Press Information

Porsche e-hybrid

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October 2014

The Porsche models with plug-in hybrid technology

Greatest possible efficiency and performance, plus an electric driving experience

The Porsche Cayenne S E-Hybrid is the first vehicle in the premium SUV market segment with plug-in hybrid drive. It makes the company the only manufacturer in the world to offer three vehicles with this drive system technology. Providing typical Porsche performance, they combine top efficiency with zero local emissions.

Cayenne S E-Hybrid	Parallel full hybrid with plug-in technology, supercharged three-litre V6 engine and synchronous electric motor with a total system output of 416 hp (306 kW); eight-speed Tiptronic S; permanent all-wheel drive; acceleration from nought to 100 km/h in 5.9 seconds; top speed of 243 km/h; electric top speed of 125 km/h; fuel consumption of 3.4 l/100 km; 79 g/km CO_2; 18–36 km electric range; 10.8 kWh lithium-ion battery.
Panamera S E-Hybrid	Parallel full hybrid with plug-in technology, supercharged three-litre V6 engine and synchronous electric motor with a total system output of 416 hp (306 kW); eight-speed Tiptronic S; rear-wheel drive; acceleration from nought to 100 km/h in 5.5 seconds; top speed of 270 km/h; electric top speed of 135 km/h; fuel consumption of 3.1 l/100 km; 71 g/km CO_2; 18–36 km electric range; 9.4 kWh lithium-ion battery.
918 Spyder	Parallel full hybrid with plug-in technology, mid-mounted 4.6-litre V8 engine and two synchronous electric motors with a total system output of 887 hp (652 kW); seven-speed dual clutch gearbox (PDK); electric all-wheel drive; acceleration from nought to 100 km/h in 2.6 seconds; top speed of 345 km/h; electric top speed of 150 km/h; fuel consumption of 3.1–3.0 l/100 km; 72–70 g/km CO_2; 16–31 km electric range; 6.8 kWh lithium-ion battery.

Porsche and Michelin: A strategic partnership focussed on performance

Michelin has been the strategic tyre partner of Porsche since 2002 and this relationship has led to the development of bespoke high performance tyres which offer Porsche owners an enhanced driving experience. Prime examples of the fruit of this partnership are the Michelin Pilot Super Sport as fitted to the Panamera S E-Hybrid, the Michelin Latitude Sport which is fitted to the Cayenne S E-Hybrid and the Michelin Pilot Sport Cup 2, which is the sole fitment on the 918 Spyder.

All of these tyres offer different performance characteristics relevant to the vehicle they are designed for but in these cases they focus particularly on environmental performance, in addition to safety, handling precision, comfort and longevity. This performance is clearly shown by the Pilot Sport Cup 2 tyres fitted to the 918 Spyder as they reduce rolling resistance to help conserve battery life and reduce CO_2 emissions in addition to offering excellent grip and handling at very high speed, as demonstrated by the world record lap time set at the Nurburgring. This ability to offer different performance characteristics in the same tyre is known as Michelin Total Performance.

Plug-in hybrid technology from Porsche

Outstanding efficiency, low emissions and driving fun

The Cayenne S E-Hybrid is the first plug-in hybrid in the premium SUV segment. It is thus a world first not only within the Porsche model range but beyond it as well, setting new standards among luxurious all-wheel drive vehicles. At the same time it is a further milestone in Porsche‘s hybrid strategy. Together with the Panamera S E-Hybrid and 918 Spyder, the company now offers three models with plug-in hybrid technology; the only premium manufacturer to do so anywhere in the world. They combine all-electric driving over relatively long distances with the benefits of modern, low-consumption internal combustion engines with no concerns about range. The key plus points: outstanding efficiency and thus low emissions. With typical Porsche driving performance still provided by all three models.

On its record run on the Nürburgring in September 2013, the 918 Spyder impressively demonstrated that through hybrid technology even super sports cars are able to reach new dimensions of performance and in terms of driving dynamics and efficiency can clearly leave conventional drive systems behind.

Part of the fun of driving all three plug-in models lies in the two drive systems‘ intelligent interplay, in which their respective advantages complement each other. The electric motor, for instance, is already deploying its full torque as the vehicle pulls away. The almost silent acceleration makes the powerful start seem even more impressive. And when driving using the internal combustion engine, the e-motor‘s power can be drawn on to provide additional assistance – a boost – at any time.

Common to all three models is a drive system set-up featuring a rear-wheel emphasis with sporty orientation. While the Panamera S E-Hybrid deploys its power wholly to the rear axle in the style of a classic Gran Turismo, the other two vehicles have all-wheel drive. The Cayenne S E-Hybrid offers permanent all-wheel drive with a self-locking centre differential. The 918 Spyder has a unique all-wheel concept with a combined drive system consisting of internal combustion engine and electric motor serving the rear axle and a second electric motor providing power to the front axle. The latter is automatically disengaged when the car‘s speed reaches 265 km/h.

