Creating Clean Automobiles:Development Stage and Products

The R1 and R2, Subaru's mini cars, underwent Minor changes in November 2005 to realize enhanced emission performance in addition to strong, smooth performance and fuel economy (exhaust emissions from the naturally aspirated engine reduced by 75% compared to the Japanese exhaust emissions standard of 2005). Also, the Subaru Legacy, which underwent Minor changes in May 2006, significantly improved its environmental performance with regards to fuel economy and emission performance. Moreover, the Legacy, which has the SI-DRIVE mounted, allows drivers the pleasure of creating their own driving style.

Fuel Economy

Automobiles emit carbon dioxide (CO_2) proportional to the amount of fuel consumed. By improving fuel economy, CO_2 will be reduced resulting in the better conservation of limited energy resources and the prevention of global warming. Subaru, while utilizing the advantages of AWD and high power engines, has been working to improve fuel economy by developing technologies that make engines more fuel efficient, reduce transfer loss in the drivetrain and reduce vehicle weight and running resistance, and we are in the process of introducing vehicles which meet the Japanese fiscal 2010 Fuel Economy Standards, the target for gasoline vehicles.

Engine Improvement

Legacy

● Both the intake efficiency and combustion were improved by adopting a intelligent-Active Valve Lift System (i-AVLS) on naturally aspirated engines (2.5 ℓ)

intelligent-Active Valve Lift System

4-1 Same length, constant pulsation exhaust system

Legacy 2.5L SOHC Engine

Enhanced Efficiency of the Drivetrain

Legacy

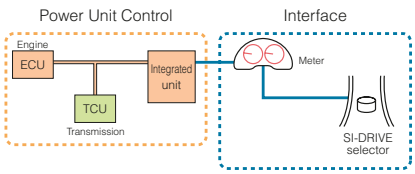
● Transfer loss in the drivetrain was reduced by adopting a low-friction type hydraulic clutch to 5AT.

Legacy SI-DRIVE

SI-DRIVE (SUBARU INTELLIGENT DRIVE)

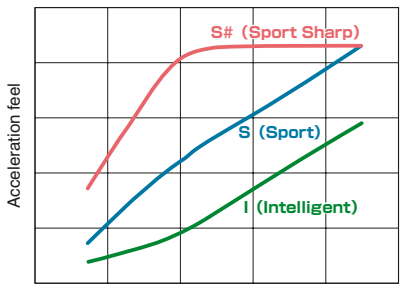
● SI-DRIVE is a system which, by comprehensively controlling the engine, transmission, meters and control switches, allows drivers to switch among three selectable modes depending on preference and driving style. For example, the "Intelligent" mode, improves upon the conventional ECO mode by regulating control units and effectively controlling engine torque output (soft mode) which, together with finely-tuned shifts and lock-up control in the automatic transmission, helps maintain low fuel consumption. The "Intelligent" mode also ensures fuel economy with the ECO gauge which promotes ECO driving (fuel-efficient driving).

■SI-DRIVE control system (Image)



SI-DRIVE selector　Multi information display　ECO gage

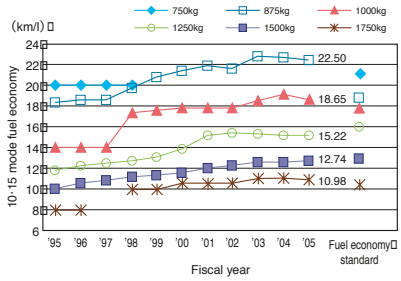
■Image showing acceleration characteristics at each controrl mode



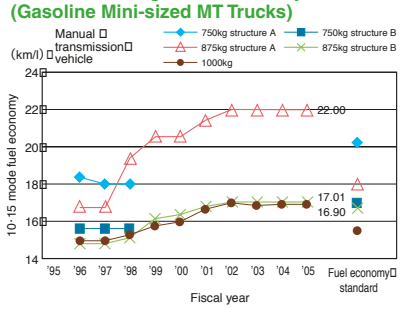
Trends in Improvement of the Average Fuel Economy by Equivalent Inertia Weight

In an effort to meet the fiscal 2010 fuel economy standards, we achieved the target in three out of the five ranks of equivalent inertia weight for gasoline passenger cars. In gasoline mini-sized trucks, we succeeded in attaining the target in all applicable ranks of the equivalent inertia weight.

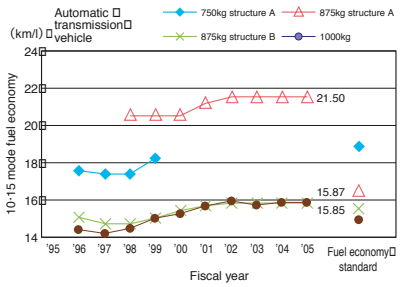
■Trends in Average Fuel Economy by Equivalent Inertia Weight (Gasoline Passenger Cars)



■Trends in Average Fuel Economy (Gasoline Mini-sized MT Trucks)

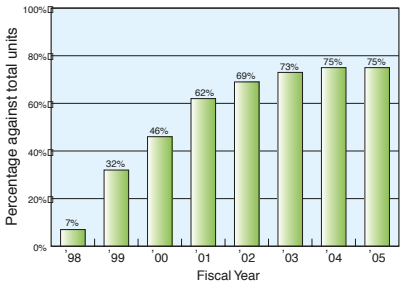


■Trends in Average Fuel Economy (Gasoline Mini-sized AT Trucks)

