Products and Technologies

Reduction of CO₂ Emissions while Driving

Gasoline and diesel engines inevitably generate exhaust gases that contain large quantities of CO₂, a cause of global warming. For the sake of the environment, Mitsubishi Motors is striving to reduce the CO₂ emissions caused by driving. Mitsubishi Motors focuses on products and technology-related initiatives, recognizing the importance of developing technologies for improving fuel economy and electric-powered systems, as well as spreading the use of vehicles equipped with these innovative systems.

Development of Electric Vehicle Technologies

We introduced our Electric Vehicle i-MiEV in 2009, and Plug-in Hybrid Electric Vehicle Outlander PHEV based on Electric Vehicles in 2013. We are also developing electric-powered vehicles by improving drive batteries and enhancing motor efficiency toward the realization of the vehicles to be expected in the future.

Outlander PHEV

Development of Improving Fuel Economy Technologies

We are committed to developing technologies to improve the fuel economy of gasoline and diesel engines, which greatly contributes to the reduction of CO₂ worldwide.

Market Launch of Eclipse Cross

The new compact SUV Eclipse Cross was first launched in Europe in October 2017 followed by Australia, New Zealand, and ASEAN in November, North America in January 2018, and Japan in March. It features a newly-developed 1.5 L downsizing direct-injection turbocharged gasoline engine. Precise control of fuel injection into the cylinder and the intake port adjusted according to the driving conditions provides exceptional fuel economy performance and achieves clean emissions.

Eclipse Cross for the Japanese market
Vehicles are expected to be environmentally-friendly. This includes preventing environmental pollution and global warming, as well as diversifying energy sources from petroleum in recent years. Mitsubishi Motors strives to address these issues through initiatives such as improving the fuel economy of conventional engine-driven vehicles and developing clean diesel vehicles. In particular, we position the electric vehicle technology incorporated in the MiEV* series as our core technology for environmental friendliness, and we are committed to developing it further. We would like to contribute to global environmental conservation by developing and promoting electric vehicles and plug-in hybrid electric vehicles featuring our electric vehicle technologies.

* Mitsubishi innovative Electric Vehicle

**Electric Vehicle i-MiEV**

The Electric Vehicle i-MiEV is powered by an electric motor, and so it emits no exhaust gases such as CO\textsubscript{2} while being driven. In 2009, Mitsubishi Motors released i-MiEV as the world’s first mass-produced Electric Vehicle. i-MiEV has built up a remarkable reputation among customers for its many advantages over conventional gasoline engine vehicles, including environmental performance, acceleration starting with maximum torque, reduced noise by the electric motor, and stability with the battery unit beneath the floor.

**Plug-in Hybrid Electric Vehicle Outlander PHEV**

Plug-in hybrid electric vehicles are powered by electricity stored in drive batteries. They use the engine to generate electric power when the battery level is low. The Plug-in Hybrid EV System for the Outlander PHEV automatically shifts to the optimum driving mode for each running condition. “EV Drive Mode” uses electric power from the drive battery and is suitable for low to medium speeds in residential and urban areas. When the battery level is low, it shifts to “Series Hybrid Mode,” which generates electric power using the engine. During high-speed driving, the vehicle shifts to “Parallel Hybrid Mode” driven by the engine and simultaneously assisted by the battery-powered motor. Based on electric vehicle technology, the system has inherently lower CO\textsubscript{2} emissions than conventional gasoline engine vehicles, delivering outstanding environmental performance. Concern over insufficient power is no longer an issue with the Outlander PHEV. It offers the advantages of EVs: powerful driving, superb quietness, and high stability.
Products and Technologies

Development of Electric Vehicle Technologies

New Value of Vehicles

Our EV/PHEVs are fitted with a large-capacity battery, which means that customers can connect their electrical appliances to use them even while on holiday or traveling. The batteries can also serve as an emergency source of electrical power in the event of disaster.*1 (For the Outlander PHEV, a maximum of 10 days*2 of electrical power can be provided, including electricity generated by the engine.*3) In addition, by adopting Vehicle to Home (V2H) technologies, which connect vehicles to the electrical supply of homes, batteries can be used for energy management or serve as an alternate power supply during power outages. These types of electric-powered vehicles are becoming more widely adopted as vehicles that have value even when they are not being driven.

