

Lean, green hydrogen machine



Hydrogen-powered Honda future with history of firsts

Fully-certified Honda fuel cell vehicles on roads now and refueling infrastructure solutions for the future

Honda unveiled the FCX Clarity fuel cell vehicle at the LA Auto Show in November.

The FCX Clarity is a next-generation, zero-emissions, hydrogen-powered fuel cell vehicle based on the entirely-new Honda V Flow fuel cell platform, and powered by a compact, efficient and powerful Honda V Flow fuel cell stack. Driving range, power, weight and efficiency are all improved—and the stylists were able to develop a low-slung, dynamic appearance previously unachievable in a fuel cell vehicle. Honda's continuing goal is to tackle the real-world performance and appeal of a hydrogen-powered fuel cell car.

Honda plans to lease the FCX Clarity to a limited number of retail consumers in Southern California, with the first deliveries taking place in summer 2008. Full details of the program will be set closer to launch, but current plans call for a three-year lease term at a price of \$600 per month, including maintenance and collision insurance. Honda is also developing a service infrastructure to balance convenience and high quality service. For periodic maintenance, the customer brings their car to a local Honda dealer; Honda will transport the vehicle to their fuel cell service facility, where work is performed, and the customer will pick their car back up from the dealer.

The technology

The FCX Clarity utilizes Honda's V Flow stack in combination with a new compact and efficient lithium ion battery pack and a single hydrogen storage tank, to power the vehicle's electric drive motor. The fuel cell stack operates as the vehicle's main power source. Hydrogen combines with atmospheric oxygen in the fuel cell stack, where chemical energy from the reaction is converted into electric power used to propel the vehicle. Additional energy captured through regenerative braking and deceleration is stored in the lithium ion battery pack, much as a gasoline/electric hybrid works now, and used to supplement power from the fuel cell, when needed. The vehicle's only emission is water.

Honda V Flow fuel cell platform

The FCX Clarity's new V Flow platform packages the ultra-compact, lightweight and powerful Honda V Flow fuel cell stack (65 percent smaller than the previous Honda FC stack) in the vehicle's center tunnel, between the two front seats. Taking advantage of a completely



new cell configuration, the vertically-oriented stack achieves an output of 100 kilowatts (kW), versus 86kW in the current Honda FC stack, with a 50 percent increase in output density by volume (67 percent by mass). Its compact size allows for a more spacious interior and more efficient packaging of other powertrain components, which would otherwise be unattainable in a low-slung sedan.

The FCX Clarity boasts numerous other advances in performance and packaging, compared to the current-generation FCX:

- a 20-percent increase in fuel economy—to the approximate equivalent of 68 mpg combined fuel economy (about 2-3 times that of a gasoline-powered car, and 1.5 times that of a gasoline-electric hybrid vehicle, of comparable size and performance)
- a 30-percent increase in vehicle range—to 270 miles
- a 25-percent improvement in power-to-weight ratio, in part from an approximate 400-pound reduction in the fuel cell powertrain weight, for superior performance and efficiency despite a substantial increase in overall vehicle size
- a 45-percent reduction in the size of the fuel cell powertrain—nearly equivalent, in terms of volume, to a modern gas-electric hybrid powertrain
- an advanced new lithium-ion battery pack that is 40 percent lighter and 50 percent smaller than the current-generation FCX's ultra-capacitor; and
- a single 5,000-psi hydrogen storage tank with 10 percent more hydrogen capacity than the previous model.



California Governor Arnold Schwarzenegger greets Dan Bonawitz, Vice President Corporate Planning and Logistics for American Honda Motor Co., Inc., during a news conference at the Los Angeles Auto Show in November 2007.

FCX Clarity design

Not only has Honda been able to push the envelope on the physical design of a hydrogen fuel cell car; they've been freed from the usual constraints of conventional powertrain technologies. The FCX Clarity's four-door sedan platform features a short-nose body and spacious cabin with comfortable accommodations for four people and their luggage. Major powertrain components—including the

KEEP RIGHT >>



electric motor, fuel cell stack, battery pack and hydrogen tank—have been made more compact and are distributed throughout the vehicle to further optimize space, comfort and total vehicle performance.

Advanced materials and components

In keeping with its theme as an environmentally-advanced automobile, the FCX Clarity features seat upholstery and door linings made from Honda Bio-Fabric—a newly-developed, plant-based material that offers CO2 reductions as an alternative to traditional interior materials, along with outstanding durability and resistance to wear, stretching, and damage from sunlight.

The car is also equipped with advanced

safety, comfort and convenience features, including a state-of-the-art navigation system with hydrogen station locations, backup camera, premium audio, climate-controlled seats and Bluetooth® connectivity.

Other tech touches include shift-by-wire, electric power steering (EPS), and a newly-designed instrument panel with an easy-to-read hydrogen fuel-consumption display.

CO2 emissions

The FCX Clarity's only emission is water. Carbon dioxide (CO2) emissions come earlier during the production of hydrogen, which varies by source; however, well-to-wheel CO2 emissions using hydrogen reformed from natural gas—the most wide-

ly used method of production today—are less than half that of a conventional gasoline vehicle. With the production of hydrogen from water by electrolysis, CO2 emissions can be further reduced and ultimately approach zero if the electricity used for electrolysis is generated using solar, wind, water or nuclear power.

