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This article first released by: Land Rover
In: Feb. 2006
Due to this article's content, it appears within the Transport section in the following areas:
Manufacturers.

LAND_e, LAND ROVER'S e-TERRAIN TECHNOLOGY CONCEPT SHOWCASES NEW ENVIRONMENTAL INITIATIVES

- Innovative application of environmental and efficient technologies that enhance both on- and off-road performance
- Real world solutions that will be available on Land Rovers progressively in the next few years
- Potential for 30 per cent improvement in fuel economy
- New technologies could reduce emissions to an approximate 150g/km CO2 (on a vehicle similar in size to a Freelander)

Land Rover is showcasing a catalogue of innovative technologies - collectively known as the e-Terrain System - that reduce both fuel consumption and CO2 emissions while also improving the outstanding breadth of capability of Land Rover's 4x4 vehicles.

The efficient technology initiatives are all illustrated by Land_e, Land Rover's e-Terrain Technology Concept. Together, they contribute to a potential 30 per cent improvement in fuel economy over a current vehicle of similar size and performance. And most of the technologies will be available on Land Rover production models starting in the next few years.

The key to Land_e's importance is that it shows available and relevant technologies - plus some new systems that are unique to Land Rover - in the most innovative and effective way possible. It combines mechanical and electrical advances to make gains in areas ranging from transmission function to cooling efficiency, and from battery power management to power steering efficiency - all without compromising the breadth of on- and off-road capability that defines all Land Rover products.

"The e-Terrain technologies are practical, feasible, real-world solutions," says Matthew Taylor, managing director of Land Rover. "In every case, they preserve - and in most cases improve - our breadth of capability. We are not prepared to dilute the essence of Land Rover. But we are committed to improving fuel economy and reducing CO2 emissions."

Over the past nine years, Land Rover's cross-range emissions output has fallen by 13 per cent, compared with the motor industry's overall average improvement of 9.7 per cent.

Indeed, the Freelander Td4 diesel's CO2 emissions compare with many hot hatches, and the seven-seater Discovery 3 TDV6 has CO2 emissions to match many saloons. Furthermore, the CO2 emissions from the latest 2006 Range Rover V8 have been improved by 11 per cent over those of the outgoing 2005 model.

In addition, more than 90 per cent of all Land Rover vehicles currently sold in Europe are diesel powered, combining the versatility of a 4x4 with the economy of a typical family car.

But the Company is committed to going much further. While adhering to Land Rover's core abilities as versatile, all-terrain vehicles, the Land_e technologies target a sub 150g/km CO2 figure which equates to a combined fuel economy figure approaching 50mpg or 5.65l/100km - in a vehicle similar in size to the current Freelander. Such CO2 emissions levels are comparable with a typical petrol B segment or diesel C segment car, representing an almost 30 per cent improvement on today's figures.

The technologies that Land_e showcases are:

- Integrated Electric Rear Axle Drive
- ISG Integrated Starter-Generator
- Innovative Propshaft with Seamless Re-connect
- Terrain Response e-Mode
- Bio-diesel capability
- ITP Intelligent Thermal Programme
- EPAS Electric Power Assisted Steering
- IMES Intelligent Management of Electrical Systems

Integrated Electric Rear Axle Drive: provides electric drive alone at low speed, plus improved 4x4 ability in tough conditions

Integrated Electric Rear Axle Drive - used in conjunction with the ISG Integrated Starter-Generator system (as described below) - improves both urban emissions and off-road ability.

Land Rover's unique electric drive is different from the hybrid technology used by some 4x4 rivals. They use electric drive only to the rear axle, significantly reducing off-road capability. Integrated Electric Rear Axle Drive enhances off-road performance by augmenting rather than replacing the mechanical drive.

Off-road, the Integrated Electric Rear Axle Drive system can provide additional torque, as required. And because electric power can offer maximum torque from standstill, it is most effective from virtually zero mph/km/h. This offers better low-speed control and enhanced pull-away in difficult situations - such as on slippery surfaces or when towing.

On-road, the additional low-speed torque input from the Integrated Electric Rear Axle Drive offers multiple advantages. It allows electric-powered 'traffic creep' and low-speed acceleration up to 20mph or 32km/h, without restarting the engine, benefiting fuel consumption and CO2 emissions. Whenever required, the ISG
system restarts the engine, and the vehicle is then propelled by a combination of electrical and conventional engine power. The combined effect of delaying the restarting of the engine plus the continued assistance of electric drive, significantly reduces fuel consumption.

