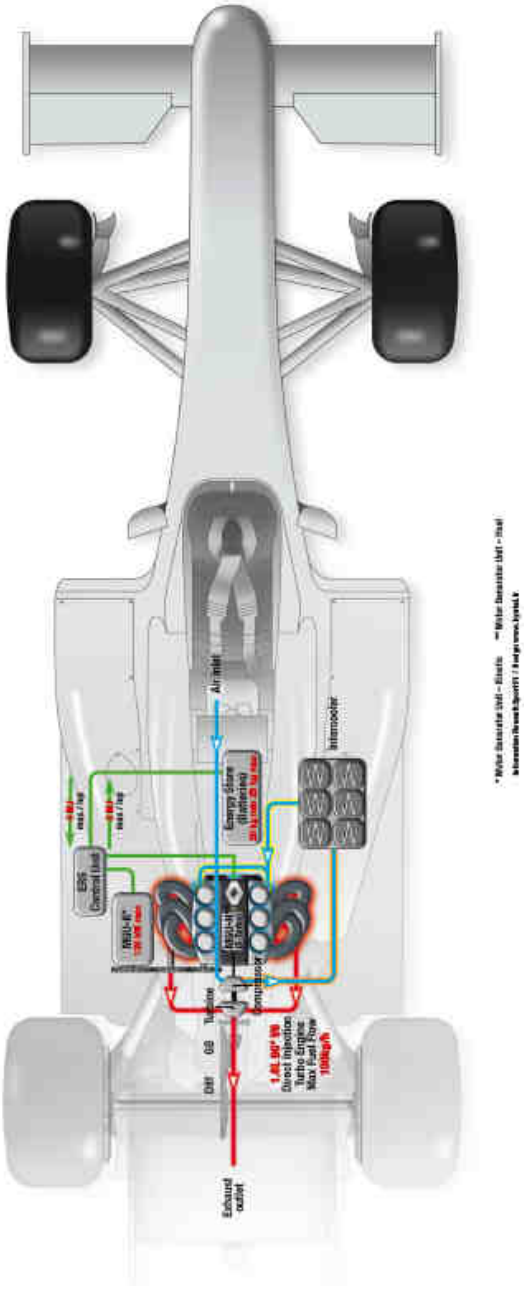


.

## Main technical data

| | MOTEUR V8 RS27 | POWER UNIT V6 |
|---|---|---|
| Characteristics | V8 90° degrees | V6 Turbo 90°degrees with 2 electric engines |
| Cubic Capacity | 2400 cc | 1600 cc |
| Number of valves | 32 | 24 |
| Weight | 95kg | 155kg (not including energy accumulator) |
| Maximum engine speed | 18,000 rpm | 15,000 rpm |
| Air intake | Normally aspirated | Single-stage turbocharger |
| Exhaust | Two exhausts | Single exhaust (exiting through the engine cover) |
| Fuel Injection | Indirect | Direct |
| Power output of the Internal Combustion Engine | >750 horsepower | > 600 horsepower |
| Amount of fuel authorised per race | No uper limit | 100kg |
| Maximum fuel flow | No uper limit | Max 100 kg /h |
| Power output from the Energy Recovering System | KERS : 80 horsepower, for a duration of 6 seconds every lapr | ERS-H + ERS-K : 160 horsepower available for a 5 times larger duration every lap |

Power Unit = Engine + ERS (Energy Recovery System)



**Energy is never lost; it is merely converted into another form**

The efficiency of a conventional internal combustion engine is approximately between 25 and 30 percent in optimal conditions of use. This means that 70 percent of the energy provided by the fuel combustion is lost in the form of heat, either via the car's radiators (exchange of heat between the engine block and the cooling fluids) or, more significantly, via the exhaust gases.

