

Press Release

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Volvo's Most Technologically Advanced Model - The Volvo V60 Plug-in Diesel Hybrid

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- 3 cars in one - putting the driver in command at the touch of a button
- 48g/km of CO₂ with 215hp+70hp performance
- Blend of electric and diesel power with all-wheel-drive capabilities

Overview of the Volvo V60 D6 AWD

The V60 D6 AWD is Volvo Car Group's most technologically advanced model ever - an electric car, hybrid car and muscle-car all rolled into one. At the touch of a button, the driver can choose which of the three cars they want to drive at any given moment.

In January 2007, Volvo Car Group and the Swedish energy supplier Vattenfall AB launched an industrial partnership whose aim was to test and develop plug-in technology. This cross-border initiative resulted in the foundation of a jointly owned company - V2 Plug-in-Hybrid Vehicle Partnership HB. The result of this partnership can now be seen with the introduction of the Volvo V60 D6 AWD, the world's first diesel plug-in hybrid.

With this car, Volvo is taking a step forward towards its 'DRIVE Towards Zero' strategy. In fact, when the V60 Plug-in Hybrid is run solely on electricity and recharged using renewable energy, this has already been achieved.

The V60 D6 AWD is only available in SE Lux trim and is fitted with an automatic Geartronic gearbox, meaning it comes with a generous amount of standard specification and in a unique and ground-breaking package.

This brand new technology, encompassed in Scandinavian design and with Volvo's reputation for safety and quality, is available from £48,775 on the road. However, following confirmation of eligibility, the V60 D6 AWD has received approval for the Government's Plug-In Car Grant (PICG) which is designed to offer incentives for buyers to choose new ultra-low carbon cars. In this scheme, buyers will receive a £5000 grant towards the purchase price of the vehicle, meaning it will be available to customers with an on-the-road price of £43,775.

Company car drivers benefit from zero Benefit in Kind company car tax until 2015 and companies benefit from 100% first year write down allowance themselves.

The V60 D6 AWD is truly designed around the driver, to not over complicate what is a technologically advanced system and to show how a hybrid can fit in as part of normal life. As such, there are only five additional buttons on the centre console giving the driver full control.

The driver is able to select the required driving mode via three buttons that give the car three entirely different temperaments:

- In Pure mode the car is powered solely by its electric motor as much as possible.
- Hybrid is the standard setting whenever the car is started. The diesel engine and electric motor cooperate to ensure optimal balance between driving pleasure and environmental footprint.

- In Power mode the technology is optimised to give the car the maximum possible power.

In addition, there is an 'AWD' button that activates the intelligent all-wheel-drive system and also the 'Save for Later' button that ensures the driver has adequate battery capacity to drive in pure electric mode later in the journey.

Sales got under way at the start of 2012 with a limited model year 2013 production run of 1,000 cars starting in November 2012. These initial cars were offered in Pure Limited specification and one colour option, however for model year 2014 these restrictions have been lifted, allowing for a greater choice for customers, whilst also benefitting from the design and feature enhancements recently announced at the Geneva Motorshow 2013.

Sales are expected to increase up to 6,000 units globally a year, while the UK is expected to contribute 150 towards this. Volvo Car Group expects that 80 per cent of total sales will be in the form of company cars.

The V60 Plug-in hybrid is the first Volvo to show the D6 badge, indicating the potential power that is on offer from its diesel engine and electric motors. The five-cylinder 2.4-litre turbo diesel (D5 engine) producing 215 hp powers the front wheels, while the 70hp electric motor powers the rear wheels. The transmission is the same six-speed automatic Geartronic gearbox as fitted to other conventionally powered models, but modified to manage the transition between power delivery from the two sources.

The rear motor is supplied with power from an 11.2 kWh lithium-ion battery pack installed under the floor of the load compartment.

Exterior Design and Features

Recently revealed at the Geneva Motorshow 2013, the V60 Plug-in Hybrid will receive the same updates as the conventionally powered V60s. The V60 is the car for people who need the versatility of an estate but want the handling of a sports sedan - all in a stylish Scandinavian package.

As a sportswagon, the V60 has a dynamic and appealing look, a low hunkered-down stance. Its broad shoulders remain, giving it a look of strength while contributing towards its safety prowess.

From the front, the new face has meant a change to the design of the front lights. The LED day running lights (DRLs) have moved from between the headlights and grille, to below the headlights by the lower air-intake.

The complete front bumper has been re-designed to incorporate these new DRLs and to further focus the look of the vehicle. The grille has been enlarged with a new, larger ironmark, the chrome surrounding strip has been removed and the radar cover has been incorporated more into the overall look of the grille. The headlight washers now sit flush with the bumper while the washer jets have been moved from the bonnet, which has also been redesigned, to underneath its rear edge, out of sight, further enhancing its streamlined look.