When quicker acceleration is required, the engine can be restarted immediately, so both the conventional engine and the Integrated Electric Rear Axle Drive system supply power from rest. In this case, the electric torque boost provided by the Integrated Electric Rear Axle Drive significantly improves acceleration without adversely affecting either fuel consumption or CO2 emissions.

The additional low-speed electric torque boost not only gives extra off-road ability, it also improves efficiency by using stored energy from the additional high-voltage battery system. Completely separate from the normal 12-volt battery system, this is a high capacity lithium-ion battery pack which is charged by regenerative braking energy.

The regenerative braking puts otherwise wasted braking energy back into the high-voltage storage battery system. When slowing the vehicle, pressing the brake pedal causes the driveshafts and propshaft to transfer energy from the wheels to the Integrated Electric Rear Axle Drive system, decelerating the vehicle and transferring the 'braking' energy to the storage battery. For harder braking and for emergency stops, the conventional braking system is retained and fully operational, working in conjunction with the regenerative braking function.

ISG Integrated Starter-Generator system improves emissions in traffic

One of the simplest yet most effective CO2-reducing features highlighted on the Land_e is the ISG Integrated Starter-Generator. The ISG package replaces the conventional alternator and continues to take its drive from the normal ancillary
belt. It is a 'micro-hybrid' system that allows the engine to be stopped automatically whenever the vehicle stops, as in traffic, and under the control of the ECU it restarts the engine quickly and smoothly when required. The engine does not idle unnecessarily when the vehicle is stationary, to the further benefit of both fuel economy and CO2 emissions.

Together the engine stop-start function of ISG, plus the regenerative braking function, provided by the Integrated Electric Rear Axle Drive offer the potential of a 20 per cent reduction in CO2 emissions. The outstanding multi-terrain ability that is at the core of Land Rover is also enhanced.

Propshaft with Seamless Re-connect enhances driving experience, and improves economy

Seamless re-connect is a system that significantly reduces fuel consumption by cutting mechanical losses. Drive to the rear wheels is automatically disconnected when conditions allow, such as cruising on a dry surface. Yet unlike hybrid and selectable 4x4 systems, there is instant access to Land Rover's full range of four-wheel drive abilities. The Propshaft with Seamless Re-connect allows the Propshaft and rear drive components to come to rest, avoiding unnecessary rotational losses.

When rear drive is required - when, for instance, the system detects slippery conditions - the system reconnects the rear axle automatically and virtually instantaneously. The system not only re-engages full 4x4 much faster than rivals, it also offers much better 4x4 capability when connected. Re-engaging drive seamlessly also has safety benefits. It does not affect the car's dynamic balance in the same way as a slower and less progressive re-connection.

The technology also reinforces Land Rover's fundamental principle to 'Tread Lightly'. By ensuring that front and rear wheel speeds are correctly matched, and with the additional control of the Integrated Electric Rear Axle drive, the drive layout virtually eliminates wheel slippage, which in turn reduces soft-surface damage - for instance on grass.

The ISG Integrated Starter-Generator, Integrated Electric Rear Axle Drive and the Seamless Re-connect propshaft are fully compatible with all Land Rover engine and transmission options, and could be adapted for any model and any market.

Terrain Response e-Mode, for improved fuel economy in town

Land_e shows six Terrain Response modes:

The e-Mode is shown for the first time and focuses principally on on-road use. This configures all the vehicle's e-terrain systems for optimised fuel economy. It always retains instantaneous access to Land Rover's four-wheel drive capability but adopts soft throttle responses, and delivers early shift points.

The other five modes are already available on some Land Rover products - General Driving; Sand; Mud and Ruts; Grass, Gravel and Snow; and Rock Crawl. In the Land_e, all use combinations of normal engine and Integrated Electric Rear Axle Drive. In all off-road modes, the engine is never shut down, even if the vehicle is stationary.

In Sand mode, primary power is supplied by the engine; the Integrated Electric Rear Axle Drive system monitors torque to detect either wheelspin or bogging-down, and intervenes as necessary, either to stop tyre slip or to provide additional torque to deal with soft, deep sand.

In Mud and Ruts mode, primary power is again supplied by the engine, while additional torque is available from the Integrated Electric Rear Axle Drive system for heavier mud or deeper ruts.