In engineering terms, the vehicles are parallel full hybrids: an electric motor and an internal combustion engine act jointly on the power train and in at least one operating state the power or torque outputs of the individual drive systems are simultaneously available. It is also possible to drive in all-electric mode.

In the case of all three vehicles the electric motors‘ high level of power output and the large battery capacity extend the electric driving mode‘s possibilities considerably. For example, via the range: depending on driving style and the demands of the route, the Cayenne S E-Hybrid and Panamera S E-Hybrid make it possible to drive in all-electric mode for a distance of 18 to 36 kilometres. At 16 to 31 kilometres, the 918 Spyder does almost equally as well. In addition, the maximum speed achievable when driving in all-electric mode increases compared to the previous models of the Cayenne and Panamera without plug-in technology. The Cayenne S E-Hybrid reaches 125 km/h and the Panamera S E-Hybrid 135 km/h. The 918 Spyder, meanwhile, reaches as high as 150 km/h. Benefits are also produced by the electric motor‘s much more powerful assistance, the so-called boost, during full acceleration.

Then there is also the charging technology. In the case of all three vehicles the high-voltage battery can be charged at any time. Either via connection to the mains (plug-in) or electively while driving via the internal combustion engine.

The Cayenne S E-Hybrid and Panamera S E-Hybrid‘s drive system concepts are closely related and geared to everyday use of a sports utility vehicle (SUV) and Gran Turismo. The 918 Spyder has a concept specially tuned to a super sports car. Via its electric motor driving the front axle and thus providing for front-wheel drive that can be individually controlled, the car‘s unique drive system layout offers new driving strategies for extremely high and safe cornering speeds. It thus leaves previous technological limits behind it and thrusts forward into whole new areas of driving dynamics and sporty motoring.

Regardless of the vehicle concept: the developers of the different Porsche models work together and constantly draw on all the company‘s pooled know-how on every aspect of hybrid concepts, electric drive systems and plug-in technology. This knowledge pool includes, for example, the latest updates in relation to the core competences of electric motor design, battery technology, performance electronics and software management. All divisions thus benefit from the primary work done in the different departments and solutions are produced that are optimised precisely for a specific model.

Also encompassed by this extensive pool of knowledge is the high technology of the Porsche 919 Hybrid, the LMP1-class racing car, with which Porsche participates in the World Endurance Championship (WEC). It is a mobile research lab for the ongoing development of hybrid technology, aiming at achieving top vehicle dynamics and efficiency. It makes available extensive findings gained from what are probably the most extreme conditions in motorsport, which can also be incorporated into production vehicles – in fact, just as the standard practice at Porsche has always been.

Great hybrid expertise at Porsche

Porsche began in 2010 with two parallel full hybrid vehicles: the Cayenne S Hybrid and Panamera S Hybrid. As role models in matters of efficiency and driving performance, these models have already won over customers around the globe: one year after its launch in 2011, for example, the sales figures for the Cayenne S Hybrid were already more than twice as high as those of the company‘s rivals in this market segment put together. The technology‘s further development as the plug-in hybrid celebrated its world premiere in 2013 in the Panamera S E-Hybrid and cancelled out the apparent dichotomy between efficiency and performance even more clearly. The Cayenne S E-Hybrid continues systematically along this path.

The full hybrid as a plug-in with high electric range, a powerful electric motor and a very efficient internal combustion engine also ranks as a pioneering concept for high-performance vehicles, as has, for instance, been realised in the plug-in hybrid super sports car, the 918 Spyder. This car, in turn, benefits from findings that Porsche has accumulated using the successful 911 GT3 R Hybrid in racing. It also appeared in 2010 and was the first 911 with an additional, individually controllable electric motor serving the front axle. Its hybrid concept: a rotating electromechanical flywheel acts as a storage unit for the brake energy, which when the vehicle brakes gets converted into electrical power by the e-motors working as generators. In order to translate this energy stored in the flywheel back into forward propulsion all that is needed is the flip of a switch alongside the steering wheel. With lightning speed the kinetic energy of the rotating flywheel mass is converted into electric power and fed to the two 60 kW (82 hp) e-motors linked to the front axle – for a maximum six seconds of boost.

There's no doubt about it: future generations of Porsche sports car will profit from the 911 GT3 R Hybrid, 918 Spyder and 919 Hybrid. And via each vehicle, whether sports car, saloon or SUV, a pioneering achievement is being repeated after more than 110 years. The world's first hybrid vehicle came from Porsche: the Lohner-Porsche 'Mixte' from 1899, designed by Ferdinand Porsche, combines a battery-powered electric drive system with an internal combustion engine. It is regarded as the first ever hybrid car to be built on a full production basis.

Porsche Cayenne S E-Hybrid

Sports utility vehicle with plug-in hybrid and all-wheel drive

The Cayenne S E-Hybrid is the first plug-in hybrid in the luxury SUV segment. In addition to the internal combustion engine as the main source of propulsion, the most important components are an electric motor integrated into the power train, the powerful lithium-ion battery and the plug-in technology. Another key element is the disengagement clutch between internal combustion engine and electric motor. It works so smoothly that driver and occupants do not notice the internal combustion engine being engaged and disengaged.