From the side, the rear's coupé wedge shape is obvious and the wave over each wheel-arch helps visually to pull the car down to the road. The various chrome details on the exterior of the car include a strip on the lower part of the front bumper and also surrounding the side windows.

The rear features high upright LED tail lights with distinctive light streams which contribute towards good visibility and safety.

From the rear, the car continues to feature the integrated tailpipes. This design created a number of issues such as the fact that at operating temperature, the tailpipes have to remain perfectly in place despite the exhaust system expanding in length by up to 25mm.

The V60 D6 AWD also benefits from silver roof rails, allowing customers to further extend the loading capacity of their vehicle.

There are a number of features specific to the hybrid, such as the lightweight 17" Thia alloy wheels with exceptionally low air drag and tyres designed for low rolling resistance. To help funnel the air-flow and reduce the drag, the V60 D6 AWD also features two winglets on the front bumper.

To differentiate the V60 D6 AWD from the rest of the range, there are a number of discreet Plug-in

Hybrid badges located on the front wings, the tailgate and on the treadplates.

Along with benefitting from the new exterior design, customers will be free to order a choice of 14 exterior colours.

Interior Design and Features

Along with the design changes to the exterior, the interior also benefits. There is a choice of three different interior combinations, a new wood inlay, a new headliner and silk metal frames around the air vents and light controls, plus a new interior lighting system in the car.

Supportive yet comfortable seats that ensure a fresh and relaxed arrival after the longest of journeys have been a Volvo strength for decades. This continues in the V60 D6 AWD where adjustments have also been made to the backs of the leather seats to provide more legroom for passengers in the rear.

At the heart of the extra versatility of the V60 is its intelligent seating where the rear seats can be folded down in three 40/20/40 segments.

The floating centre stack, now a Volvo design trademark, is the centrepiece of the V60 cockpit. It was inspired by Swedish furniture and the depth of the stack gives the effect that it "floats".

The cabin is full of easy-to-use technology, all part of Volvo's high-tech but easy to use HMI (Human-Machine Interface). The infotainment system - combining audio, navigation, mobile phone and other functions - is presented on a 7" colour screen in the upper part of the centre console. It's set high to make it easier for the driver to keep his or her eyes on the road. All functions can be controlled from the steering wheel, or by controls directly below the screen.

DAB is fitted as standard, as is Bluetooth hands-free telephone system.

The Adaptive Digital Display, which debuted in the all-new V40, is also fitted to the V60 D6 AWD. This active TFT (Thin Film Transistor) crystal display takes the interaction between car and driver to a new dimension, always displaying the most important information in any given situation. The Active TFT can be changed according to the information the driver wishes to see and can be set to four different settings:

- The Elegance theme is the base mode with a traditional and calm aura.
- The Eco theme features green background illumination, designed to create an environmentally inspired look. An Eco meter is displayed on the left. The current and accumulated fuel consumption figures are displayed - and the driver is rewarded with a green E light when eco-driving is optimal.
- The Performance theme has red background illumination, creating a sporty atmosphere. In the centre, a rev counter scale replaces the speedometer displayed in the Elegance and Eco versions. Vehicle speed is shown digitally in the centre of the display. The right display includes a power meter - a gauge that informs the driver how much power is available and how much power is being used at any given moment in time.
- Specific to the V60 D6 AWD, there is an additional Hybrid Theme with blue illumination. It includes hybrid and battery information that supports energy-efficient use of the ingenious driveline.

The rain sensor fitted to automatically activate the wipers is also used for headlight activation, automatically switching from DRLs to headlights without any action from the driver (light switch must be set to AUTO).

Driving Dynamics

The chassis on the V60 D6 AWD is the same Dynamic chassis fitted to its conventionally powered V60 stablemates. There are a number of slight modifications to the suspension and bushes to compensate for the increased weight from the battery pack and electrical components. However great care has been taken to ensure the same pleasing driving dynamics remain.

The suspension is fully independent using coil springs, and has been tuned for agile, responsive

behaviour. Front suspension is by MacPherson struts and rear is by multi-link.

The V60 is of course agile, responsive and really good to drive, but being a Volvo, it offers predictable handling and security on all road conditions, from dry tarmac, to ice, to snow, to heavy rain.

The majority of the damper tuning was carried out in England due to the unique mixture of surfaces that make up the road network.

Volvo's Dynamic Stability and Traction Control (DSTC) system is fitted as standard and it helps stop skids and slides, using sensors to detect if any of the wheels loses traction or grip. If so, power is cut to the relevant wheel. If the sensors detect early signs of a skid, the system automatically brakes the relevant wheel to reduce speed and regain control.