“Improving the energy efficiency of an engine entails transmitting as much of the energy produced as possible to the wheels mechanically and re-using as much of the energy resulting from the fuel’s combustion as possible. The aim of the new regulations is effectively to increase combustion efficiency thanks to the combination of downsizing, turbocharging and the recovery of the energy contained in exhaust heat (ERS-H) and lost as heat under braking (ERS-K) and then re-using this energy as electricity.” Rob White (Deputy General Manager and Technical Director, Renault Sport F1)

**Downsizing and turbocharging**

Turbocharging enables a high proportion of the power to be recovered despite the lower maximum revs limit and the smaller cubic capacity which have a direct impact on the air that flows into the engine.
To compensate for the smaller cubic capacity, turbocharging permits the recovery of some of the energy wasted as heat in the exhaust gases to drive the turbo. This energy is then used to compress the intake air (compressor) and increase the pressure inside the cylinders. However, the efficiency of the turbo produces more energy than is necessary to compress the intake air. So, to clear this excessive energy and prevent the turbo from spinning too fast, all turbocharged engines are equipped with a waste gate.

- **Direct fuel Injection**

Direct fuel injection permits accurate control of the form and rate of the fuel spray inside the cylinders and not inside the intake manifolds as is the case with indirect injection.

- **Electrification and double energy recovery system:**

  - **An unprecedented exhaust heat energy recovery system:**

The considerable energy contained in exhaust gases as they exit an engine equates to almost 55 percent of the energy provided by the fuel (see "Energy is never lost…" sidebar). This is a huge loss. In the case of the 2014 power unit, however, the motor-generator unit (MGU-H) mounted on the turbo will permit a proportion of this otherwise wasted thermal energy (eliminated via a 'waste gate') to be recovered and converted into electricity. This electricity is then stored in the battery or used by the other motor-generator unit (MGU-K) to drive the car. This system will allow the MGU-K to be used for practically an entire lap. This system is known as ERS-H (Energy Recovery System - Heat).

A second valuable function of it is to drive the (big) turbo after a period of braking, thereby avoiding the phenomenon of lag (which can last several seconds) before the torque 'requested' by the driver is delivered by the (small) V6 engine.

  - **An ERS-K (Energy Recovery System – Kinetic) twice as powerful as today's KERS and capable of releasing stored energy for 34 seconds per lap**

Under braking, the kinetic energy of a racecar is dissipated by the brakes in the form of heat. The regulations allow a proportion of this energy to be transformed into electricity via the MGU-K motor-generator unit connected to the crankshaft of the internal combustion engine.
This motor-generator unit will be capable of recovering 2MJ (Mega Joules) and delivering 4MJ per lap, which equates to a use for approximately 34 seconds per lap (as opposed to 6.5s/lap in the case of today's KERS).

The MGU-K will be capable of delivering peak power of 120 kilowatts (more than 160 horsepower). This system is known as ERS-K (Energy Recovery System – Kinetic).

Recovering this thermal and kinetic energy will not lead to an increase in the amount of fuel consumed. It will truly be a 'free' energy supply.

**‘Compound’ engines**

The principle of recovering energy by placing a turbine in the exhaust line of a reciprocating engine and transmitting this energy to the crankshaft is not new. It was even used prior to World War 2 on certain airplane engines and a mechanical form was developed for trucks. The process is known as a ‘compound’ engine.
The advantage of an electric turbo-compound solution is that it enables the released energy to be controlled in real time in order to use it when and where it is really necessary. Depending on the need of the moment, it can be transmitted to the crankshaft, employed to maintain the speed of the turbine (and thereby reduce inertia during the transient phase), or quite simply stored in the battery until required.

**The innovations featured on Renault’s power unit:**

This 2014 power unit, its turbo, two electric motor-generators, battery and electronic control unit calls for a highly sophisticated system to manage the energy and power that is available to the driver.

The principle of recovering braking energy and releasing it via the MGU-K (120kW) is similar to the KERS currently used in F1. However, the recovery of exhaust gas energy is new and it is this combination of two systems which makes the power unit so innovative and consequently an accelerator of progress in the realm of engine energy efficiency

# 04

# THE 2014 F1 REGULATIONS: AN INNOVATION ACCELERATOR FOR RENAULT

**Thanks to the regulations the FIA has produced for 2014, there will be far more parallels between Formula 1 and production cars. These regulations will enable the engine specialists to speed up progress in the following domains:**

- **Downsizing and supercharging**
- **Electrification (the proportion of electrical energy will become more preponderant in the cars' performance)**
- **Energy efficiency and electrical energy management strategies to optimise how available energy is used to go the fastest possible.**

