

Press Release

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Volvo Cars' new Drive-E powertrains - efficient driving pleasure with world-first technologies

Volvo Car Group's (Volvo Cars) new Drive-E range of powertrains takes efficient driving pleasure to a new dimension in which the number of cylinders is no longer important to describe power and drivability. The first diesel engine from the 2-litre, 4-cylinder Drive-E powertrain family is now available to order. This new diesel version features world-first i-Art technology, helping lower emissions and increase drivability.

"We have created smaller, more intelligent engines with power curves that give exciting driveability compared with engines with more cylinders, yet deliver the fuel economy of only four cylinders. In addition, by adding electrification such as plug-in hybrid technology, we will reach power figures in the V8 territory," says Derek Crabb, Vice President Powertrain Engineering at Volvo Cars.

The whole Drive-E engine range, which during the development phase was called Volvo Engine Architecture (VEA), basically consists of two 4-cylinder engines, one common rail diesel and one direct-injected petrol version. They replace eight engine architectures on three platforms. In the future, Drive-E diesels will range from 120 to 230hp while petrol versions will start at 140hp and go all the way up to 300-plus hp.

Several levels of turbo charging open up the flexibility to cover the whole range, from fuel-efficient derivatives through to high power and torque variants. In order to cover all customer requirements, some engines will also gain added performance via electrification or other spearhead technology.

The Drive-E powertrains project started back in 2008 and has commanded a 2 billion SEK investment in the engine plant. It is expected that the new Drive-E engines will be fully implemented in all Volvo cars by the end of 2015.

Volvo Cars' powertrain experts have developed the engines in-house and built at Volvo Cars' high-tech engine plant in Skövde, Sweden.

Such is the demand for the new D4 in the UK, current lead times are stretching to approximately 4 months, double that of every other engine available within the range.

"The sophisticated Drive-E technologies give the customer high performance, improved fuel economy, considerably lower emissions and a powerful sound character. Our 4-cylinder engines will offer higher performance than today's 6-cylinder units and lower fuel consumption than the current 4-cylinder generation," says Derek Crabb. He adds: "If you take a 4-cylinder Drive-E engine versus any 6-cylinder engine, there's a massive weight and size reduction for the same power. Fuel economy savings are anything from 10 to 30 per cent, depending on which engine you're comparing it to."

Drive-E introduction to the UK

Initially, the new S60, V60, XC60 FWD, V70, XC70 FWD and S80, will be available with the first diesel engine from the Drive-E family, the new D4, with 181hp. Powering the front wheels, the D4 is fitted with a 6-speed manual transmission as standard and available with a new 8-speed automatic gearbox, contributing to a refined drive and excellent fuel economy.

New 8-speed automatic gearbox

To deliver an increased responsive, smooth and fuel-efficient drive, the engine can be teamed up with a new 8-speed automatic gearbox.

The driver is able to change gear manually using the gear-lever and is also able to put the gearbox into Sport mode that quickens up the accelerator pedal response and provides gearshift points at higher engine speeds. Also available as a cost option is Paddle Shifters which are fitted on the rear of the steering wheel, allowing the driver to change gear manually without moving his/her hands from the steering wheel.

Prepared for electrification

The Drive-E engines are prepared for future electrification from the start. Key components, such as the Integrated Starter Generator (first seen in the world's first plug-in diesel hybrid, the V60 D6 AWD), can be connected easily - and the compact size of the 4-cylinder engines means that the electric motor can be fitted in the front or rear of the vehicle. The battery pack will be located in the centre of the car.

Downsizing without compromises

Volvo Car Group is highly confident that the focus on 4-cylinder Drive-E powertrains is the right way to create the desirable blend of power, drivability and fuel efficiency.

"The power you get from an engine has nothing to do with its size; it is about the amount of air that you can get to flow through it. You can also make an engine more efficient if you make it smaller. So, if you can get more air through a smaller engine, you can still get the same power but at better efficiency," says Derek Crabb, concluding: "When I was involved in Formula One engines, they were producing 1.5-litre turbo charged engines capable of over 900 hp. And these new Volvo Drive-E engines have in fact been tested on the racetrack already. The engine we used in Volvo's WTCC car in 2011 was a Drive-E prototype and by the last race we set a new track record."