Corner Traction Control sharpens handling. A refinement of the DSTC system, it uses torque vectoring to improve turn-in. When taking a curve, the inner driven wheel is braked at the same time that extra power is fed to the outer driven wheel. This modified system also includes a roll angle sensor that identifies any possible skid at an early stage.

The V60 also features Engine Drag Control that prevents the wheels from locking during engine braking on a slippery surface.

Drivetrain

The V60 D6 AWD is powered by two sources:

- A 2.4 litre twin-turbocharged diesel, developing 215hp and 440 Nm of torque powering the front wheels.
- A 70hp electrical motor, developing 200 Nm of torque powering the rear wheels.

The diesel engine fitted to the V60 D6 AWD is in principle the same engine as fitted to the D5, with a number of modifications to fit the hybrid installation.

Amongst these changes, the most noticeable is the removal of a conventional alternator which is replaced by an Integrated Starter Generator (ISG) that acts as a starter motor and high performance generator.

It is coupled directly to the crankshaft which allows for faster starting, necessary for seamless transfer of power from electric to diesel.

During cold conditions and when the car is initially started, the conventional starter motor is used until the ISG has reached an adequate operating temperature.

The rear wheels are powered by a single motor, located in the rear sub-frame, similar to the conventional mechanical rear axle. This is then linked to the wheels by driveshafts. The electrical current is fed from the main battery pack to power the motor or during regeneration, from the motor back to the battery pack.

Gearbox

The V60 D6 AWD is fitted with a Geartronic automatic gearbox with specially modified software to enable the smooth transfer of power from electric to diesel, or manage the combination of the two power sources together.

Two-stage braking system

The V60 D6 AWD features a unique two-stage braking system. When the driver presses the brake pedal, the system uses the electric rear motor to slow the vehicle. This braking energy is then used to re-charge the battery pack. In the driver display, it is possible to view when this is happening when bubbles appear in the battery charge indicator.

The mechanical brakes are activated only when the situation requires more braking power than

the rear motor can provide.

The Five Hybrid Buttons

To ensure the driver pays as much attention to the road as possible and ensure the driver isn't 'blinded by science', there are only five additional buttons on the centre floating console.

Pure, Hybrid and Power

The Pure, Hybrid and Power driving modes give the V60 Plug-in Hybrid its three different temperaments:

- In Pure mode the car is powered solely by its electric motor as much as possible. If the battery pack has been recharged with electricity from renewable sources, its range is up to 31 miles with no carbon dioxide emissions from the tailpipe. The electric range varies with terrain, climate and driving style.
- Hybrid is the standard setting whenever the car is started. The diesel engine and electric motor cooperate to ensure optimal balance between driving pleasure and environmental footprint. CO₂ emission (NEDC, mixed driving cycle for certification) is just 48g/km and it has a total range of up to 560 miles.
- In Power mode the technology is optimised to give the car the maximum possible power. The diesel engine and electric motor have a total power output of 215+70 horsepower and maximum torque of 440+200Nm. The electric motor's lightning-quick torque delivery contributes to the car's acceleration from 0 to 60mph in 5.8 seconds.

Save For Later

The driver can choose to save battery power in order to drive on pure electricity later on, for instance in an urban green zone or in the heart of a city.

When Save is activated, the on-board system ensures that there is always sufficient charge for driving later in Pure mode. If necessary, the high-tension alternator will charge the battery pack so there is sufficient capacity for driving in Pure mode.

The Save function will adapt itself according to the state of charge:

- If the battery is charged fully, the Save function will stop the vehicle from using battery power and drive on diesel only, until the driver either presses the Save button again or chooses Pure.
- If the battery is depleted, the engine will charge the battery in order to give approximately 12.5 miles of Pure electricity driving.

AWD

Pressing the AWD button activates the electrical four-wheel drive. Instead of the mechanical power transfer of conventional four-wheel drive, the central control unit distributes power between the diesel-driven front wheels and the electrically-driven rear axle. The electric four-wheel drive system has been designed to provide better grip when starting and when driving on slippery roads, for instance in snow or mud.

However, owing to the electric motor's lower power, torque to the rear wheels is limited and four-wheel drive is active up to 75mph.

When four-wheel drive is activated, the diesel engine operates continuously and the generator ensures that the charge level in the battery pack is sufficient to supply the rear axle with the necessary power.

Since electric four-wheel drive is only activated by the driver when necessary, it is more economical than conventional permanent four-wheel drive.