Honda has developed its own solar cells, with half the CO2 emissions in the production stage compared to conventional crystalline silicon cells, and has begun mass-production and retail sales of this technology in Japan for both commercial and residential use.

Clean and sustainable vision

Under its slogan of *Blue Skies for our Children*, Honda has worked for forty years at reducing the environmental impact of the automobile, including efforts to reduce emissions, boost fuel efficiency and now many industry-leading efforts to advance the hydrogen fuel cell vehicle—a technology and fuel that Honda believes may hold



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MVD Licensed Driving School Programs

DrivingMBA's primary objective is to keep teen drivers and all of us safer on the road. Stories about teen drivers continue to be featured in newspapers and publications across the country. DrivingMBA is the only driving school in Arizona that uses state-of-the-art driving simulators to train its students. The airline industry has been using this type of technology for decades to train pilots. The military also uses this type of technology to train soldiers, AND DrivingMBA's equipment is the same equipment that is being used by police academies throughout the country, including here in Arizona, for its advanced driver training. The effectiveness of this type of driver training is indisputable, and DrivingMBA has documented results that prove its driver education program works.

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the ultimate promise for a clean and sustainable transportation future. Honda's pioneering achievements in this area include the first EPA and CARB certification of a fuel cell vehicle (2002); the first lease of a fuel cell vehicle (2002); the first fuel cell vehicle to receive an EPA fuel economy rating (2002); the first cold-weather customer (2004); the first and still only individual retail customers (2005, 2007); and the first and still only fuel cell vehicle to be eligible for a federal tax credit.

In five years of use with fleet customers including government entities in California, Nevada and the state of New York, the FCX has performed well under often harsh conditions, with minimal service support even in the extreme heat of the Western deserts and the bitter cold of the Northeast.

2006 Honda FCX Specifications

ENGINE

Drive MethodFront-wheel drive
Motor TypeAC Synchronous
Electric Motor (permanent magnet)
Maximum Output (horsepower)107
Maximum Torque (ft.-lbs.)201
Fuel Cell Stack TypeProton Exchange Membrane Fuel Cell (PEMFC)
Fuel Cell Maximum Output (kW)*86
Ultra-Capacitor Electrostatic Capacity (F)*8
Maximum Speed (mph)93
Vehicle Range (miles, EPA mode)190

EXTERIOR DIMENSIONS

Length (in.)164.0
Overall Width (in.)69.3
Overall Height (in.)64.8
Wheelbase (in.)99.3
Tread (front/rear, in.)59.1/60.2
Vehicle Weight (lbs.)3,713
Number of Occupants4

FUEL

TypeCompressed hydrogen gas
StorageHigh-pressure hydrogen tank
Tank Capacity (L)156.6
Gas Volume when Full (kg)3.8
Maximum Pressure when Full (psi)5000.0

* Honda in-house test values

Hydrogen Home Energy Station and improved solar-cell technology

Honda is also developing technology to answer the "chicken and the egg" dilemma of the vehicle and the refueling infrastructure. The Home Energy Station is a home refueling unit that provides hydrogen from natural gas for vehicle refueling, heat for domestic hot water use and electricity for the home.

Honda has begun using the Home Energy Station IV at its Honda R&D Americas, Inc. facility in Torrance, California. This fourth-generation experimental unit is designed to provide fuel for a hydrogen-powered fuel cell vehicle, as well as heat and electricity for a home. The new system is more compact and efficient, with a lower operating cost than previous models; it was announced along with the FCX Clarity hydrogen-powered fuel cell vehicle at the LA Auto Show.

Honda's Home Energy Station technology is designed to facilitate the broader adoption of zero-emissions fuel cell vehicles, like the FCX Clarity, by developing a home refueling solution that makes efficient use of a home's existing natural gas supply for production of hydrogen, while providing heat and electricity to an average-size home.

The Home Energy Station IV can reduce both cost and carbon dioxide (CO₂) emissions for the consumer. Compared to the average U.S. consumer's home with grid-supplied electricity and a gasoline-powered car, a home using Home Energy Station IV to help produce heat and electricity and also to refu-

el an FCX Clarity can reduce CO₂ emissions by an estimated 30 percent and energy costs by an estimated 50 percent.

"Honda is striving to address the need for a refueling infrastructure for hydrogen fuel cell vehicles," said Ben Knight, Vice President of Honda R&D Americas. "The Home Energy Station represents one promising solution to this issue, while offering the added benefit of heating and powering the home more efficiently."

Working with technology partner Plug Power, Inc., Honda began operation of a Home Energy Station in October, 2003. Home Energy Station IV represents the latest evolution of the technology with a 70 percent reduction in size compared to the first unit, making it even more suitable for household installation. By combining gas purification and power generation components, overall size reduction and efficiency gains are achieved, while enabling it to switch from hydrogen refining to power generation when needed.

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