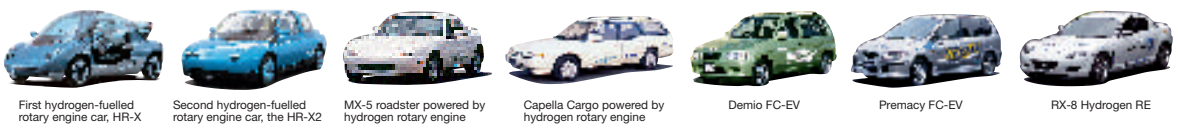
MAZDA RENESIS HYDROGEN ROTARY ENGINE [Reference exhibit]

The Mazda way to improve relations between people, the automobile and the planet

Mazda is committed to creating better relations between the motorized society and the global environment of the 21st century, while, at the same time, maintaining and advancing the company's characteristic Zoom-Zoom spirit. Thoughtful, innovative products developed by Mazda can balance the dual needs of both the environment and the driving enthusiast.

One example of Mazda's most recent efforts—the RENESIS Hydrogen Rotary Engine—is being showcased at the 2003 Tokyo Motor Show.

As the world's only manufacturer of rotary engines, Mazda continues to develop and explore all the potential and possibilities of this unique internal combustion engine. The RENESIS is Mazda's next-generation rotary engine that was launched in early 2003 in the all-new Mazda RX-8. By virtue of its smooth performance, compact size and unique driving characteristics, RENESIS was named International Engine of the Year in June 2003. It delivers high power output for a naturally aspirated engine of its size and demonstrates significantly improved fuel economy and reduced emissions compared with previous generation rotary engines.



First hydrogen-fuelled rotary engine car, HR-X | Second hydrogen-fuelled rotary engine car, the HR-X2 | MX-5 roadster powered by hydrogen rotary engine | Capella Cargo powered by hydrogen rotary engine | Demio FC-EV | Premacy FC-EV | RX-8 Hydrogen RE

1991 1993 1995 1997 2001 2003

1991	Mazda develops its first hydrogen-fuelled rotary engine car, HR-X (hydrogen storage tank with metal hydride)
1992	Test drives fuel cell golf cart
1993	Mazda develops its second hydrogen-fuelled rotary engine car, the HR-X2. Develops experimental MX-5 roadster powered by hydrogen rotary engine.
1995	Conducts on-road tests for two years of Capella Cargo powered by hydrogen rotary engine.
1997	Develops Demio FC-EV (direct hydrogen fuel cell)
2001	Develops Premacy FC-EV (methanol reforming fuel cell)
2003	Develops RX-8 Hydrogen RE (electronically-controlled hydrogen direct-injection rotary engine with high-pressure hydrogen fuel tank)

Now, as the auto industry's attention turns to hydrogen as a potential source of power for fuel cell vehicles, Mazda confidently presents a realistic example of its hydrogen-power technology, embodied in the hydrogen-powered version of the RENESIS.

Fun to drive and environmentally sound, the RENESIS Hydrogen Rotary Engine is a Mazda-unique alternative-fuel vehicle. It is the ultimate demonstration of the flexibility of the unique rotary engine, maintaining a traditional driving feel, yet realizing extremely clean emissions through the use of hydrogen.

The RENESIS Hydrogen Rotary Engine capitalizes on the advantages of the rotary engine to assure the same ease-of-operation and reliability whether the engine is running on gasoline or hydrogen fuel. Moreover, since the engine requires modifications to run on hydrogen, it could enable production of a relatively low-cost hydrogen-powered alternative-fuel vehicle.

The engine has been developed with a dual-fuel system, allowing it to run on either gasoline or hydrogen, as Mazda believes desirable, flexible automotive choices will help effectively promote the usage of hydrogen fuel and the development of a supporting infrastructure.

The fruit of over ten years of research and development of hydrogen power

The RENESIS Hydrogen Rotary Engine is not Mazda's first effort in this area of advanced R&D. In 1991, Mazda developed and tested its first hydrogen rotary-powered prototype vehicle, known as the Mazda HR-X. Concurrent with the development of the HR-X2, the engineering team also developed an experimental version of the MX-5 roadster in 1993, powered by a hydrogen rotary.

Two years later, in 1995, Mazda was granted approval by Japan's then Ministry of Transport to conduct on-road tests of two hydrogen rotary-powered Capella Cargos. At this time, Mazda also began to experiment with fuel cell electric vehicles (FC-EV) alongside its hydrogen rotary engine program. In 1992, Mazda developed a prototype vehicle with fuel cell electric battery, and in 1997, created a Mazda Demio FC-EV.

In 2001, Mazda began conducting public road tests of the methanol-reforming type Premacy FC-EV. Data on driving performance, fuel consumption, exhaust emissions and other parameters were collected during on-road tests to advance studies aimed at commercialization.