With the internal combustion engine switched off, it starts whenever the driver wishes: if he or she consciously exceeds the noticeable pressure point when pushing down on the accelerator pedal, the engine starts up instantly, comes immediately up to speed, the disengagement clutch closes and the full accelerating force of both motors is available to the driver without practically any delay.

In the Cayenne S E-Hybrid the drive system concept has been further developed and optimised for use in an SUV. Two important differences are a high-voltage battery with a greater energy capacity of 10.8 kWh (Panamera S E-Hybrid: 9.4 kWh) and, offered as an optional extra for the Cayenne S E-Hybrid, a charger with a higher power level of 7.2 kW. This gives total flexibility: if it is connected to the domestic mains, it works like the standard charger in 3.6-kW mode and fully charges the battery in around three and a half hours. If you plug it into a high-voltage connection, it works in 7.2-kW mode and has the battery fully charged in under 90 minutes.

The lithium-ion battery‘s case is identical to the one in the Panamera S E-Hybrid – this is part of Porsche‘s modular strategy and geared to enabling the use of components across multiple model generations. However, via new cells with a greater capacity of 28 Ah each (in the Panamera S E-Hybrid: 24 Ah) the high-voltage battery benefits from the latest advances in rechargeable battery technology and its greater capacity helps the Cayenne to achieve an identical electric range of 18 to 36 kilometres, depending on driving style and topography. The improved battery thus compensates, for example, for the greater weight and driving resistance levels of the Cayenne compared to the Panamera.

A direct comparison of the Cayenne S E-Hybrid with its predecessor, the Cayenne S Hybrid, underlines the progress. The previous vehicle had a nickel-metal hydride battery with an energy content of 1.7 kWh and no plug-in concept. The electric motor‘s power output has more than doubled from 34 kW (46 hp) to 70 kW (95 hp). Total fuel consumption is now 3.4 l/100 km (NEDC) instead of the previous 8.2 l/100 km, which equates to CO_2 emissions of 79 g/km. On the old model it was 193 g/km of CO_2. It goes without saying that the Cayenne S E-Hybrid complies with the Euro-6 emissions standard.

The supercharged three-litre V6 engine and electric motor‘s total combined power output of 416 hp and total torque of 590 Nm in the Cayenne S E-Hybrid facilitate driving performance levels of sports car standard: nought to 100 km/h in 5.9 seconds and a top speed of 243 km/h. The electric top speed is 125 km/h.

For the transmission of power Porsche uses the proven Tiptronic S. The eight-speed automatic gearbox features additional functions for use in a parallel full hybrid vehicle. Due to the modified e-motor characteristics, a dedicated gear-change strategy is, for example, implemented for the E-Power mode. In all-electric mode the vehicle drives across the full relevant speed range at an rpm level that compared to the hybrid mode is higher and thus optimised for effectiveness. In Sport mode a hybrid-specific gear-change strategy is also available.

Cayenne S E-Hybrid owners remain connected to their vehicle via the standard Porsche Car Connect system: via smart phone it enables data such as the charge level or energy efficiency figures to be accessed and the optional auxiliary climate control system to be controlled. The latter cools and heats the vehicle interior with the ignition switched off – to get it to the right temperature ahead of the journey, while the vehicle is still connected to the mains. No energy is therefore used for this on the move and the electric range thus increases.

Driving modes for appropriate use of electric drive

The added amount of electric power opens up an even greater variety of possible ways of driving for drivers of the Cayenne S E-Hybrid and Panamera S E-Hybrid. Via buttons in the centre console both models provide a choice of switchable modes: the E-Power mode facilitates largely all-electric driving. It is enabled by default, so that – providing the battery is suitably charged – every journey can be started in all-electric fashion.

If the driver disables E-Power, the operating strategy switches to Hybrid mode. This is geared towards efficiency and alternates fully automatically between electric and hybrid driving with load point shifting, coasting, energy recuperation and boosting. As a basic principle in hybrid operation the six-cylinder engine is activated earlier in order to hold back the battery‘s available energy content for later phases of electric driving. Disabling the E-Power mode also keeps the high-voltage battery‘s existing charge level largely constant so that electric range is available for the next urban stage.

Pressing the Sport button enables Sport mode and thus the hybrid drive system‘s full performance potential. The boost – the sporty side of the Cayenne S E-Hybrid and Panamera S E-Hybrid – is then noticeable. As soon as the position of the accelerator pedal reaches 80 per cent, internal combustion engine and electric motor work together, pooling power output and torque for typical Porsche driving fun.

The E-Charge mode enables the high-voltage battery to be efficiently charged while driving. If desired, the full electric range is thus always available. The E-Charge mode switches the electric motor to generator function and produces via that an additional load, which causes the internal combustion engine to work within particularly efficient operating ranges. When topping up the charge via the internal combustion engine, for example on long motorway runs, the Cayenne S E-Hybrid and Panamera S E-Hybrid thus obtain more energy from every drop of fuel, which then gets stored in the high-voltage battery and is available for later zero-emission journeys.