Charging and the Electrical System

The Volvo V60 Plug-in Hybrid is recharged via a regular power socket (230V/6A, 10A or 16A) at home or in a car park. The charging time depends on the level of the current. A full 10A charge takes 4.5 hours. The time is shortened to 3,5 hours with 16A, while a charge in a 6A socket takes 7.5 hours.

Each vehicle is supplied with a charging cable that makes it possible to charge from a regular mains 3-pin socket. A regulator incorporated into the charge lead allows the customer to choose the number of amps the vehicle can draw from the electrical supply. As part of the buying process, customers are urged to check and ensure their electrical supply at home (or point of charge) is safe to take the necessary draw.

The vehicle is fitted with a Mennekes socket and there are a number of leads available that allow the driver charge the vehicle dependent on their charging source:

- Mennekes to UK 3-pin - standard cable supplied with the vehicle
- Mennekes to Mennekes - allows for 16 amp 'smart' charging, cutting the charging time
- Mennekes to European 2-pin - for use within European mainland
- Mennekes to 16amp 3-pin socket - can be connected to 3-pin industrial socket, caravan and motor-home socket.

Battery Pack

The battery pack is a 11.2kW lithium-ion battery located in the rear of the vehicle and consists of 10 modules, each containing 20 cells. There is an integrated computer that monitors the system and compares temperature and charge level in each of the 200 cells. The battery pack also has an integrated water-cooling system driven by the car's climate unit.

Confidence in the longevity of the battery fitted is supported by an 8 year/100,000 mile warranty to cover defects in its construction and charge capacity.

Integrated Starter Generator (ISG)

The ISG is used to start the diesel engine when required. It is directly connected to the crankshaft and is much quicker and quieter (a consequence of silent electrical running) than a traditional starter motor. It also acts as a generator by using the diesel engine to charge the battery pack and provide power direct to the rear motor when required.

Heating and Air-conditioning

To aid in the pre-conditioning and ensure the climate within the car is as required when not using the diesel engine, the V60 D6 AWD has a fuel driven heater and electric air-conditioning. As with all of Volvo's diesels, the PTC heater is used (like an electric bar heater) to heat the cabin, however if this is insufficient, the fuel (diesel) driven heater will engage to heat the cabin. Normal air-conditioning only operates while the engine is running, however during electric operation this would not work. Therefore, an electric air-conditioning system is fitted to ensure the climate within the cabin is as required.

Running costs

The cost of the battery pack means the plug-in hybrid is more expensive to buy than a Volvo V60 with a conventional combustion engine. However, fuel costs are one-third compared with a conventional combustion engine and the electric motor is almost four times as efficient. The exact cost depends on the customer's energy supplier but is roughly £1.30 for a full charge, giving up to 31 miles of range.

European electricity production has an emission ceiling, meaning that even if all vehicles were to run on electricity, electricity production itself is not allowed to produce more carbon dioxide. Emissions from millions of exhaust tailpipes would be transferred to a small number of production facilities which are easier to control and which will operate on the basis of the EU's trade in emission rights, something that does not apply to the transport sector at present.

Electric vehicles use relatively little electricity, for instance, a single wind-power station produces sufficient renewable energy to power 3,000 electric cars.

Preconditioning

To get a comfortable start to the journey, the driver has the possibility to preheat or cool the passenger compartment during the recharging process. This means that more battery capacity

can be used for powering the car once on the move.

The pre-conditioning also includes the possibility to cool the batteries. The battery pack has an ideal working temperature of 20-30°C. This means that the pre-cooling is highly important for maximising the charging capacity and thereby the driving range on each charge. The timing is programmed via the car's setup menu or remotely via Volvo On Call.

According to the settings set by the driver, the V60 D6 AWD has two heating possibilities:

- When plugged in, a PTC (Positive Temperature Coefficient) air heater is used. This can also be used while the vehicle is in motion and being driven on electric only.
- The car also has a Fuel Operated Diesel heater that can be used if the car determines that the PTC has insufficient power to reach the required temperature.
- The air-conditioning will be activated if plugged in in order to cool the passenger compartment.

There is a setting within the car menu to select whether the vehicle is inside or outside and also if the fuel operated heater should be used, in order to stop fumes from the heater being emitted in an enclosed space.

Unique Acoustics

Volvo Car Group faced new challenges when developing the V60 D6 AWD due to the virtual silent electric running which alters the car's acoustic footprint both inside the vehicle and in the surrounding road environment.

To many, the electric car is described as being totally silent, but from an acoustic expert's perspective the electric car's silence is a bit of a misnomer.

"The combustion engine sound is instinctively connected to our perception of driving a car. It works as an acoustic mat that blankets other sounds. When that mat is lifted off, you suddenly become aware of a number of other sounds," says Martin Spång at Volvo Car Group's Sound laboratory.