*1 Please follow the instructions for each vehicle when connecting appliances.
*2 Calculated based on an approximate daily electric power consumption of 10 kWh for an average household. (excluding conversion efficiency such as from V2H equipment)
*3 When connected to V2H equipment, the engine cannot be used to generate electricity.
Products and Technologies

Development of Fuel Economy Improving Technologies

The key issues in developing technologies for improving fuel economy are how to minimize waste when burning fuel, and how to reduce the resistance of air intake and the friction of sliding parts. Mitsubishi Motors uses these perspectives to promote the development of technologies for improving the fuel economy of new engines.

Variable Valve Timing Mechanism "MIVEC"
Mitsubishi Innovative Valve Timing Electronic Control System

Idle-Stop "AS&G" Auto Stop & Go

AS&G is an idling stop function that automatically stops and starts the engine when the vehicle stops or moves off. It improves fuel efficiency by not running the engine when the vehicle is stopped. When fitted with a coasting stop function, AS&G stops the engine while decelerating.

![Idle-Stop "AS&G" Auto Stop & Go](image)

Reducing Engine Friction

Reducing Friction Inside the Engine to Improve Fuel Economy

Various engine losses can affect fuel economy: exhaust loss, cooling loss, mechanical friction loss, pump loss, and drive loss of auxiliary units. Engine friction is a mechanical friction loss resulting from combustion gas within the cylinder causing engine parts such as the piston and crank shaft to move. This friction loss is mainly caused by these sliding parts.

We make improvements to decrease the sliding resistance of such parts to reduce engine friction.

Approaches to Reducing Engine Friction

- **Improving contact surfaces**
  Optimization of the shape and surface treatment of the piston skirt, and surface treatment of the cam
- **Reducing contact force**
  Improvements to the shape, and reduction of tension of piston rings, optimization of the set load of valve springs, crank shaft layout, shape of timing chain, tension of timing belt, etc.
- **Reducing friction by improving lubricants**
  Application of low-viscosity engine oils
- **Reducing resistance when stirring the engine oil**
  Optimization of the oil level

New MIVEC engine

Exhaust side

Variable lift sensor

Continuously variable valve lift system

Intake side

Variable cam phase system

Variable lift electric actuator

The new MIVEC is a variable valve timing mechanism for minimizing fuel consumption. The intake valve lift is continuously varied according to the operating condition to reduce intake resistance. This minimizes air intake energy loss, resulting in improved fuel efficiency.
Products and Technologies

Development of Fuel Economy Improving Technologies

Components other than the engine also need to be examined to improve fuel economy. Mitsubishi Motors is developing various technologies related to the vehicle body.

CVT
Continuously Variable Transmission
A continuously variable transmission (CVT) varies transmission ratio by seamlessly changing the effective diameter of the pulleys. It seeks to improve fuel efficiency by controlling driving power. Based on throttle position information, driving power is controlled in accordance to the driving condition to achieve the most efficient balance between the engine and CVT.

“Assist Battery” Deceleration Energy Recovery (Power Generation Control)
This technology controls power generation under various driving conditions such as idling, accelerating, and cruising by conducting intensive charging of the battery using electric power generated while decelerating. Reducing the load on the engine raises fuel efficiency.