Through recuperation and storage in the high-voltage battery, the brake system recovers brake energy that is normally lost. Depending on how forcefully the driver pushes down on the brake pedal, the electric motor‘s generator function is first switched on up to the maximum possible load before the conventional brake then adds to the brake force.

The hybrid manager coordinates the interplay between internal combustion engine and electric motor with disengagement clutch and gearbox. Factors it takes into account include the condition of the high-voltage system, such as the temperature and charge level of the lithium-ion battery. This is permanently monitored by the battery management system, which communicates with the hybrid manager.

Electric driving experience

Hybrid-specific indicators on the instrument cluster and optionally available Porsche Communication Management (PCM) system provide the driver at all times with the key information. The power meter, for instance, replaces the analogue speedometer display and provides the driver with information by showing the power called off from the hybrid system and its energy regeneration performance. The vehicle‘s speed is shown digitally in the central round instrument panel‘s display.

The power meter visualises the power threshold at which the internal combustion engine is activated. In combination with the accelerator pedal characteristics and the noticeable pressure point at this threshold, the driver is better able to manage electric driving, receiving both visual feedback and a response that can be felt. The power meter also shows the driver other useful information: for example, that the system is ready when the ignition is switched on (‘Ready‘ indicator), an efficient or particularly sporty driving range (‘Efficiency‘ or ‘Boost‘ range) and the internal combustion engine‘s activation point for boosting the power output.

In order to provide a constant view of the plug-in hybrid drive system‘s two power reserves, the fuel tank indicator has been supplemented by an analogue indicator of the battery charge status. In addition, the electric range is shown by a TFT display. The calculation takes into account both the electric range in E-Power mode based on the battery‘s charge level and the remaining hybrid range based on the amount of fuel in the tank. The two residual ranges are indicated separately.

By kick down, the full system power can be utilised at any time in order, for instance, to overtake a vehicle in front. In such situations the E-Power mode remains enabled in the background and facilitates all-electric driving whenever the acceleration is again more moderate and the vehicle is not exceeding the electric top speed.

The 918 Spyder‘s hybrid concept

With the 918 Spyder, Porsche has launched into the future of the sports car. In addition to top performance on the racetrack, it is able to glide through the city with zero emissions and in almost total silence. Maximum performance from 887 hp of system power and fuel consumption of 3.1 litres per 100 kilometres (NEDC) are the result of its unique plug-in hybrid concept.

The 918 Spyder is the first production car to feature three motors independent of each other, which can be individually controlled and at the same time enable a unique all-wheel drive concept. They thus fully exploit every possibility that the combined drive system provides. Via a 'mapping switch' on the steering wheel the driver is able to choose between five driving modes, which optimally control the sole or mixed drive system. The spectrum ranges from all-electric driving all the way to an uncompromising set-up for the racetrack. The 918 Spyder is thus a vehicle with competitive racing credentials and at the same time an uncomplicated everyday sports car.

The 4.6-litre eight-cylinder engine delivering 608 hp and the rear electric motor with an output of 115 kW (156 hp) are arranged in line on a common shaft and drive the rear axle via the Porsche Doppelkupplung (PDK). With an output of 95 kW (129 hp), the second electric motor sends its power via a single-stage gearbox and a disengagement clutch to the front wheels. Optimum coordination of the three power sources is one of Porsche's core competencies and ensures the 918 Spyder's outstanding performance: thanks to the additional, individually controllable front-wheel drive in the 918 Spyder, it is possible to implement new driving strategies for extremely high and safe cornering speeds.

The overall concept results in a crankshaft-equivalent maximum torque of 1,280 Nm in seventh gear. The term 'crankshaft equivalent' expresses the amount of torque that the engine of a conventional drive system would have to produce in order to develop the same drive-wheel traction. The characteristics of the high-rev naturally aspirated engine with immense torque at higher engine speeds and the electric motors with powerful torque right from a standstill complement each other ideally: within a broad rpm range of 800 to 5,000 revolutions per minute, the torque plateau always remains above 800 Nm.

For the driver the drive system concept means almost limitless power from the very first revolution and associated with that fast starts, a strong pull-away and impressive acceleration. In addition it provides enormous driving fun whenever by pressing on the accelerator the high-torque electric motors give an extra boost to the V8 high-rev engine and release the unrestricted full power and a catapult-like capacity for acceleration. In 2.6 seconds the car reaches 100 km/h; in 7.3 seconds it's at 200 km/h.

The hybrid module deploying its power to the rear axle is connected directly to the V8 engine. It consists in the main of the electric motor and a dry disengagement clutch as the connecting element to the internal combustion engine. Acting as a parallel hybrid module, it powers the 918 Spyder both individually via the internal combustion engine or electric motor and combined via both drive systems as well. Typically for a super sports car from Porsche, the power pack sits in front of the rear axle and has no direct mechanical connection to the front axle.