In a plug-in hybrid car, sounds such as the splashing of diesel in the fuel tank now penetrate the driver's consciousness when the car runs solely on electric power. There is the same heightened awareness of noise from the road surface, wind, pumps, fans and relays.

When the diesel engine cuts in again, however, the car sounds once more 'normal'.

In order to find the right acoustic profile for the Volvo V60 Plug-in Hybrid, Volvo Car Group's experts worked on the creation of an ideal, uniform sound in their computers. The challenge is to adjust all the various noise sources so that the car reproduces this uniform sound irrespective of the propulsion mode being used.

To combat this challenge, Volvo Car Group's acoustic lab was used. A 2500 square metre concrete chamber where the silence is so oppressive that it is almost audible. Sound-absorbing wedges coating the walls and ceiling are designed to dampen reflecting sound. The lab is entirely insulated from the rest of the building to prevent any background sound from seeping through.

The floor is hard and smooth so as to resemble and reflect sound in the same way as a road surface does. Test cars can be driven on rollers with various surface treatments to simulate different road types.

Production

The assembly of the world's first diesel plug-in hybrid has been successfully integrated on the same production line as the regular powered V60, V70, XC70, S80 and XC90 models at the Torlanda plant in Gothenburg. Volvo Car Group is the first in the industry to integrate a plug-in hybrid in an established production flow together with other car models. This integration has allowed the possibility in principle of having the same options available as the standard V60.

All the additional equipment and additional systems in the plug-in hybrid have led to parts of the final assembly line being rebuilt and modified. The adaption makes it possible to smoothly integrate the assembly of over 300 more parts that are included in the plug-in hybrid compared to an equivalent V60.

A few examples of the integrated production flow are:

- The electric motor along with its drive shafts is fitted on the same station as the final drive on the standard all-wheel drive models.
- The cooling system and the high voltage cables are assembled on the Pallet, which is used to assemble the car's drive train and chassis parts.
- The battery pack is lifted in through the car's tailgate short side forward. It is then spun a quarter of a turn in the passenger compartment - a manoeuvre that takes 60 seconds and carried out with less than 20 millimetres to spare.

Options

Personal Car Communicator

Although very similar to the look of the standard remote fob, the PCC can do a lot more than just activate the locks and alarm. A simple push of a button can, within a few seconds, tell the car owner if:

- the car is locked or unlocked
- the alarm has been triggered

The information is available and up-to-date as long as the distance between the PCC and the car is 100 metres or less. In addition, the most recent data is logged so the owner can at any time and any place check whether the car was locked when it was parked.

Park Assistance

While reverse park assist sensors are fitted as standard, front park assist sensors are available as an option, as is the fitment of a reverse camera showing guide lines.

Towing

A rarity amongst hybrid vehicles, the V60 D6 AWD has been developed to allow owners to tow trailers. The max braked towing weight is a hefty 1800kg which matches the rest of the 2.4 litre twin turbo powered V60s. If a Volvo towbar is fitted, the electrical system and hybrid system is tailored, such as the reverse sensors being disabled when selecting reverse. Included is also a stability program called Trailer Stability Assist (TSA). TSA dampens the swaying 'snaking' motion that can occur when towing, which can sometimes lead to serious accidents. TSA operates with the DSTC system to stabilise the rig by braking one or more wheels while at the same time restricting the engine's torque.

Volvo On Call

Volvo's On Call system uses advanced telematics to call for help during an emergency. The system uses the integrated GSM telephone and GPS satellite navigation to automatically call the emergency services when an airbag or seatbelt pre-tensioner is triggered during an accident. Alternatively, you can ring the emergency services by pushing a red SOS button located by the front reading light switches.

If the car breaks down or you need help, pressing the Volvo On Call button will put you straight through to a Volvo On Call operator who can offer roadside assistance.

Volvo On Call also offers vehicle tracking in case of theft.

Volvo On Call App

Available to download free on iPhone, Android and Windows smartphones, the app enables users to connect to the vehicle and to view a wide variety of information about their car. Features include checking whether the car is secure (if not, users can lock the doors remotely), locating the vehicle on a map (useful if you've parked in an unfamiliar city), see fuel level, average mpg, mileage and trip meter data, plus basic maintenance details such as bulb faults, and brake fluid, oil and coolant levels. It also allows users to see a driving journal, outside temperature at the car's location, honk and flash (handy for locating the car in a busy car park), passenger compartment preconditioning, hybrid battery state of charge, charge reminder and a charge interruption warning.

First launched in 2011, total downloads of the Volvo On Call app have reached 52,000, with the UK market accounting for 7%. Amongst the current features, research has shown that the most used features are the car locator and viewing the driving journal.