The RENESIS Hydrogen Rotary Engine, as presented at the 2003 Tokyo Motor Show, is another step forward in these ongoing efforts to experiment and develop alternative-fuel solutions.

*Sanctioned by the Ministry of Land, Infrastructure and Transport

Mazda RENESIS Hydrogen Rotary Engine technologies

The RENESIS Hydrogen Rotary Engine incorporates an electronically-controlled hydrogen injector system (the hydrogen is injected in a gaseous state). The system draws air from the side port during the induction cycle and uses dual hydrogen injectors in each of the engine's twin rotor housings to directly inject hydrogen into the intake chambers. The following technologies have been introduced to help maximize the benefits of the rotary engine in hydrogen combustion mode.

●Direct injection system

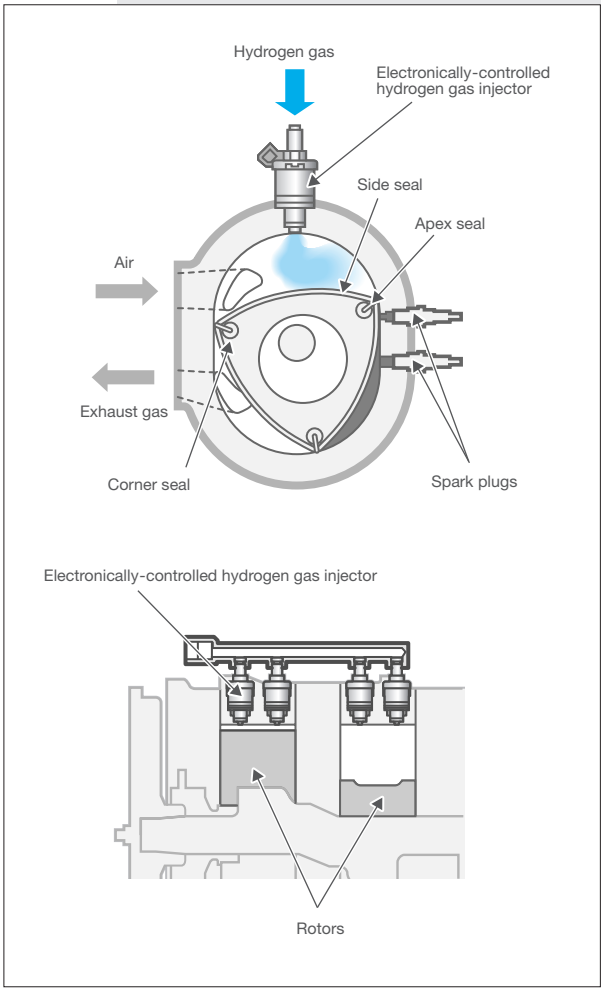
By virtue of its construction—with separate chambers for induction and combustion—the rotary engine is ideally suited to burn hydrogen without inviting the backfiring that can occur when hydrogen is burned in a traditional piston engine. The separate induction chamber also provides a safer temperature for fitting the dual hydrogen injectors with their rubber seals, which are susceptible to the high temperatures encountered in a conventional reciprocating engine.

●Twin hydrogen injectors

Because hydrogen has an extremely low density, a much greater injection volume is required compared with gasoline. This demands the use of more than one injector, which can be difficult to achieve with a conventional reciprocating engine because of the structural constraints that prevent directly mounting injectors in the combustion chamber. In contrast, the rotary engine provides adequate space for installation of two injectors per induction chamber. With its twin hydrogen injectors, Mazda's hydrogen rotary engine is both practicable and able to deliver sufficient power.

●Excellent mixing of hydrogen intake charge

In a reciprocating engine, the output shaft turns through 180 degrees in one cycle, whereas the rotary engine's output shaft covers a greater angle of 270 degrees, enabling a more vigorous intake flow for ample mixing of the hydrogen-air intake charge. This promotes production of a uniform mixture, which is critical for hydrogen combustion.