The transmission of power is handled by a seven-speed dual-clutch gearbox optimised for high-performance use. Compared to the other Porsche model ranges, it is turned over 180 degrees about the longitudinal axis in order to ensure the lowest possible installation position and thus centre of gravity for the entire vehicle. Whenever no drive power to the rear axle is required, the two drive systems can be disconnected by opening the disengagement clutch and PDK clutches. This facilitates typical Porsche ‘coasting‘ up to a speed of 150 km/h with internal combustion engine switched off.

All-wheel drive provided by front-axle electric motor

The 918 Spyder‘s second electric motor deploys its power to the front axle with no mechanical link to the rear wheels. The drive torque for each axle is controlled separately. The hybrid super sports car thus has the electric Porsche Traction Management system (ePTM), which gives the 918 Spyder its unique traction and driving dynamics. The electric motor is – unlike for the rear axle – a permanent-magnet synchronous motor with internal rotor. This type of electric motor concentrates particularly great power output on a small volume with high rotary speed and low weight.

The downstream gearbox is set up for the best possible performance both when pulling away and driving around the circuit. The constant gear ratio is selected in such a way that at low driving speeds a high level of torque is generated. The electric motor reaches its maximum rotary speed at 16,000 rpm, which equates to a vehicle speed of around 265 km/h. Above this driving speed the gearbox and the electric motor are decoupled via the integrated claw coupling. The electric all-wheel drive function is thus practically available at all times.

Hybrid module with innovative cooling system

For the rear-axle-mounted, permanent-magnet synchronous motor with external rotor and single-tooth winding Porsche has developed an innovative cooling concept, making it the first hybrid motor cooled both with water and air. As the electric motor has a power output of over a third more again than in the Cayenne S E-Hybrid and Panamera S E-Hybrid, there is an increased need to dissipate heat. The Porsche engineers have come up with a new cooling concept, in which the stator, i.e. the fixed inner section of the electric motor, is water-cooled as before. The permanent magnets of the outer, rotating section are, on the other hand, cooled by air. This is done by a fan wheel that sucks the outside air over the air filter via an air duct with a manifold. Numerous ducts arranged inside the housing draw off the heat, resulting in homogeneous airflow distribution and even cooling of the windings. This extremely powerful cooling system is a prerequisite for high levels of continuous power output, for example on the racetrack.

Lithium-ion battery with plug-in charging system

The 918 Spyder‘s traction battery is more powerful than any other electric energy storage currently being used in hybrid vehicles: at 1.7 kW/kg it has the highest specific power output of all hybrid batteries and delivers both with the e-boost and during energy recuperation an extremely high output level of 230 kW. In order to meet the great demands by the electric motors, the individual cells of the traction battery have been developed specifically for the 918 Spyder and geared to top performance. The battery is housed in a transverse position in the floor of the monocoque chassis behind the seats. It can be charged either with alternating current via the on-board charger or with direct current via the optional Porsche Speed Charging Station. The charge socket is integrated into the right B-pillar behind a flap.

Porsche 919 Hybrid

Fundamental technological research at racing speed

Porsche has returned with the most innovative racing car in the company's history to the top class of the World Endurance Championship (WEC) and to the 24 Hours of Le Mans. Redesigned from the ground up, the highly complex 919 Hybrid features an audacious engineering concept with a clear objective: the highest possible energy efficiency through all components working to optimum effect. This applies both to the prototypes' aerodynamics and the uncompromising lightweight construction of every element. It applies especially, however, to the ultra-modern energy recovery and drive systems – technologies that have great relevance to use in production models as well. The racing car is thus Porsche's fastest test laboratory.

The WEC's redefined technical rules gave the Porsche engineers a lot of freedom, which they have utilised with great creativity for extraordinary solutions. The amount of fuel available per lap serves as the primary limiting factor for the performance of the works cars in the LMP1-H category. In addition, at least one hybrid system is mandatory. The rule-makers, however, have allowed free choice of system type and of the method of storing the recuperated energy. The engine design and displacement are also not prescribed.

Porsche chose an unusual route and opted for two different recuperation systems for the 919 Hybrid. The first works relatively conventionally and is already being used in similar form in the Porsche 918 Spyder: during phases of braking, a generator linked to the front axle converts kinetic energy into electrical power. The second is even more progressive and is unmatched even in the starting field of the sports car world championship, as it uses the thermodynamic energy of the discharged exhaust gas. An additional turbine generator unit takes on here the task of the so-called waste gate, a control valve that protects turbo systems from overloading by letting pressure peaks escape into the air. This previously lost exhaust gas energy is used by the unit (called a MGU-H: motor generator unit – heat) to generate electricity. That makes the Porsche 919 Hybrid the only racing car in the LMP1-H class that recovers excess energy not only when braking, but when going at full throttle as well.