In Grass, Gravel and Snow mode, control is more important than power, so engine power is fed in only once the vehicle is underway. Integrated Electric Rear Axle Drive is used for driving away without wheelspin even on very slippery surfaces - by constantly monitoring torque and intervening rapidly to prevent tyre slip. In this mode, the Integrated Electric Rear Axle Drive can respond to wheelspin even more quickly than the engine management, and can cancel the initial slippage within one-eighth of a wheel rotation - a critical figure that is small enough to regain grip and prevent permanent damage even on wet grass. No other system achieves this.

In Rock Crawl mode, speeds are typically below 5mph/8km/h. Integrated Electric Rear Axle Drive now provides the primary power source, boosted as necessary by normal engine torque. In all cases, the great advantage of Integrated Electric Rear Axle Drive is that an electric motor offers maximum torque at the lowest wheel speeds, for the ideal mix of power with control.

Bio-diesel moves towards a lower carbon fuel

An increasing emphasis on diesel power is clearly important to overall CO2 reductions, and bio-diesel capability extends the potential advantages. Bio-diesel is a fuel derived from renewable and sustainable sources, such as natural oils from soya beans or other easily cultivated vegetable or cereal crops. It is currently commercially available as a blend of bio-derived diesel and petroleum-derived diesel, in varying proportions, and bio-diesel offers reduced emissions compared with petroleum-derived diesel.

Currently, a five per cent bio-derived content is typical with forecourt diesel. Potentially, a vehicle could operate on a 25 per cent bio-diesel mix, which is a realistic goal within a few years, and one supported by the oil industry and governments. A vehicle running on 25 per cent bio-diesel mix could potentially reduce its CO2 emissions by up to 25 per cent. Next generation bio-fuels made from crop wastes are also being developed, and these will deliver even greater CO2 reductions, as well as being more sustainable.

Other important technologies can make a difference

Beyond the efficiency-enhancing drivetrain technology, the Land_e showcases other fuel saving technologies.

The ITP Intelligent Thermal Programme controls engine parameters including exhaust heat management and cooling system function. Through heat exchangers, the EHRS (Exhaust Heat Recovery System) utilises what is normally wasted heat from the exhaust system to promote faster engine and gearbox warm-up from cold, with several advantages. In a production application, ITP could also control Active Aero Vanes, which would allow specific sections of the radiator aperture to be closed under certain operating conditions. That would reduce high-drag airflow through the radiator core and engine bay when cooling air is not needed - for instance at low ambient temperatures and when running in low-load conditions. The vanes would also be closed during engine warm-up, again to ensure that the engine reaches optimum operating temperature as quickly as possible. Faster engine and catalyst warm-up significantly reduces emissions in the first minutes after a cold start, and by bringing engine and gearbox oils up to operating temperature more quickly, it reduces mechanical frictional losses.

An electronically controlled thermostat and cooling circuit give far more accurate control of coolant temperature than a conventional system, allowing the engine to run closer to its optimum temperature. The system also incorporates an electric water pump, which, unlike the conventional belt-driven water pump, is driven only on demand, and at variable speeds, avoiding inefficient and unnecessary overspeed running. Mechanical energy savings, optimum temperature control and fast warm-up from start offer the potential for additional CO2 emissions benefits.

Significant benefits are also possible with the use of electric power steering technology, EPAS (Electric Power Assisted Steering). EPAS completely eliminates the pumped hydraulic assistance of a conventional system and powers the steering rack directly, by electric servo motor. That eliminates pumping power losses,

including the significant losses when the pump is being driven at high speed even though assistance is not required, again offering a noticeable CO2 benefit compared to a belt-driven hydraulic system. The higher-voltage electrical supply made possible by ISG also allows the possibility of more powerful assistance for more demanding use - on off-road terrain, for example.

All electrical system functions are controlled by IMES (Intelligent Management of Electrical Systems), with further efficiency gains. It incorporates a closed-loop system that monitors battery charge, vehicle electrical system demands, and generator speed and load. It uses the monitored data to ensure that the whole electrical system operates in the most efficient way. It charges the battery only when it needs it, avoiding the over-charging associated with 'non-intelligent' systems, and unless it is absolutely necessary, it avoids charging the battery when it is in 'low-acceptance' states - such as cold ambient conditions, below around 10 degrees C. It also regulates high electrical loads until the alternator is operating at high efficiency, which gives a further reduction in CO2 emissions.