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Saab BioPower Hybrid Concept: World's First Fossil-free Hybrid Vehicle



- Innovative hybrid concept based on pure bioethanol
- Zero fossil CO2 emissions in all modes
- 260 bhp Saab BioPower engine running on E100 fuel
- Increased performance with threefold torque boost from electric motors
- Fuel saving 'Zero Mode' for city driving on electric power only
- Energy saving features including regenerative braking
- Space efficient modular design uses existing vehicle architecture
- All-wheel drive for improved traction

Making its world premiere at the Stockholm Motor Show today, the ground-breaking Saab BioPower Hybrid Concept delivers zero fossil CO2 emissions, enhanced performance and a range of energy-saving features by combining the use of pure bioethanol fuel and electric power generation for the first time. As the world's first fossil-free hybrid vehicle, the Saab 9-3 Convertible show car also becomes the world's first hybrid soft-top.

Packing formidable pulling power from its 260 bhp (191 kW) 2.0-litre turbo BioPower engine and 53 kW electric motors, the BioPower Hybrid Concept in the Saab 9-3 range of cars can briefly generate torque values three times greater than its petrol-only equivalent. It is a sporty combination that makes for improved performance, as you would expect from Saab, as well as greater fuel economy and an extended driving range.

Saab's modular hybrid system features a maintenance-free, 300-volt battery bank designed to last the lifetime of the vehicle, a 38 kW rear-mounted electric motor, a 15 kW integrated starter generator and all-wheel-drive with electric power transmission to the rear wheels. The entire system has been packaged without sacrificing cabin accommodation or trunk space, as demonstrated by its unveiling in the Saab 9-3 Convertible.



The all-aluminum 2.0-litre BioPower engine is modified to run on pure E100 bioethanol fuel, giving zero fossil CO₂ exhaust emissions, and operates in tandem with the electrical power system. This offers fuel-saving stop/start functionality, torque boosting electric power assistance on demand, an electric-only 'Zero Mode' for city driving and regenerative braking.

The BioPower Hybrid Concept prototype car, a 9-3 Convertible with automatic transmission, is expected to achieve zero to 100 km/h acceleration in just 6.9 seconds, a substantial improvement against 8.8 seconds for the equivalent petrol model. Even more impressive is 80 to 120 km/h acceleration on 'kick-down' in only 5.5 seconds.

"Hybrids are certainly interesting for Saab in the future and this project allows us to evaluate and explore the potential of hybrid technology in combination with our existing and already-proven BioPower technology," says Jan Åke Jonsson, Saab Automobile's Managing Director. "Although the exact hybrid application shown in this concept does not currently figure in our production plans, the project has been extremely valuable in helping us further our expertise. It shows how we could develop the sporty performance associated with Saab while using only renewable resources and saving energy overall."

The Saab BioPower Hybrid Concept is the first project to be announced under a joint investment programme between General Motors R&D (Research and Development) and the Swedish Government. This has seen the establishment of a research and development office in Trollhättan, Sweden, focusing on vehicle safety, engine emissions and advanced manufacturing in collaboration with Swedish universities, research laboratories and suppliers.

Saab is a 100 percent subsidiary of General Motors which is committed to reducing vehicle emission and improving fuel economy through the implementation of a three-tiered, advanced propulsion technology strategy. The ultimate goal is the introduction of hydrogen fuel cell powered vehicles that emit only water and remove the vehicle from the environmental debate.

In the near to mid-term, hybrid propulsion will bridge the gap between today's technology and tomorrow's hydrogen fuel cell powered vehicles. GM is also focused on introducing alternative fuels and new technologies to improve the efficiency of internal combustion engines and transmissions, further reducing vehicle emissions and increasing fuel economy.

BioPower propulsion

The Saab 9-5 2.0t BioPower is already an outstanding sales success in Sweden, where it is currently the best selling environmentally-friendly vehicle on the market and able to exploit a fast-developing network of filling stations selling E85 (85% bioethanol/15% petrol) fuel.



The Saab BioPower Hybrid Concept now goes a step further by using an engine fuelled by pure E100 bioethanol. This is a BioPower evolution of the current all-aluminium, 16-valve 2.0-litre turbo engine in the Saab 9-3 range. It now develops 260 bhp and an impressive 375 Nm maximum torque, 24 per cent and 25 per cent more respectively than on petrol. The engine incorporates an integrated starter generator (ISG) and also charges a 300-volt battery bank, mounted under the floor of the boot.

The Saab BioPower Hybrid Concept retains a flex-fuel capability and features a Spark Ignited Direct Injection (SIDI) system for optimum combustion with E100; ensuring the same cold starting performance as a normal petrol engine. Variable inlet and exhaust cam phasing is used for optimum breathing and more durable valves and valve seats are fitted, together with bioethanol-compatible materials for the fuel system.

The compact 42-volt ISG, built into the flywheel between the engine and transmission, is the power behind the Saab BioPower Hybrid Concept's fuel-saving, stop/start functionality. It serves a multi-functional role as a starter motor, alternator and 15 kW engine power booster, while also helping to iron out residual crankshaft vibrations.

For the Saab BioPower Hybrid Concept application, a series of further steps are taken to optimise the engine's fuel saving capacity. Auxiliary functions, such as the water pump, air conditioning and power steering systems, are now removed from the engine's belt drive and electrically powered instead, through the hybrid system.

The five-speed automatic transmission, with Saab Sentronic sequential selection, includes an all-wheel drive capability by the simultaneous addition of electrically powered drive to the rear wheels.