While Decelerating

When Starting from a Stop and Driving

Eco-Drive Support
We are spreading equipment to support eco-driving, such as by equipping our vehicles with eco-drive support displays including an eco-lamp and fuel economy meter in the combination meter and central information display.
Products and Technologies

Development of Fuel Economy Improving Technologies

**Eco-Drive Support Equipment Display (for Outlander)**
- **Eco-lamp**
  Lights up while driving in a fuel-efficient manner.
- **Fuel consumption meter**
  Displays the average and current fuel economy.
- **Idle-stop duration**
  Displays the cumulative time of engine halts by the AS&G idle-stop mechanism.
- **Eco-drive assist**
  Displays how fuel-efficient the current driving style is.
- **ECO Score**
  Determines the driving status at predetermined intervals, and displays the eco-drive rate in a leaf-shaped gauge.

**Aerodynamics**
Improving aerodynamic performance for better fuel economy.
We optimize the shape of our vehicles to deliver excellent aerodynamic characteristics through repeated analysis and wind tunnel tests using Computational Fluid Dynamics (CFD) from the conceptual design stage.

**Weight Reducing Technologies**
We improve fuel economy by reducing vehicle weight. We use aluminum, light but strong high-tensile strength steel panels, and rationalization of structures to keep vehicle weight down while ensuring safety through a larger vehicle body, thereby achieving a balance between fuel economy and safety.
Vehicles powered by gasoline and diesel engines inevitably emit combustion gases from the engine while driving. These exhaust gases contain pollutants. Mitsubishi Motors constantly develops and promotes gasoline and diesel engine vehicles that emit lower concentrations of these noxious exhaust gases.

**Improving Gasoline Engine Vehicles**

Since the 1960s, emissions of carbon monoxide, hydrocarbons, and nitrogen oxides (NOx) have been steadily restricted by regulations. We have taken various measures since such regulations were first introduced. We currently comply with these regulations by applying electronically controlled fuel injectors and advanced catalyst technologies to the combustion control system.

**TOPICS**

**Additional ULEV* 70 Vehicles for North America Introduced**

The compact SUV *Eclipse Cross* for the North American market is now compliant with the ULEV70 standards, which substantially reduce emissions of harmful substances.

* Abbreviation for Ultra Low Emission Vehicle

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**Improving Diesel Engine Vehicles**

For diesel engine vehicles, carbon monoxide, hydrocarbons, NOx, and particulate matter have been regulated in some countries, such as Japan, United States and European countries, since the 1970s. Since such regulations were first introduced, we have taken measures including improving the combustion technology. To comply with these regulations, we have developed and produced clean diesel engines by systemizing technology such as VG turbochargers, controlling combustion with a common rail fuel injection system, introducing after-treatment using NOx trap catalysts, and diesel particulate filters.

**VG Turbocharger**

The VG turbocharger helps to improve fuel economy and suppress emissions of particulate matter through optimum supercharging across the engine’s operating range.

**Common Rail Fuel Injection System**

Particulate matter and NOx can be generated due to incomplete combustion. In Mitsubishi Motors vehicles, this is suppressed using a high-pressure fuel pump, common rail accumulator that stores highly pressurized fuel, and electronically controlled fuel injectors.

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**NOx Trap Catalyst**

This converts toxic NOx into harmless nitrogen.

**Diesel Particulate Filter (DPF)**

This substantially reduces particulate matter.

**Vehicles with Clean Diesel Engines**

* Abbreviation for Ultra Low Emission Vehicle

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* Abbreviation for Ultra Low Emission Vehicle
Products and Technologies

Reduction of In-Cabin VOCs

To provide customers with a healthy and safe cabin space, Mitsubishi Motors works to reduce volatile organic compounds (VOCs) inside the cabin. VOCs are compounds that easily volatilize at room temperature such as formaldehyde and toluene. These compounds are thought to cause sick building syndrome, and may irritate the eyes, nose, and throat. In an automobile cabin, they are mainly generated by adhesives and paint used in interior parts.

The Japan Automobile Manufacturers Association, Inc. (JAMA) established voluntary guidelines for reducing vehicle cabin VOC concentration levels (the "Voluntary Guidelines") applicable to new model passenger cars marketed starting from the 2007 fiscal year. Please see the JAMA website for details regarding the Voluntary Guidelines.


