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HydroGen4 Hits the Road in Europe

- European part of world's largest fuel cell vehicle fleet starts operation
- Technical improvements in performance and usability

Berlin. The introduction of GM's fourth generation hydrogen-powered vehicles brings the world closer to a safe, commercially viable car that produces no CO₂ emissions.

HydroGen4 is powered by GM's most advanced fuel cell system, which features considerable improvements from the last generation in everyday usability, including performance, durability and the capability to start and operate in sub-zero temperatures.

"Fuel cell propulsion with hydrogen highlights General Motors' commitment to remove the car from the environmental debate," says Carl-Peter Forster, President of GM Europe.

The HydroGen4 is the result of 10 years of research and development on hydrogen and fuel cells that cost more than one billion dollars. Ten such vehicles will be operated in Berlin as part of the Clean Energy Partnership (CEP), representing the European portion of GM's Project Driveway test program, the largest-ever real world evaluation of fuel cell vehicles, involving a total of more than 100 HydroGen4 test cars.

Feedback from Project Driveway in the U.S. and in Germany not only gives GM engineers essential validation data, but also provides a valuable insight into the likely ownership and driving experience of future customers.

The CEP vehicles will be equipped with a wireless data transfer system that helps engineers by feeding vehicle performance data to a GM/Opel server. Maintenance of the vehicles will be done at a regular Opel dealer in Berlin.



How the HydroGen4 works

At the heart of HydroGen4 is its fuel cell stack. This converts stored chemical energy (from hydrogen) into electrical energy without combustion or any CO₂ emissions. An electro-chemical process in the fuel cell combines hydrogen and oxygen to produce electricity, with water vapor as its only by-product.

Inside each cell, hydrogen on the anode catalyst splits into protons and electrons. The positively-charged protons pass through a membrane to the cathode, while the negatively-charged electrons travel in an external circuit and produce an electrical current on the way. On the cathode catalyst, oxygen reacts with the electrons and protons to form water vapor. A single fuel cell stack, connecting a large number of individual cells, can thus produce enough power to drive an electric motor.

HydroGen4's stack consists of 440 series-connected cells that produce the electrical output to power a 73 kW synchronous electric motor, delivering zero to 100 km/h acceleration in around 12 seconds. The front-wheel drive HydroGen4 has a top speed of 160 km/h and also benefits from an excellent low speed pick-up, due to the 320 Nm electric motor's instant torque characteristics.

Compared to the HydroGen3, the individual cells of HydroGen4's stack are now positioned horizontally – as opposed to vertically – to give improved vehicle packaging and a lower weight location. At the cathode, an electric turbo compressor, instead of a screw type, is now used to provide the fuel cells with air, i.e. oxygen. This increases efficiency and acoustics.

HydroGen4 can start and run in sub-zero temperatures. This is a considerable advance over its predecessor and is an important benefit for everyday usability. It has been achieved by a number of measures, including thermal insulation, water management and a revised operating strategy.



HydroGen4 runs on compressed hydrogen gas

HydroGen4 has a tank system with three, 700-bar high-pressure vessels made from carbon-fiber composite material, which can hold a total of 4.2 kg of hydrogen. This provides an operating range of up to 320 kilometers.

Experience from our HydroGen3 fleet, in which several vehicles used cryogenic liquid hydrogen storage systems for comparison purposes, led to GM's decision to use 700 bar compressed hydrogen storage.

The major drawback of liquid hydrogen storage is its unavoidable boil-off phenomenon. Even with optimum insulation, liquid hydrogen in vehicle tanks gradually warms up over time, allowing some of it to vaporize. After a few days, this amount of hydrogen must be vented from the tank in order to reduce the build-up of pressure, leading to an inevitable and significant loss of fuel.

Buffer battery enables regenerative braking

The fuel cell system in HydroGen4 is supported by a nickel-metal-hydride buffer battery with a capacity of 1.8 kWh. The battery ensures improved driving performance by covering electrical peaks in the vehicle's load demands.

In addition, the efficiency of the entire propulsion system is improved, as the buffer battery enables regenerative braking. When braking or driving downhill, the electric motor reverses to generator mode and uses the electrical energy produced to charge the battery. If the driver has to brake harder, HydroGen4 will also be decelerated hydraulically, as is the case in a conventional car. This combination of regenerative and hydraulic brake performance is called brake blending. It is applied by the ESP driving stability program, or when the required deceleration exceeds the maximum regenerative braking capacity.

Such battery and braking technologies are valuable crossover developments shared with GM's innovative extended-range electric vehicle (E-REV), the recently announced Chevrolet Volt which is scheduled for commercial production in 2010 in the United States.



The HydroGen4 uses the GM's compact crossover body variant, offering the same comfort, spaciousness and safety of today's conventional cars. The fuel cell system fits within the space of the conventional engine compartment. The nickel-metal hydride battery pack sits under the floor in the middle of the vehicle.

Compared with the production vehicle, the HydroGen4 has extra cooling air inlets in the lower front corners to serve the fuel cell system's requirements. At the rear, in place of the exhaust pipe the new fascia under the bumper has four thin vertical slits which release the clean water vapor. This patented design lets onlookers know that this is no ordinary internal combustion engine vehicle.

The vehicle boasts a long list of standard safety features including driver and passenger frontal air bags and roof rail side-impact air bags; anti-lock braking system (ABS) and ESP.

GM commitment to fuel cell development

As fuel cell development at GM continues step by step towards commercialization, its Fuel Cell Activities research division, with over 600 employees, has been integrated into the structure of regular series development work, a preparatory step for the eventual volume production of fuel cell vehicles.

Contacts:

Uwe Deller

+49 6142 7 60178 (office)
+49 160 368 5913 (mobile)

uwe.deller@gm.com

Andrew Marshall

+49 6142 7 73815 (office)
+49 171 221 3605 (mobile)

andrew.marshall@gm.com

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