**The bridges and dialogue that exist between the race engine specialists and their counterparts who work on Renault's road cars stand out as major assets for the company. This arrangement enables Renault to constantly improve the energy efficiency and performance of both its race and production engines.**

**Formula 1: a hi-tech laboratory for Renault**

In 2010 Renault reaffirmed its commitment to Formula 1 by refocusing its efforts on its preferred activity and core area of expertise, namely the design and development of engines for use by different teams. Renault's return to the world championship was a sign of just how important this discipline was to the brand. In addition to being a formidable springboard for the promotion of its image worldwide, the tip of international motor racing's pyramid serves as a perfect laboratory for Renault for the development and testing of new technologies in extreme conditions.

**Breakthroughs in F1 feed production vehicles, and vice-versa**:

At Renault, the bridges between the worlds of F1 and mass production are a reality. The close collaboration that exists between the race engine specialists and their production engine colleagues, as well as the one-off projects that involve both parties, are a definite plus that allow breakthroughs in F1 to benefit road going engines, and vice-versa. The values of this collaboration are speed of response, flexibility and the pooling of expertise.

This approach enables Renault to constantly improve the energy efficiency of both its race and road going engines in many different ways:

1/ The speed at which developments occur in F1 and the analytical skills of Renault's race engine specialists enable the company to explore new technical solutions in extreme conditions. Competing with specialist makes on the racetrack also provides Renault, as a volume manufacturer, with a unique grasp of cutting-edge engine architectures

2/ The wide variety of skills available across Renault is a major advantage that is also beneficial to Renault Sport F1. For example, Renault Sport F1 makes intensive use of Renault's materials laboratory, as well tools like the scanning electron microscope.

3/ To work on the 2014 power unit, 30 of Renault's most talented engineers were deployed to work with Renault Sport F1's own teams from the very beginning of the project.

4/ Viry-Châtillon's resources are also used for production-related projects. Twizy's motor, for example, was developed on the test benches at Renault Sport F1.

**Energy engines: Renault's technological excellence in F1 for the benefit of all motorists**

Renault's excellence on the racetrack has already found its way into the specification of its production engines. A prime example is the latest generation of Energy engines that have benefitted from the input of skilled specialists from the world of Formula 1. Philippe Coblence and Jean-Philippe Mercier, two of the men behind the success of the Renault V10 in the 1990s, were respectively responsible for the development engineering work on the Energy dCi 130 diesel engine, the modular Energy TCe 90 (three cylinders, turbocharged), the Energy TCe 115 and the Energy TCe 130 (four cylinders, turbocharged, direct fuel injection). The two former heads of Viry-Châtillon's design office brought their expertise to the table to take downsizing to new limits thanks to technical solutions and processes brought with them from F1. Energy engines boast an unprecedented technological package for their level of range and, compared with their predecessors, deliver combined-cycle fuel savings of up to 25 percent for the vehicles they power.

# 05

# APPENDIX

## INTERVIEW WITH GASPAR GASCON

**Powertrain Engineering Director, Renault**

**What features are shared by Renault's F1 and production engines?**

I would say three things: their DNA, the technology they use to a certain extent and, last but not least, the human and professional skills which go into them.

Above all, Renault's F1 and production engines share the same genes. Whether they are designed to power road going vehicles or to drive single-seater F1 race cars, Renault engines share the same DNA in three areas, namely:

**1/ Power**:

- In F1, the Renault RS27 delivers more than 750hp. It is acclaimed for its performance and will power one-third of the cars on the grid in 2013.
- Production Renault engines boast a specific power output that is among the very best for an engine made by a volume manufacturer.

**2/ Fuel consumption**:

- - In F1, weight is public enemy number one. Low fuel consumption is clearly an advantage since it means you can carry less fuel, and that makes the car lighter and therefore faster. Renault's F1 engines are reputed for their energy efficiency.
- - Meanwhile, Renault's production engines are among the very best in terms of their low $CO_2$ emissions for their cubic capacity. For example, New Clio Energy dCi 90's fuel consumption of 3.2 litres/100km and $CO_2$ emissions of 83g/km allows it to rival with the best hybrid cars.