In order to reduce the amount of in-cabin VOCs, we are taking measures to reduce the sources of VOCs as well as VOCs themselves. All new models since the Mitsubishi i launched in January 2006 satisfy the voluntary guidelines set by the Japan Automobile Manufacturers Association (JAMA).

Example of Measures to Reduce VOCs

<table>
<thead>
<tr>
<th>Central panel</th>
<th>Reduced organic solvents in the surface painting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpet</td>
<td>Reduced aldehydes in pile adhesives</td>
</tr>
<tr>
<td>Seat</td>
<td>Reduced organic solvents in fabric adhesives</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Adsorbs and decomposes formaldehyde using the clean air filter deodorizing function</td>
</tr>
<tr>
<td>Air-conditioner</td>
<td>Reduces VOCs with clean air filter with deodorizing function</td>
</tr>
</tbody>
</table>
Environmental Initiatives

Products and Technologies

Recycling Initiatives

Automobile Recycling Initiative Established

In the 1980s, large-scale illegal dumping of automotive shredder dust occurred due to a shortage of final disposal sites for such dust. In response, the Ministry of International Trade Industry (the present Ministry of Economy and Industry) METI drew up the Used Automobile Recycling Initiative in May 1997, to encourage proper recycling and disposal. Following METI’s action, the Japan Automobile Manufacturers Association, Inc. (JAMA) established a voluntary action project called the “Automobile Recycling Initiative” in February 1998. Mitsubishi Motors introduced the “Mitsubishi Motors Recycling Initiative” in the same month.

In the Mitsubishi Motors Recycling Initiative, we set targets and continued improving the ease of recycling, reducing the use of lead (except for batteries), and introducing recycled parts (bumpers, interior substrate materials, floor mats, etc.) for new vehicles. In line with this unique guideline, we consider ease of recycling from the initial stage of designing and developing products, and have achieved our voluntary target values.

Dealing with Automobile Recycling Acts of Other Countries

Since the Automobile Recycling Law was enforced in Japan in 2005, automotive manufacturers have been properly recycling shredder dust of discarded automobiles, airbags and fluorocarbons (3 items), thus helping to create a recycling-based society. The ELV Directive (2003) was enacted in Europe as well, specifying ease of recycling as a certification requirement and promoting recyclable design. We will comply step-by-step with automobile recycling regulations which are now being introduced in developing countries in Asia.
Products and Technologies

Recycling Initiatives | Recycling-Based Design and Development

Under vehicle recycling legislation in Japan and Europe, automobile manufacturers are obligated to consider recycling when developing products. Mitsubishi Motors conducts design and development that actively incorporates not just recycling, but all aspects of the 3Rs including reduction and reuse. Since 1999, we have implemented the 3Rs in the stage starting with conceptual design in accordance with our unique Recycling Plan Guidelines. With regard to wires and harnesses, and motors, we have improved detachability and ease of recycling in accordance with the Harness Design Guidelines. Parts made from recycled materials include spare tire covers and battery trays made with recycled material from bumpers replaced during repairs performed by dealers.

Use of Recycled Parts on New Vehicles

We proactively adopted 3R designs in accordance with the Recycling Plan Guidelines for all vehicles developed in fiscal 2017. Eclipse Cross, which was launched in fiscal 2017, uses easily recyclable thermoplastic resin for exterior and interior parts. We will continue to manufacture vehicles with due consideration for the 3Rs from the initial stages of development to promote resource conservation and simplify recycling.

Main parts (indicated in green) that use thermoplastic resin on the Eclipse Cross. Top: Exterior, Bottom: Interior
Products and Technologies

Recycling Initiatives | End-of-Life Vehicle Recycling

Mitsubishi Motors encourages recycling of end-of-life vehicles to reduce the environmental impact of waste from these vehicles. In Japan, the EU, and other regions, we promote recycling in accordance with the automobile recycling laws of each country.