Fleet Proposition

With high performance and low CO₂, the new D4 engine gives company car buyers a no compromise choice with beneficial monthly BIK tax payments. In comparable power and transmission combinations, Volvo now offers class-leading emissions resulting in class-leading BIK figures. Examples:

Volvo	Benefit In Kind Monthly Payments (2013/2014)		Competitor Example	Benefit In Kind Monthly Payments (2013/2014)	
	20%	40%		20%	40%
S60 D4 Business Edition	£53.99	£107.99	BMW 320d SE	£89.79	£179.58
S60 D4 Business Edition Auto	£65.67	£131.33	BMW 320d ED Step Auto	£79.68	£159.36
V60 D4 Business Edition	£56.79	£113.59	Mercedes C220 Estate Executive SE	£85.27	£170.54
V60 D4 Business Edition Auto	£68.87	£137.73	Mercedes C220 Estate Executive SE Auto	£110.53	£221.06
XC60 D4 FWD R-Design	£97.02	£194.04	Land Rover Freelander 2.2 eD4 Dynamic 2WD	£138.99	£277.98

Technical Information

Engine

All engines produced fulfil the stringent requirements for consumption and emissions with environmental impact and meet all global exhaust requirements in force between 2013-2017 (EURO6b, LEVIII and PZEV).

Compared with existing engines with equivalent output, a significant weight saving of between 30kg and 50kg per car can be made.

The Drive-E engine family is characterised by the following:

- **Reduced Inner Friction** - Generally improves the engine's efficiency, resulting in lower fuel consumption and higher power output. Examples of friction-improving measures include improved surface treatment of cylinder bore and crankshaft, as well as a fully variable oil pump. A new thinner synthetic engine oil is also used to improve friction.
- **Smart Heat Management** - The facility to "short circuit" the water pump enables the coolant flow to be minimised and the warming-up phase to be shortened. From this, climate performance and fuel economy can be optimised.
- **Fuel Injection with Pressure Control** - The fuel injections can be controlled very effectively using the advanced i-ART nozzles.
- **Advanced Combustion Control** - Optimised combustion chambers and inlet ducts, together with swirl dampers and an injection pressure of up to 2500 bar, are parameters that ensure the conditions for high performance and low emissions.
- **Belt-driven Fuel Pump** - The high-pressure fuel pump needed a higher speed in order to provide for the high rail pressure of up to 2500 bar. The pump is therefore driven at the same speed as the crankshaft via the camshaft's drive belt.
- **Exhaust After-treatment with LNT (Lean NOx Trap)** - Euro 6 is fulfilled by means of a very precise control of the fuel injections, in combination with a change in hardware in the catalytic converter.

The basic engine design is very similar to previous engines used within Volvo cars for both petrol and diesel. Both the engine block and cylinder head are produced in aluminium while the cylinder head itself is chill cast while the cylinder block and sump are pressed aluminium alloy.

The crank system in the new engine family is largely the same regardless of whether it is a petrol or diesel engine. The same crankshaft is used for all variants, while there are small differences in pistons and connecting rods.

The diesel engines in the Drive-E family use four-valve technology and twin camshafts. Drive takes place via a belt in front of the engine where the timing belt drives the exhaust camshaft with a timing belt pulley, while the intake camshaft is driven by the exhaust camshaft via drive gears in the rear of the engine. The timing belt also drives the high-pressure fuel pump and mechanical water pump.

The electric pump in the fuel tank supplies the high-pressure pump with fuel. The high-pressure pump is driven by the timing belt.

i-ART (intelligent Accuracy Refinement Technology)

i-ART is the result of a close collaboration with Denso, creating a new common-rail diesel injection system. The ECM (Engine Control Module) measures the pressure and temperature in each injector via sensors in each of the injectors. By monitoring the pressure and temperature in each cylinder, the fuel injection can be adjusted for each individual cylinder. Conventional diesel injection systems use a single pressure sensor in the fuel rail, which only controls the injection pump. However, on Drive-E engines, each injector has a pressure and temperature sensor that monitors the injection process. This information ensures that the i-ART system injects the ideal amount of fuel into each cylinder.

Several injections per work cycle ensure a precise combustion and reduced combustion noise. This helps with economy and engine knock associated with diesel engines. System capacity is up to 9 injections per work cycle, but normal driving uses approx. 3-4 injections.

The combination of higher injection pressure (up to 2500bar compared to existing 1800bar) and i-ART technology improves fuel economy and results in lower emissions and higher engine power output. This can provide up to 2% improved fuel economy.