Using the converted kinetic and thermal energy, both systems feed liquid-cooled lithium-ion batteries – an in-house development, where Porsche is again going its own way. The ultra-modern storage media are based on partner A123 Systems' cell technology and combine relatively large storage capacity with very high power density. In the view of Alexander Hitzinger, LMP1 Technical Director, they thus offer the best compromise between rapid power input and output. During phases of acceleration they direct their energy to the front generator, which then acts like a single electric motor and drives both front wheels via a differential. In this way the Porsche 919 Hybrid has a form of temporary all-wheel drive, as the internal combustion engine's power reaches solely the rear axle.

The amount of electrical energy that is allowed to be recuperated per lap and reused for boosting is restricted for the LMP1-H racing cars. The rules provide for four classes between 2 and 8 megajoules (MJ). The Porsche 919 Hybrid lines up in the 6-megajoule category, a level not being exceeded by anyone this season in the WEC. Translated to the Le Mans' 13.629-kilometre 'Circuit des 24 heures', this means: the prototype is allowed to use exactly 1.67 kilowatt hours (kWh) per lap, the equivalent of 6 MJ (1 MJ = 0.28 kWh). Looked at over a race distance of 360 laps, the new 919 Hybrid uses 601.2 kilowatt hours. With that much electric power a 60-watt light bulb would shine for over 10,000 hours. Or in other words: with the energy that Porsche's LMP1 hybrid recuperates during one Le Mans race, today's most efficient compact electric car, the Volkswagen e-Golf, could travel 4,733 kilometres. That's roughly equivalent to the distance from New York to Los Angeles.

Porsche opted for an unusual concept in the choice of internal combustion engine as well. As a pioneer of the downsizing philosophy, the four-cylinder engine combines a relatively small cubic capacity (just 2 litres) with mono-turbocharging, four-valve technology and petrol direct injection. Thanks to its V-configuration, it provides the ideal intersection between low weight and compact size, plus structural rigidity, high power output and thermodynamic benefits. The permitted fuel consumption is linked by the rules directly to the amount of electrical energy that the driver uses for boosting per lap. In the 6-MJ class it is just 4.79 litres at Le Mans for the Porsche 919 Hybrid's petrol engine with an output of 500+ hp. Despite equal levels of driving performance, the use of energy has thus gone down by a good 30 percent compared to last year.

Specifications Porsche Cayenne S E-Hybrid*

Body:

Unitary construction, fully galvanised lightweight all-steel body; two-stage driver and front passenger airbags; side airbags for driver and front passenger; curtain airbags over the roof frame and side windows from A-pillar to C-pillar; seating for five persons.

Aerodynamics:

Drag coefficient c_d:	0.36
Frontal area A:	2.81 m^2
c_d x A:	1.012

Drive system:

Parallel full hybrid with plug-in technology, internal combustion engine and hybrid module with electric motor and decoupling clutch.

System power	416 hp (306 kW) at 5,500/min
Max. torque	590 Nm at 1,250–4,000 rpm

Internal combustion engine:

Water-cooled six-cylinder V engine; cylinder angle 90 degrees; aluminium crankcase and cylinder heads; four overhead camshafts; four valves per cylinder; variable inlet valve timing; hydraulic valve lifter; supercharger charging; direct petrol injection; one three-way catalytic converter per cylinder bank, each with two oxygen sensors; engine oil 8.1 litres; electronic ignition with solid-state ignition distribution (six individual ignition coils); thermal management; extended auto start/stop function Plus.

Bore	84.5 mm
Stroke	89.0 mm
Displacement	2,995 cm^3
Compression ratio	10.5:1
Engine power	333 hp (245 kW) at 5,500–6,500 rpm
Max. torque	440 Nm at 3,000–5,250 rpm
Power output per litre	111.2 hp/l (81.8 kW/l)
Max. engine speed	6,500/min
Fuel type	super

* Specifications may vary according to markets

Electric motor:

Permanent magnet synchronous machine

E motor power	95 hp (70 kW) at 2,200–2,600 rpm
Max. torque	310 Nm at 0–1,700 rpm

Electrical:

High-voltage system/traction battery: 382 Volt; lithium-ion battery; 10.8 kWh; plug-in system: charged from electrical mains via standard Porsche Universal Charger (AC) and on-board charger (3.6 kW or optionally 7.2 kW). 12-volt vehicle electrical system; battery capacity 75 Ah.

Power transmission:

Engine and transmission bolted to form one drive unit; Porsche Traction Management (PTM): permanent all-wheel drive with limited-slip centre differential; basic torque distribution (FA/RA) 42/58; eight-speed Tiptronic S.

Gear ratios

1st gear	4.92
2nd gear	2.81
3rd gear	1.84
4th gear	1.43
5th gear	1.21
6th gear	1.00
7th gear	0.83
8th gear	0.69
Reverse	4.02
Final drive ratio	3.27
Converter diameter	241 mm

Suspension:

Front axle: aluminium double wishbone suspension; struts with steel springs and internal, hydraulic double-tube gas dampers.