Sensus Connected Touch

Sensus Connected Touch enables connectivity and Internet in the car and turns the 7-inch display into a state-of-the-art infrared, beam-scanned touch screen. The user has access to full Internet browsing (except when driving), voice activated digital music service Spotify, Internet radio (TuneIn and Orange Live Radio) with thousands of channels from all over the world, on-line (Google) Map and Search, Embedded Connected 3D navigation with online traffic info and dangerous zone warnings, Free Parking locator, weather information, a number of native and web applications, App Store for new functions and updates as well as a Volvo service locator.

Option Packs

- Winter Pack - heated windscreen and heated washer nozzles
- Winter Illumination Pack - heated windscreen, heated washer nozzles, auto dimming outer rear view mirrors and extra interior lighting.
- Driver Support Pack - Collision Warning with Full Auto Brake, Pedestrian and Cyclist Detection, Adaptive Cruise Control, Distance Alert, Queue Assist, Lane Departure Warning, Driver Alert Control, Active High Beam, Road Sign Display, Blind Spot Information System and Cross Traffic Alert.
- Family Pack - integrated 2-stage booster cushions on outer rear seats and power child locks.
- Security Pack - Personal Car Communicator, keyless drive and laminated windows including water repellent front side windows.

Safety and Security

"Cars are driven by people, therefore the guiding principle behind everything at Volvo is, and must remain, safety." declared co-founders Assar Gabrielsson and Gustaf Larson. This has been the guiding principle behind everything designed and built at Volvo Cars since the first car was built back in 1927.

Volvo has been a safety pioneer ever since the company was founded with inventions such as the three-point seat belt, the safety cage, rear seat belts and side impact airbags. To continue this, Volvo has concentrated on the unique aspects of hybrid safety with the overall goal of giving the same safety standard in the V60 D6 AWD as the conventionally powered V60s.

City Safety

Fitted as standard, City Safety avoids low speed accidents - statistically, the most common type of crash. These accidents typically happen in towns and they typically involve tailbacks of traffic. City Safety either eliminates such accidents or reduces the severity of the impact. The system works up to speeds of 31mph.

A laser sensor, fitted behind the rear-view mirror and looking through the windscreen, keeps an eye on traffic in front of the vehicle. It can detect vehicles up to 6 metres (approximately 30 feet) in front of the car's front bumper. City Safety reacts to vehicles in front that are either stationary or moving in the same direction.

City Safety helps either avoid or reduce the severity of the collision by automatically braking the car and reducing the throttle opening.

Volvo Car UK's own statistics show that chauffeur company, Tristar, reduced its 'at fault' rear impacts by 28% in the first six months of trialling City Safety.

Pedestrian and Cyclist Detection

Pedestrian Detection with Full Auto Brake was first launched in 2010, and 2013 sees the enhancement of this system to now include detection of cyclists. It uses a radar unit integrated into the car's grille, a camera fitted just behind the interior rear-view mirror, and a central control unit. The radar detects any object in front of the car and determines the distance to it. The camera

determines what type of object it is.

If a pedestrian or cyclist is detected, the driver first receives an audible warning combined with a flashing light in the windscreen's head-up display. At the same time, the car's brakes are pre-charged. If the driver does not react to the warning and an accident is imminent, full braking power is automatically applied.

This system can either stop or reduce the severity of the impact and likelihood of serious injury or death.

Collision Warning

Volvo's world-first Pedestrian Detection is a technical development of the company's Collision Warning system, which uses the nose-mounted radar to warn drivers if they're about to hit another vehicle, and apply the brakes automatically if necessary.

Unlike Pedestrian and Cyclist Detection and City Safety, this automatic braking technology is designed for higher speed, such as that encountered on motorways. A radar sensor fitted behind the grille, and a digital camera behind the windscreen, automatically monitor the distance to the vehicle in front.

If the vehicle in front suddenly brakes, or is stationary, or you are travelling too close, a red warning light flashes on the windscreen and a warning buzzer sounds. The braking system is also automatically pre-charged to prepare for panic braking: the pads move closer to the discs and the hydraulic brake pressure is increased. If the driver does not react to the warnings and a collision is imminent, automatic braking is applied to reduce the severity of the accident.

Automatic braking is only applied as a last resort. If the driver does not react or is too late, the car will automatically brake.

Lane Departure Warning

The Lane Departure Warning (LDW) helps the driver stay in the intended lane. The forward-looking digital camera monitors the left and right lane markings. LDW registers the car's progress between the lane markings and generates a sound if the driver shows signs of unintentionally drifting out of the lane or crossing the lane marking.