Mazda RX-8 Hydrogen RE

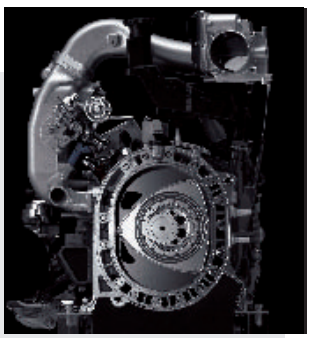

Hydrogen meter

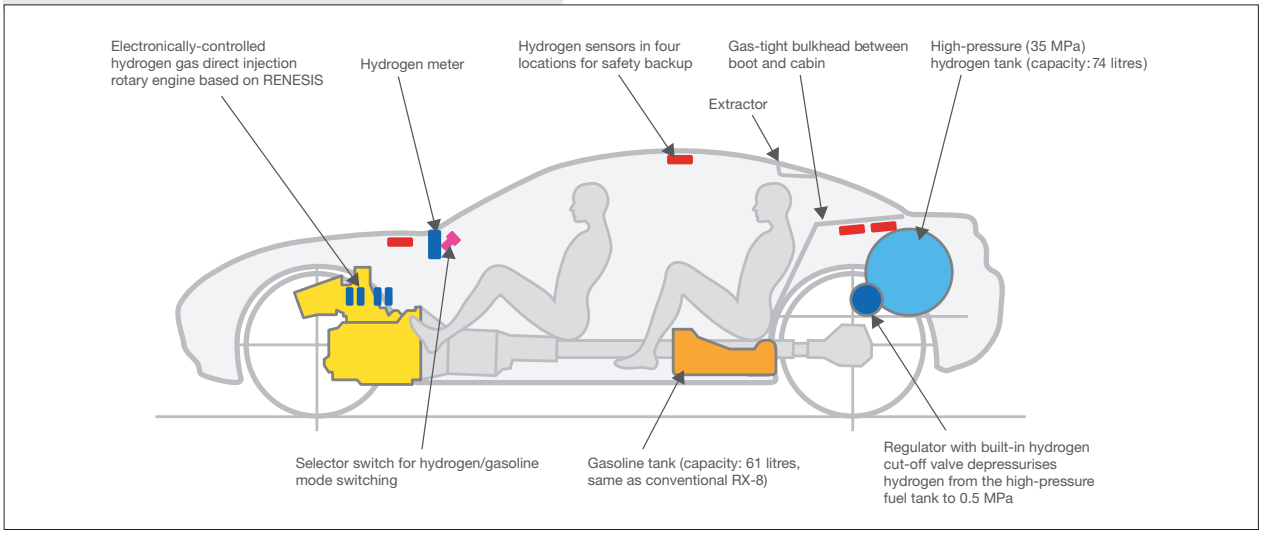

High-pressure hydrogen tank


Hydrogen gas filler

The RENESIS Hydrogen Rotary Engine is currently undergoing running tests in a special-edition Mazda RX-8 Hydrogen RE test vehicle. The test vehicle is equipped with a dual-fuel system that consists of a high-pressure hydrogen tank and separate gasoline tank, and can run on either hydrogen or gasoline. It is as reliable and easy to operate when running on hydrogen as on gasoline.

In addition to the revolutionary RENESIS rotary engine, the Mazda RX-8 Hydrogen RE test vehicle benefits from improved aerodynamics, optimised tires and weight-saving measures, as well as a host of technologies for exceptional environmental compatibility.


RENESIS Hydrogen Rotary Engine



●Three layer wet-on paint: This water-based paint dramatically reduces emission of organic solvents, saves energy by shortening the drying process and reduces CO_2.

●Plant-based plastic for interior parts: Plant-based plastic is an attractive alternative to plastics derived from fossil fuels such as petroleum. Plant-based plastic fiber-reinforced extrusion-molded plastic employing cellulose extracted from timber is used for quarter panels, and reduces CO_2 emission.

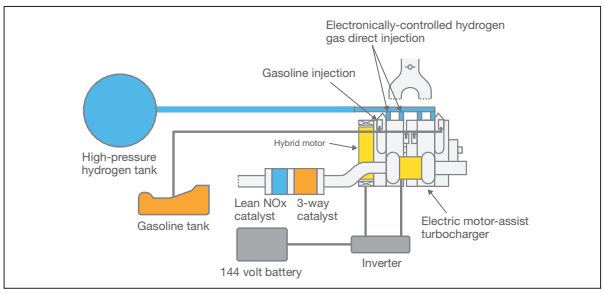
●Low-resistance brakes: Use of a fast-fill tandem master cylinder reduces brake drag.

●Low-resistance hub carriers: Reduced friction hub carriers help cut power losses.

■ **Mazda RX-8 Hydrogen RE Main Specifications**

Dimensions	Overall length	4435mm
	Overall width	1770mm
	Overall height	1340mm
	Wheelbase	2700mm
	Track: front/rear	1500mm/1505mm
	Occupancy	4 persons
Engine	Type	Mazda RENESIS hydrogen rotary engine with ISG
	Maximum power	Using Gasoline: 154 kW (210 PS) @7200 rpm Using Hydrogen: 81 kW (110 PS) @7200 rpm (target)
	Maximum torque	Using Gasoline: 222 N·m@5000 rpm Using Hydrogen: 120 N·m@5000 rpm (target)
Transmission	Type	5MT
Suspension	Suspension system: front/rear	Double wishbone/Multi-link
Brakes	Main brake system front/rear	Ventilated disc
Tires and wheels	Tires front/rear	225/45R18
	Wheels front/rear	18×8JJ

Future Systems of Hydrogen Rotary Engine Cars



At the 2003 Tokyo Motor Show, Mazda is also presenting a number of technologies currently being developed that could help support the potential for a futuristic hydrogen rotary system.