**3/ Robustness:**

- Performance serves no purpose if it doesn't go hand-in-hand with reliability. With a score of 11 F1 Constructors' titles to its name, Renault has demonstrated the robustness of its race engines. The 2014 FIA regulations mean that engines will need to cover twice the distance as before.
- The reliability of Renault's production engines is recognised by the surveys carried out by independent bodies like ADAC, as well as by our partners, including Daimler which organised an intensive test programme for our 110HP 1.5 dCi engine that now powers the new A-Class.

In addition to their shared genes, production engines also benefit from technologies that come directly from F1, including:
The use of aluminium to bring down weight (ENERGY TCe),
Cooling system (ENERGY dCi 130),
U-Flex piston rings (ENERGY dCi 130),
Reduced friction thanks to DLC (diamond like carbon) technology (ENERGY TCe and dCi),
Downsizing (ENERGY TCe and dCi).

Last but not least, and this is one of Renault's chief strengths, production engines benefit from the expertise of the staff who work in F1, and vice-versa:
- The design office responsible for the ENERGY dCi 130 engine was led by Philippe Coblence who enjoyed a long career at Viry-Châtillon.
- The design office responsible for the ENERGY TCe 115,130 and ENERGY TCe 90 petrol engines was overseen by Jean-Philippe Mercier, who came from Viry-Châtillon and who has now returned to supervise the downsizing of the forthcoming F1 power unit.

Thanks to these shared genes, technologies and skills, our savoir-faire in the field of production engines is acclaimed just as much as our expertise in F1.

## A CHAMPION OF THE TRANSFER OF TECHNOLOGY

## Jean-Philippe Mercier: “What goes around comes around!”

**Powertrain engineering Director, Renault Sport F1**

A pool of about 30 Renault engine engineers has been despatched to help the team at Viry-Châtillon by contributing their experience of production engines to the development of the 2014 power unit. Their numbers included Jean-Philippe Mercier, former design office manager in the days of the V10 and also one of the genitors of the Energy TCe range of production engines which notably power New Clio.

"Direct injection is about to arrive in F1 but I’m not sure how many people realise that it is Viry-Châtillon that developed the first Renault engine – and the first European engine – to be equipped with direct fuel injection, at the end of the 1990s,” he relates. “That engine was known as the ‘IDe’ and was entirely designed by Renault Sport F1. I have learnt a great deal from my experience of downsizing for production cars with the Energy TCe engines. Total production of F1 engines, which comprise something like 2,000 precision components, is limited to a few hundred units, whereas a production engine is made up of just 250 or so parts but 100,000 of them may be made annually. The challenge is the same in both cases and involves seeking the best possible compromise between performance, energy efficiency and reliability.

“I am now back at Renault Sport F1 to work on the F1 power unit for 2014. Hopefully, my experience of downsizing engines for road cars will benefit this new electrified V6 1.6 Turbo that takes its inspiration from solutions tried on production engines. What goes around comes around.”

## AVENUES OF RESEARCH FOR PETROL ENGINES

### Improving energy efficiency

The challenge faced by petrol engines chiefly concerns reducing their $CO_2$ emissions and thereby improving their efficiency thanks to the following techniques:

- Downsizing with no loss of performance. The solution of a smaller cubic capacity combined with a turbocharger offers the greatest potential for bringing down fuel consumption.
- Direct injection. The direct injection of fuel into the combustion chamber permits fuel consumption savings of between 10 and 15 percent.
- Variable valve timing. Although the fuel consumption savings permitted by this technology do not exceed around 10 percent, it is a valuable solution when combined with other technologies like downsizing and direct injection.

### The ascendance of electronic control systems

Electronic control systems play an increasingly important role (high-performance control units, algorithms which incorporate more and more physical models, virtual sensors, etc.) when it comes to improving powertrain performance (conventional internal combustion engines and electric motors) and reducing energy consumption. Advanced equipment and software optimise control of the entire driveline in all situations to ensure that vehicles are enjoyable to drive, reliable, energy-efficient (low $CO_2$ emissions), while minimising pollutants, noise, etc.

The new F1 regulations mean that race engines will need to meet the same demands.

**Press office contact:** Telephone : +33 1 76 84 63 36 - Internet : www.media.renault.com – www.renault.com