Blind Spot Information System

The V60 D6 AWD offers enhanced Blind Spot Information System (BLIS), which is now radar-based, to help the driver avoid potentially dangerous lane-changing manoeuvres. The technology can monitor and alert the driver to rapidly approaching vehicles up to 70 m (166 feet) behind the car. Of course, it still informs the driver about vehicles in the blind spots on both sides of the car.

The BLIS uses radar sensors located in the rear corners of the car, behind the bumper cover. The radar continuously scans the area behind and alongside the vehicle.

Warnings are displayed in LED indicators located in each A-pillar. A steadily glowing LED indicates when the radars cover a vehicle in the zone. The second warning level - LED flashing - occurs if the driver uses the turn indicator when the first alert is active.

Cross Traffic Alert

Cross Traffic Alert uses the same radar sensors at the rear end of the car to alert the driver to traffic crossing from the sides when he or she is reversing out of a parking space. This is especially helpful in tight and crowded areas where the side view might be limited or impaired.

The function warns of traffic up to 30 metres (100 feet) from the car. Smaller objects like bicycles and pedestrians may also be detected. The alert, which remains active as long as the target is present in the zone, is delivered to the driver as an audible signal and a warning in the centre screen.

Adaptive Cruise Control

To help the driver maintain a safe distance from the car in front, Volvo has developed Adaptive Cruise Control (ACC). It uses a radar sensor to measure continuously the distance to the vehicles in front and automatically adapts the speed of the car to help ensure the distance is not too short

Driver Alert Control

A unique technology to alert tired and distracted drivers, Driver Alert Control monitors the car's progress between the lane markers and warns the driver if his or her driving pattern changes in a random or uncontrolled way.

Active High Beam

Active High Beam now makes it possible to use high beam continuously thanks to an ingenious mechanism that prevents dazzling of oncoming drivers. The main advantage of Active High Beam Control is that the traffic environment outside the shaded area is still illuminated by the high beam. This improves the driver's chances of detecting objects at the side of the road, such as parked cars, unprotected road users and animals.

When an oncoming car approaches or when catching up with another car from behind, the system helps to prevent dazzling of the other driver by shading out only as much of the beam as necessary.

A digital camera monitors other vehicles and their headlamps and tail lamps. Advanced image processing software analyses this data and provides information about the position and direction of other vehicles. The calculation serves as the basis for automatic shading.

Active Bending Xenon Lights

Compared with conventional halogen headlights, Volvo's active bending lights - using dual xenon technology - more than doubles the driver's range of vision. The lamps are motorised, and can turn up to 15 degrees in either direction, as they follow the direction of the steered wheels. Thus, they help the driver to "see around corners". The headlights also self-adjust, always maintaining the correct angle to the road, maximising illumination and avoid dazzling oncoming motorists.

Road Sign Information

This technology displays road signs in the instrument display. The forward-facing camera detects speed limit signs as well as "no overtaking" signs and the road sign icon is then displayed until a new sign is detected.

Other Safety Equipment - all fitted as standard

The V60 D6 AWD features world-class crash safety including a safety cage with effective deformation zones and various grades of high-strength steel.

Safety belt pre-tensioners are standard in the front and outer rear seats and the front seats are equipped with whiplash protection (WHIPS) to help prevent neck injuries. Both the driver and front seat passenger seat have dual stage airbags. There are also side airbags integrated in the front seat backrests.

The Roll Over Protection System includes a robust body structure, seat pre-tensioners and Inflatable Curtains. The Inflatable Curtains cover both sides, from the A-pillar to the C-pillar, and deploy in frontal offset, side or rollover accident situations.

Hybrid Safety

The Volvo V60 D6 AWD was designed to offer the same safety standard as any other Volvo and it includes a systematic approach to all safety aspects related to battery power when it comes to owning and driving and also in the event of an accident.

Volvo Car Group is conducting wide-ranging and thorough analysis of a variety of safety scenarios for cars with electric power. Through advanced automatic monitoring of battery status and by encapsulating the battery and protecting it effectively in a collision, the result is a world-class safety level.

Due to the electric power, it adds new possible safety scenarios to the overall picture and these too must be dealt with. Volvo's safety experts have meticulously analysed the five accident sequence phases and developed unique solutions for the battery and for protection of the occupants as necessary.

1. Normal driving: An advanced monitoring system keeps watch and ensures that each cell maintains the correct voltage level and optimal operating temperature by regulating the cooling system. This is of significance to safety as well as for battery capacity. In the event of any deviation, the battery is automatically shut down as a preventive measure.