These next-generation technologies are being refined to help achieve the dual goals of drivability comparable with gasoline cars and excellent efficiency derived from the practical use of energy. An example of these technologies includes an electric-motor-assisted turbocharger to enhance the efficiency of hydrogen combustion and regeneration of energy from the car's exhaust. Additionally, in an effort to capitalize on existing hybrid technology, Mazda continues to refine the idle-stop system; regenerative braking systems; electric acceleration assistance systems; and other means of improving the efficiency of the entire vehicle. By combining these various technologies, Mazda is aiming to achieve advanced clean-running vehicles that also deliver an exceptional driving experience in line with the company's Zoom-Zoom spirit.

Electric-motor-assist turbocharger

An electric-motor-assist turbocharger is used to maximize the effectiveness of forced induction throughout the rev range. At low rpm, beginning at approximately 1000 rpm, an electric motor operates to assist the turbocharger and increase induction efficiency. At high rpm, the turbocharger is driven in a traditional fashion, by the flow of exhaust gas alone.

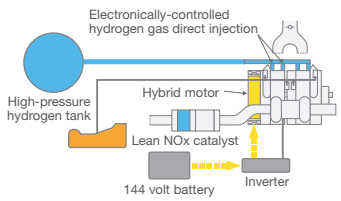
Mazda Hybrid System

The Mazda Hybrid System is composed of a motor, inverter and a 144-volt battery. When the vehicle is stationary—for example, when waiting at traffic signals—the system normally stops the engine to reduce fuel consumption and exhaust gas emissions, and restarts it automatically with the electric motor when the driver is ready to accelerate.

Additionally, when the engine is running at low rpm, the electric motor is used to boost engine torque and effectively improve response. During deceleration, the motor operates as an electrical generator, recovering the braking energy and using this energy to recharge the battery.

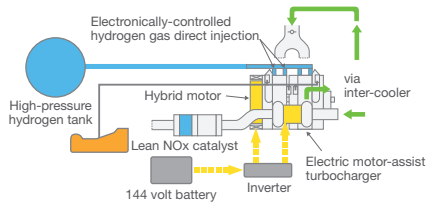
Basic operating pattern

Hydrogen fuel: From stationary to moving on



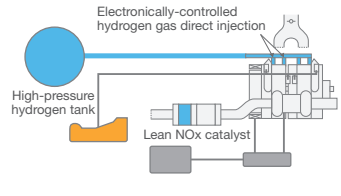
●Hydrogen fuel: From stationary to moving on
The engine is normally stopped automatically when the vehicle is stationary (the engine is not stopped when battery recharging is required). The engine is automatically restarted by electric hybrid motor when moving off.

Hydrogen fuel: Accelerating from standing position



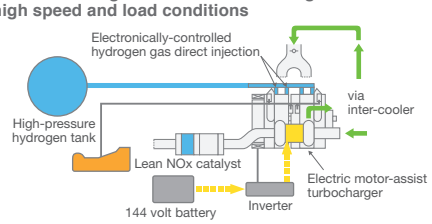
●Hydrogen fuel: Accelerating from standing position
The electric hybrid motor provides torque assist for initial acceleration when the engine is running at low rpm. Further assist is provided by the electric-motor-assist turbocharger, which begins operating at approximately 1000 rpm.

Hydrogen fuel: During steady running



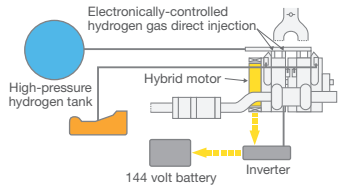
●Hydrogen fuel: During steady running
Running on hydrogen fuel. Lean combustion promotes NOx emission levels as low as just a few parts per million.

Hydrogen fuel: During acceleration or running under high speed and load conditions



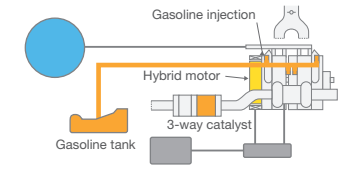
●Hydrogen fuel: During acceleration or running under high speed and load conditions.
The electric-motor-assist turbocharger boosts induction to assure ample power with lean combustion.

Hydrogen fuel: During deceleration



●Hydrogen fuel: During deceleration
Fuel cut-off by electronic throttle control. In addition, the motor/generator recovers electric power through battery charging.

Gasoline fuel



●Gasoline fuel
A gasoline and air mixture is introduced through the side ports of the rotor housing as with a conventional RENESIS rotary engine. The engine is normally stopped when the vehicle is stationary, and restarted automatically by the motor when moving off. Changing between gasoline and hydrogen fuel is achieved by a simple switch operation from the driver's seat.