Rear axle: multi-link suspension with lower transverse links, two individual upper links and tie rod; struts with steel springs and internal hydraulic double-tube gas dampers.

Brakes:

Brake system capable of regenerative braking for recovering brake energy; dual-circuit brake system with separate circuits for front and rear axles.

Front: six-piston aluminium monobloc brake callipers; internally ventilated brake discs, 360 mm in diameter and 36 mm thick.

Rear: four-piston aluminium monobloc brake callipers, internally ventilated brake discs, 330 mm in diameter and 28 mm thick.

Porsche Stability Management (PSM); vacuum brake booster; brake assist; multi-collision brake; electric parking brake.

Wheels and tyres:	Front and rear	8.0 J x 18	with	255/55 R 18

Weights:	Unladen weight DIN		2,350 kg
	Gross vehicle weight rating		3,050 kg
	Maximum trailer weight		3,500 kg
	Maximum draw bar weight		140 kg
	Maximum roof load		100 kg
Dimensions:	Length		4,855 mm
	Width		1,939 mm
	Width with door mirrors		2,165 mm
	Height		1,705 mm
	Wheelbase		2,895 mm
	Track widths	front	1,655 mm
		rear	1,669 mm
	Luggage comp. capacity		580–1,690 l
	Fuel tank capacity		80 l

Performance:	Top speed	243 km/h 151 mph
	Electric top speed	125 km/h 78 mph
	Acceleration: 0–100 km/h	5.9 s
	0–60 mph	5.4 s
	0–160 km/h	13.7 s
	0–400 m (1/4 mile)	14.2 s
	0–1,000 m	25.7 s
Fuel consumption: (ECE R 101)	Fuel consumption combined	3.4 l/100 km
	Electrical consumption combined	20.8 kWh/100 km
	CO_2 emissions combined	79 g/km
Electric driving range:		approx. 18–36 km
Emissions class:		Euro 6

Status: October 2014

Specifications Porsche Panamera S E-Hybrid*

Body:

Unitary construction, lightweight body in mixed material steel-aluminium-magnesium design; dual-stage driver and front passenger airbags; side and knee airbags for driver and front passenger; head airbags (curtain airbags) for all four occupants; active front lid for pedestrian protection; four seats.

Aerodynamics:

Drag coefficient c_d:	0.29
Frontal area A:	2.33 m^2
c_d x A:	0.68

Drive system:

Parallel full hybrid with plug-in technology, internal combustion engine and hybrid module with electric motor and decoupling clutch.

System power:	416 hp (306 kW) at 5,500 rpm
Max. torque:	590 Nm from 1,250 rpm to 4,000 rpm

IC engine:

Water-cooled six-cylinder V engine; aluminium crankcase and cylinder heads; four overhead camshafts; four valves per cylinder; variable inlet valve timing; hydraulic valve lifter; supercharger charging; direct petrol injection; two three-way catalytic converters per cylinder bank, each with two oxygen sensors; engine oil 8.1 litres; electronic ignition with solid-state ignition distribution (six individual ignition coils); thermal management; auto start-stop function.

Bore:	84.5 mm
Stroke:	89.0 mm
Displacement:	2,995 cc
Compression ratio:	10.5:1
Maximum engine speed:	6,700 rpm
Fuel type:	Super
Engine power:	333 hp (245 kW) from 5,500 to 6,500 rpm
Max. torque:	440 Nm from 3,000 to 5,250 rpm

*Specifications may vary according to markets

Electric motor:

Permanently excited synchronous motor.

E motor power:	95 hp (70 kW) from 2,200 to 2,600 rpm
Max. torque:	310 Nm from 0 to 1,700 rpm

Electrical system:

12 Volt vehicle electrical system; battery capacity 75 Ah. High-voltage system / Traction battery: 384 Volt; lithium-ion battery; 9.4 kWh; 24 Ah; charged from electrical mains via standard Porsche Universal Charger (AC) and on-board charger (3.6 kW) (plug-in system).

Power transmission:

Engine and transmission bolted to form one drive unit, rear wheel drive via double-joint driveshafts; eight-speed automatic transmission with torque converter (Tiptronic S).

Gear ratios:

1st gear	4.92
2nd gear	2.81
3rd gear	1.84
4th gear	1.43
5th gear	1.21
6th gear	1.00
7th gear	0.83
8th gear	0.69
Reverse	4.07
Final drive ratio:	2.92
Converter diameter:	241 mm

Suspension:

Front axle: aluminium double wishbone suspension; air suspension; hydraulic coaxial gas pressurised dampers.

Rear axle: aluminium multi-link suspension with suspension subframe; wheels independently suspended on four links; air suspensions with switchable added volume; hydraulic coaxial gas pressurised dampers.

Variable adjustment of damper forces (Porsche Active Suspension Management, PASM).

Brakes:

Dual-circuit brake system with separate circuits for front and rear axles.

Front: six-piston aluminium monobloc brake callipers; internally ventilated brake discs, 360 mm in diameter and 36 mm thick.