Response to Automobile Recycling Laws in Japan

The company accepts automobile shredder residue (ASR), airbags, and fluorocarbons for recycling. For the recycling of ASR, we participate in ART (Automobile Shredder Residue Recycling Promotion Team: Team established by Nissan Motor Corporation, Mazda Motor Corporation, Mitsubishi Motors, etc.) to jointly process ASR. As a result of the creation of new processing facilities and other measures, the ASR recycling rate in fiscal 2017 was 98.1%, substantially above the statutory standard of 70% in effect since 2015. We will continue to develop new recycling facilities to ensure the stable processing of ASR. The company outsources the treatment of airbags and fluorocarbons to the Japan Auto Recycling Partnership (JARP).

In addition, for the effective use of recycling fees deposited from customers, we proactively works on increasing the recycling rate by conducting efficient recycling and proper processing of these three items.

Recycling Promotion in the EU

Response to the EU's Directive on the Recycling of End-of-Life Vehicles

In the EU, automobile manufacturers or importers must accept and recycle end-of-life vehicles in accordance with the End-of-Life Vehicles Directive.* The company built a system of acceptance and recycling in line with the actual situation of EU member countries centering on our European subsidiary MME (Netherlands).


Provision of Dismantling Information

In the EU, automobile manufacturers must provide dismantling information for new model vehicles to treatment operators. The company provides such information on a timely basis by using the International Dismantling Information System (IDIS) jointly developed by automobile manufacturers.

Response to the EU's Directives on Approval for Vehicle Models for Recyclability

In the EU, satisfying the minimum 95% recyclability rate is a requirement for type approval of vehicle models, and the company established a system that satisfies the requirements of this directive. Our vehicles sold in the EU meet the requirements of the directive under this system. We will continue to acquire recyclability approval for all new models sold in the EU.

Collection of Drive Batteries in Electric-Powered Vehicles/Construction and Operation of the Recycling System

The company established and operates a drive battery collection system for the purpose of recycling technology development and proper treatment of end-of-life drive batteries in electric-powered vehicles and plug-in hybrid vehicles in Japan, Europe, and North America.
In cooperation with suppliers, we are complying with the REACH regulation, a general system for the registration, evaluation, authorization, and restriction of substances used in the EU.

**Flow of Data Collection through IMDS**

![Flow of Data Collection through IMDS](image)

**Initiatives to Reduce Hazardous Substances in Mitsubishi Motors Products**

Mitsubishi Motors uses IMDS to manage data concerning materials. Through this process, we confirm compliance with use regulations and reductions in the use of hazardous substances in new vehicles and vehicles in ongoing production. We will continue to take measures to ensure compliance with regulations and reduce the use of hazardous substances.

**Material Data Control by the International Material Data System (IMDS)**

Data on the hazardous substances contained in vehicle parts delivered by suppliers are collected by the International Material Data System (IMDS), an international system for collecting such data. Together with overseas plants such as Mitsubishi Motors (Thailand) Co., Ltd. (MMTh), we utilize the collected data under a globally centralized internal system for reducing hazardous substances.

In accordance with the reduction targets of the Japan Automobile Manufacturers Association, Inc. and EU end-of-life vehicles directive, Mitsubishi Motors is working to reduce the use of four substances (lead, mercury, cadmium, and hexavalent chromium). We have established internal technical standards to voluntarily reduce hazardous substances. We are also taking measures to comply with regulations on the use of hazardous substances in each country in compliance with the REACH regulation concerning substances. At present, in addition to lead, mercury, cadmium, hexavalent chromium and other heavy metals, the use of VOCs (volatile organic compounds), bromine-based flame retardants and various other substances is regulated. Regulations similar to European ones are being enforced in developing countries in Asia as well.

*REACH stands for 'Registration, Evaluation, Authorisation and Restriction of Chemicals.' Enacted on June 1, 2007, the REACH regulation is a general system to register, evaluate, authorize and restrict the use of substances.