The new D4 engine has a two-stage turbocharging system consisting of turbochargers from Borg-Warner. The engine is set-up with a small and a large turbo, very similar to the system on the existing 5-cylinder D5 diesel engine. The small turbo helps at the lower engine speeds and when the engine reaches higher engine speeds, the second turbo kicks in. This helps to build torque quickly, smoothly and efficiently with minimal turbo-lag, and compared to the previous D4, allows the torque curve to continue for a longer period of time.

Emission Control

The close-coupled catalytic converter also has a particulate filter built in. In addition to functioning as a conventional oxidation catalytic converter for HC and CO, the catalytic converter substrate takes care of the residual NOx gas by means of a so-called LNT (Lean NOx Trap). LNT works by means of a different mixture of precious metals binding the nitrogen oxides to the substrate, which

is then emptied at regular intervals in accordance with a special procedure.

The catalytic converter/LNT allows the D4 engine to pass Euro 6 emission certification.

Cooling system

To help with heat management, the D4 engine uses a mechanical water pump. In addition to the mechanical water pump, two further electric water pumps are used, one for cooling the EGR when the vacuum valves are closed, and one for the passenger compartment (Start/Stop).

In order to achieve faster heating of both the engine and the passenger compartment, a number of valves are used that regulate where the coolant within the system is distributed, helping to limit the cooling capacity when not required.

EPAS (Electrical Power Assisted Steering)

The S60 and V60 with the D4 engine are equipped with EPAS, an electricity-assisted rack steering gear with a parallel-mounted electric motor. In principle, EPAS in the S60 and V60 works in the same way as EPAS in the V40.

The EPAS allows for the integration of safety and driver support functions that involve the steering, such as Lane Keeping Aid and Park Assist Pilot. Lane Keeping Aid applies extra steering torque to the steering column when the car gets close to a lane marking and is about to leave the lane. The forward-looking digital camera monitors the left and right lane markings and the Lane Keeping Aid registers the car's progress between the lane markings and takes action if the driver shows signs of unintentionally drifting out of the lane. As a first step, the car applies gentle steering wheel torque to help the driver steer back onto the intended course. If the car leaves the lane, the technology generates a distinctive warning through a haptic vibration in the steering wheel.

EPAS also allows for the fitment of Park Assist Pilot. This technology helps the driver parallel park the vehicle by taking control of the steering while the driver only has to control the speed. The parking manoeuvre is based on front, rear and side-facing ultrasonic sensors.

Transmission

The same thinking behind the reduction of the number of engines available was also behind the new gearbox strategy. Up to eight different types of gearbox have been available world-wide, but with the introduction of the Drive-E family, this reduces to just two, the 8-speed automatic and the 6-speed manual.

New 8-speed Automatic Gearbox

The new gearbox is an electronically controlled 8-speed automatic gearbox developed together with Aisin AW. By using eight gears, the engine is allowed to operate at a load where the efficiency is highest. The engine's speed can be kept low, resulting in low fuel consumption and thus also low CO₂ emissions.

The eight gears allows for a wider gear range, the first gear being lower to help acceleration and the top gear being higher to benefit fuel consumption at higher cruising speeds, with the entire range helping to increase drivability. The gear changes themselves have been improved and the speed at which the gears change has also been increased.

ECO+

ECO+ is a function for cars with the automatic gearbox and can reduce fuel consumption by up to 5% depending on the driver's driving behaviour. The function allows the driver to drive the car in a more environmentally conscious manner.

NB. Published fuel consumption figures are conducted WITHOUT using ECO+ mode.

On activation of ECO+, the following are activated:

- Eco Coast - means in practice that engine braking is deactivated at certain speeds
- Accelerator pedal response - a softer application of the response, which then requires longer pedal travel
- Gearshift points - changed gearshift pattern
- Climate control system - air conditioning deactivated, amongst other things
- Changed behaviour of Start/Stop
- Changed strategy for activating the turbo

Eco Coast is a function that helps the driver to maintain the car's kinetic energy when the accelerator pedal is released, at which point engine braking is deactivated and the engine changes down to idling speed.

For further reduction of fuel consumption, the internal combustion engine will be switched off directly during braking, as soon as the speed has dropped to approximately 4mph, up from the standard 0mph.

New 6-speed Manual Gearbox

The manual gearbox has been revised and modified in several areas:

- Lower weight
- Revised internal components
- Reduced oil volume
- Internal friction reduction

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Old S60, Old V60, Volvo XC60, Press Releases, 2014, XC70 (2008-2016), V70 (2008-2016), S80 (2008-2016), Product News

Descriptions and facts in this press material relate to Volvo Car UK's car range. Described features might be optional. All information is correct at time of going to press and may be altered without prior notification.

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