Rear: four-piston aluminium monobloc brake callipers, internally ventilated brake discs, 330 mm in diameter and 28 mm thick.

Porsche Stability Management (PSM); vacuum brake booster; brake assist; electric parking brake.

Wheels and tyres:	front	8 J x 18	with	245/50 ZR 18
	rear	9 J x 18	with	275/45 ZR 18

Weights:	Unladen weight DIN		2,095 kg
	Allowable gross weight		2,580 kg
	Maximum roof load		75 kg
Dimensions:	Length		5,015 mm
	Width		1,931 mm
	Width with door mirrors		2,114 mm
	Height		1,418 mm
	Wheelbase		2,920 mm
	Track widths	front	1,658 mm
		rear	1,662 mm
	Luggage comp. capacity		335–1,153 l
	Fuel tank capacity		80 l

Performance:	Top speed		270 km/h
	Electric top speed		135 km/h
	Acceleration:		
	0–100 km/h		5.5 s
	0–160 km/h		12.2 s
	0–200 km/h		19.0 s
	0–1,000 m		24.5 s
Fuel consumption per ECE R 101:	Fuel consumption	Combined	3.1 l/100 km
	Electrical consumption	Combined	162 Wh/km
	CO_2 emissions	Combined	71 g/km
Electric driving range:			approx. 18–36 km
Emissions class:			Euro 6

Status: October 2014

Specifications of the Porsche 918 Spyder*

Body:	Two-seat Spyder; carbon-fibre-reinforced plastic (CFRP) monocoque interlocked with CFRP unit carrier; two-piece Targa roof; fixed roll-over protection system.
Drivetrain:	Parallel full hybrid; 4.6-litre V8 mid-engine with dry-sump lubrication; hybrid module with electric motor and decoupler; electric motor with decoupler and transmission on front axle; auto Start Stop function; electrical system recuperation; four cooling circuits for motors, transmission and battery; thermal management.
Displacement:	4593 cm^3 (V8 engine)
Engine power:	608 hp (447 kW) at 8700/min (V8 engine) 286 hp (210 kW) at 6500/min (electric motors) 887 hp (652 kW) at 8500/min (combined)
Max. torque:	917–1280 Nm (overall system, depending on the gear)
Maximum revs:	9150 rpm
Power output per litre:	132 hp/l (V8 engine)

*Specifications may vary according to markets

Power transmission: Combustion engine with hybrid module and transmission bolted together to form a single drive unit; seven-speed Porsche Doppelkupplung (PDK); rear-wheel drive; front electric motor with transmission for driving the front wheels (decoupled from 265 km/h); five pre-selectable operating modes for optimum coordination of all drive units.

Gear ratios	PDK
1st gear	3.91
2nd gear	2.29
3rd gear	1.58
4th gear	1.19
5th gear	0.97
6th gear	0.83
7th gear	0.67
R gear	3.55
Final drive ratio	3.09
Clutch diameter	220 mm/164 mm

Chassis: Double-wishbone front axle; optional electro-pneumatic lift system at front; electro-mechanical power steering; multi-link rear axle with adaptive electro-mechanical system for individual rear wheel steering; electronically controlled twin-tube gas-filled shock absorbers at the front and rear with Porsche Active Suspension Management (PASM) system.

Brake system: High-performance hybrid brake system with adaptive recuperation; internally ventilated and perforated front ceramic brake discs (PCCB) with a diameter of 410 mm and thickness of 36 mm; rear discs with a diameter of 390 mm and thickness of 32 mm.

Wheels and tyres: 918 Spyder wheels
(Weissach package: 918 Spyder forged magnesium wheels)

Front	9.5 J x 20	with	265/35 ZR 20
Rear	12.5 J x 21	with	325/30 ZR 21

Weight:	DIN weight empty		1674 kg (Weissach package: 1634 kg)
Dimensions:	Length		4643 mm
	Width		1940 mm
	Height		1167 mm
	Wheelbase		2730 mm
	Track widths	Front	1664 mm
		Rear	1612 mm
	Luggage compartment volume, VDA		~110 l
	Tank capacity		70 l
Energy supply:	Lithium-ion battery with 6.8 kWh capacity (BOL nominal), 230 kW maximum power and mains-compatible plug-in charging system.		
Performance:	Top speed		345 km/h
	Purely electric		150 km/h
	Acceleration:		
	0–100 km/h		2.6 s
	0–200 km/h		7.3 s (Weissach package: 7.2 s)
	0–300 km/h		20.9 s (Weissach package: 19.9 s)
	0–60 mph		2.5 s
	1/4 mile		10.0 s (Weissach package: 9.9 s)

Consumption (NEDC):	Overall	3.1 l/100 km (Weissach package: 3.0 l/100 km)
CO_2 emissions:	Overall	72 g/km (Weissach package: 70 g/km)
Power consumption:		12.7 kWh/100 km
Efficiency class: **Germany**		A+
Range purely electric:		16–31 km
Warranty: **Vehicle (battery)**		4 years (7 years)

Status: October 2014