2. Conflict: The battery pack adds weight that can create new conditions for the vehicle's dynamics and alter the car's behaviour, for instance in fast avoidance manoeuvres. The braking system can handle the increased mass, and DSTC (Dynamic Stability and Traction Control) helps the driver contain the situation.

3. Avoidance: If a frontal collision is imminent and the driver is acting too late to brake the car, automatic systems such as Collision Warning with Full Auto Brake and City Safety are activated to help avoid or reduce the effects of a collision.

4. Collision: In order to reduce the effects of a collision, the safety experts have focused on protecting all electrical components.

The rear structure has been modified to ensure a controlled deformation that helps protect the battery pack, which is located under the load floor. Steel beams and other parts of the structure are reinforced. The battery pack is also sturdily encapsulated.

The electric system is monitored by two systems:

- Crash sensors linked to the battery measure the physical collision forces. At the very moment of collision, they send information about the collision to the car's computer, which automatically shuts off the power supply.
- Insulation measurement reacts on deviations in the electrical system. The contactors are opened immediately to brake the power if an earth fault is detected
- If the battery is damaged, resulting in gas leakage, there are special evacuation ducts that lead the gas out under the car. In the event of extreme heat, the occupants are shielded by the battery's encapsulation.

5. After the collision: Volvo Car Group will work together with the emergency rescue services, providing them with detailed instructions on how to safely make sure that the power supply is disconnected before the rescue work begins.

The high voltage in the battery is separated from the car. All high voltage cables are orange to make them easy to identify.

Future Technology

VEA and SPA

Volvo's next generation cars will be built on its own in-house vehicle platform, labelled SPA (Scalable Product Architecture). It has been designed to consist of shared modules and scalable systems and components, all manufactured in a flexible production system to allow for different types and sizes of future vehicles. The first vehicle to be built on the SPA platform will be the all-new XC90, due on sale in the UK in 2015.

In parallel with SPA, Volvo Car Group is also developing an all-new four-cylinder fuel-efficient engine family known as VEA (Volvo Engine Architecture). These engines will be built in Skövde and will start to make their appearance during 2013.

XC60 Plug-in Hybrid Concept

Volvo Car Group unveiled the XC60 Plug-in Hybrid Concept at the North American International

Auto Show in Detroit in January 2012, a highly economical hybrid and powerful high-performance car rolled into one. It features much of the same technology and also has the same Pure, Hybrid and Power buttons as the V60 Plug-in Hybrid, however, is fitted with a 280hp four cylinder VEA petrol engine powering the front wheels and a 70hp electric motor powering the rear wheels. To demonstrate the potential power, it carries the T8 badge.

Electric car recharging time cut to 1.5 hours

Volvo Cars Group has started initial testing of a new fast-charger for electric cars that cuts recharging time to an outstanding 1.5 hours - six times faster than today's on-board devices. The new charger has been installed and is being evaluated in a number of Volvo C30 Electric cars.

Car body panels to serve as the car battery

Tests are currently under way on body panels serving as rechargeable batteries. A battery that stores braking energy while you drive and that also stores energy when you plug in the car overnight to recharge. Among the foremost challenges in the development of hybrids and electric cars are the size, weight and cost of the current generation of batteries. In order to deliver sufficient capacity using today's technology, it is necessary to fit large batteries, which in turn increases the car's weight.

A composite blend of carbon fibres and polymer resin is being developed that can store and charge more energy faster than conventional batteries. At the same time, the material is extremely strong and pliant, which means it can be shaped for use in building the car's body panels. According to calculations, the car's weight could be cut by as much as 15 per cent if steel body panels were replaced with the new material.

The combustion engine that drives the front wheels is switched off as soon as the braking begins. The energy in the flywheel can be used to accelerate the vehicle when it is time to move off once again, or to power the vehicle once it reaches cruising speed.

Inductive charging for electric cars

Volvo Car Group is participating in an inductive charging project to develop systems and methods that need neither power sockets nor charging cables. With inductive charging, energy is transferred wirelessly to the car's battery via a charging plate buried in the road surface.

The charging plate consists of a coil that generates a magnetic field. When the car is parked above the plate, energy from the plate is transferred without physical contact to the car's inductive pick-up. The energy that is transferred is alternating current. This is then converted into direct current in the car's built-in voltage converter, which in turn charges the car's battery pack.

Flywheel technology

Studies show that flywheel technology that could not only cut fuel consumption by up to 20 per cent, but also help produce a very eco-efficient solution that makes a four-cylinder engine feel like a six-cylinder.

The aim is to develop a complete system for a kinetic energy recovery system, known as KERS. During braking, the resulting energy causes the flywheel to spin at up to 60,000 revs per minute. When the car starts moving off again, the flywheel's rotation is transferred to the rear wheels via a specially designed transmission.

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