Hybrid booster

A parallel hybrid system has been adopted, where the control strategy is based on efficient 'energy management' - recovering, storing and feeding back energy that is otherwise lost in a vehicle powered only by an internal combustion engine. The engineering team have utilised General Motors' hybrid experience in the development of stop/start engine functionality, electric rear-wheel drive systems and regenerative braking. Apart from converters to manage AC/DC and 12, 42 and 300-volt interfaces, the system consists of just three core components: two electric motors and a battery bank.

Electric energy storage is provided by a 42-cell, 300-volt lithium-ion battery bank, designed to be entirely maintenance-free throughout the lifetime of the vehicle. Its performance is carefully monitored and governed by an electronic control unit, through which electric current from the engine is fed.



This power pack is accommodated under the floor of the trunk, without taking up any stowage space, as demonstrated in the Stockholm show car.

The battery supplies a compact 38 kW electric motor located between the rear wheels which powers a transmission differential and drive shafts. At low speeds, this Rear Drive Unit (RDU) is able to briefly generate 666 Nm of additional torque.

In reverse operation, the motor acts as a generator to provide 'regenerative braking'. It automatically recovers kinetic energy otherwise lost during braking and converts this into additional battery charging. It also performs the same function whenever the driver lifts off the throttle, harnessing the energy in the rotating drive shafts. This is achieved without any perceptible change in the rate of deceleration.

The second electric motor is the integrated starter generator (ISG) located within the flywheel between the engine and main transmission. On demand, it contributes 15 kW of additional power and 120 Nm of extra torque to the output of the engine through the front wheels.

Driving Benefits

The sophisticated electronic control of the hybrid componentry is matched to the operating parameters of the BioPower engine to provide seamless power assistance and power saving functionality.

Under transient driving conditions, both electric motors are activated to augment the power of the engine, increasing standing start acceleration and in-gear performance for safe overtaking. This briefly raises total power by as much as 28 per cent - without raising fuel consumption.

At take off, the Saab BioPower Hybrid Concept also exploits the instant torque generation of its electric motors, smoothly adding strong, accelerative power during the engine's pick-up, from tick-over to about 1,500 rpm. It is during this phase that the available pulling power, or torque, is more than tripled.

An estimated fuel saving of 5-7% is provided by the automatic engine stop/start function. Whenever the vehicle is stationary, the engine is immediately shut-off to save fuel. As soon as the brake is released, it is automatically started again by the powerful ISG. The operation is carried out seamlessly and requires no input from the driver.

In congested driving conditions, fuel saving is taken a step further by the Saab BioPower Hybrid Concept's 'Zero Mode' operation - giving zero fuel consumption, and, of course, zero emissions - which can be selected by the driver via a button in the central console. At speeds below 50 km/h, 'Zero Mode' will shut off the engine and again switch the car over to electric power only through the RDU.



In this mode, the battery bank provides a range of between 10 and 20 kilometres. The engine is smoothly re-engaged whenever the battery status approaches a low charge level or the electronic throttle opening requires acceleration beyond the 50 km/h operating limit.

Whenever the engine is shut down, all auxiliary functions, such as the power steering, air conditioning and lighting, remain unaffected because they are now permanently electrically-powered through the battery. The removal of unnecessary loadings on the engine further contributes to fuel economy and in mixed driving the estimated range of Saab 9-3 BioPower Hybrid Concept test vehicles, with a standard 62 litre tank, is a competitive 800 kms.

Finally, in low grip road conditions, traction can be optimised by the addition of rear-wheel drive for improved handling and safety. For example, when the electronic traction control system (TCS) is activated at the front wheels, the car can be balanced by the application of rear drive.

Driver instrumentation for the Saab BioPower Hybrid Concept is as discreet as the installation of its hybrid engineering. In the main instrument cluster, icons are illuminated to indicate when the car is running on engine and/or electric power. An additional gauge is also fitted to show the power status of the battery bank. Under electric power, the needle will steadily fall and then rise again when the engine provides charging. The turbo boost gauge is calibrated by tree icons, a playful reminder of the car's renewable energy source.

In overall operation, the Saab BioPower Hybrid Concept is designed to deliver enhanced performance and valuable energy savings. The concept can enrich driving appeal while also moving further towards the goal of sustainable mobility.

Further Information:

GM has a diverse hybrid programme, with three separate systems designed to provide an opportunity for more consumers to own a hybrid vehicle and benefit from increased fuel savings. Next year, GM will introduce in the USA the world's first two-mode hybrid system in the Chevrolet Tahoe and GMC Yukon full-size SUVs. This will be mated with Active Fuel Management™ to deliver a fuel economy improvement of at least 25 per cent. The Saturn Vue Green Line SUV, with a new, more affordable hybrid system giving estimated fuel savings of up to 20 per cent, goes on sale in the US this summer. Hybrid vehicles currently on the US market include the Chevrolet Silverado and GMC Sierra pickup trucks with fuel saving stop/start technology.

Bioethanol fuel is produced commercially from agricultural crops such as sugarcane, corn and other forms of biomass. When considering CO₂ emission savings, the whole chain - feedstock, fuel supply and vehicle combustion - must be considered. Dependent on its source and its production process, the use of bioethanol can reduce CO₂ emissions up to 90% against fossil petrol. This is because emissions from its combustion are balanced by an amount of CO₂ that is removed from the atmosphere when energy crops are grown. In this way, the CO₂ present in the atmosphere remains in a natural cycle, whereas CO₂ emissions from the use of a fossil fuel - such as petrol or diesel - add new CO₂ to the atmosphere which has been locked up in oil deposits underground.