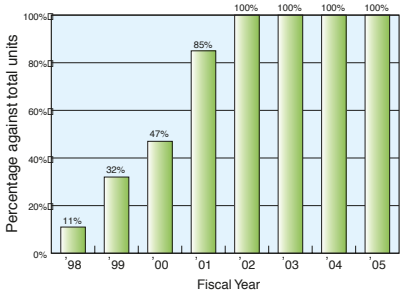


Trends in Improvement of Attainment Rates for Fiscal 2010 Fuel Economy Standards

■Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards (Gasoline Passenger Cars)



■Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards (Gasoline Mini-sized Tucks)



Exhaust Emissions

Substances such as carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx), which are emitted from automobiles, are one of the causes of air pollution in metropolitan areas where there is intensive motor traffic. In order to improve the state of the air, Subaru is gradually launching low emission vehicles (certified by the Ministry of Land, Infrastructure and Transport) that meet standards stricter than the regulations.

Application Status of Low Emission Vehicle

Vehicles with naturally aspirated (NA) engines reached the "☆☆☆☆" level, with exhaust emissions reduced by 75% compared to the 2005 standards as a result of the revision of the catalzyer layout in the R1 and R2, to which Minor changes were made in fiscal 2005. Also, the Legacy with NA engine (excluding the 2.0ℓ model), to which Minor changes were made in May 2006, reached the "☆☆☆☆" level with exhaust emissions reduced by 75% compared to the 2005 standards, and the turbo Legacy reached the "☆☆☆" level, with exhaust emissions reduced by 50% compared to the 2005 standards.

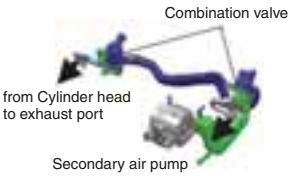
Exhaust Emissions Measures in the Legacy

● NA models (2.5ℓ and 3.0ℓ) reached the "☆☆☆☆" level, with exhaust emissions reduced by 75% compared to the 2005 standard as a result of adopting a new intelligent-Active Valve Lift System (i-AVLS)*1 (for 2.5ℓ vehicles) and revising the exhaust system and catalyzer layout (for 2.5ℓ and 3.0ℓ vehicles).

● Turbo models (2.0ℓ) reached the "☆☆☆" level, with exhaust emissions reduced by 50% compared to the 2005 standard by adopting new tumble generated valves, which improve combustion, and a secondary air system*2, which combusts unburned gases.

■＊1 : intelligent-Active Valve Lift System (i-AVLS)

■＊2 : Secondary air system



Exhaust Emissions Measures in the R1 and R2

● The engines for the R1 and R2 reached the "☆☆☆☆" level, with exhaust emissions reduced by 75% compared to the 2005 standards as a result of revising the catalyzer layout and the fuel and ignition control settings for when the engine is cold.

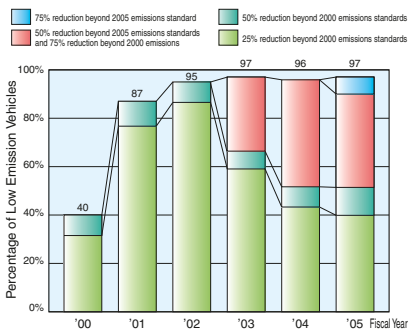
Exhaust Emissions Measures in Samber

● The SOHC-NA engine for the vehicle code VB clean and TB clean reached the "☆☆☆" level, with exhaust emissions reduced by 50% compared to the 2005 standards. In order to reduce exhaust emissions (HC in particular) when the engine is cold, we used a finer-cell catalyst, reviewed the composition of noble metals in the catalyst, and adopted the Double O_2 sensor system to improve the accuracy of oxygen concentration measurement in exhaust emissions.

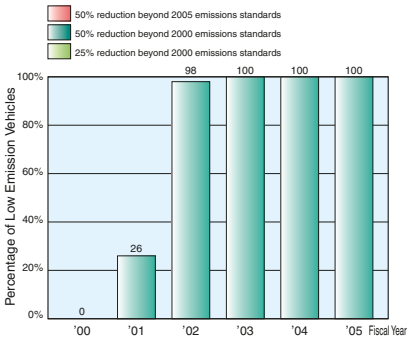
Trends in Improvement of the Percentages of Low Emission Vehicles

The system to certify low emission vehicles started in April 2000. The percentages of the low emission vehicles shipped as Subaru are as follows.

■Trends in Percentages of Low Emission Vehicles



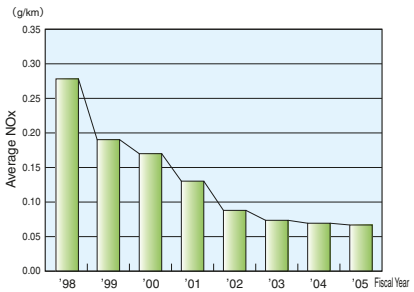
■Trends in Percentages of Low Emission Light Trucks



Trends in NOx average

By launching low emission vehicles which meet the standards represented by the low emission vehicle certification standard into the market, Subaru has been able to reduce the average amount of NOx emitted by Subaru Vehicles every year as shown in the chart below.

■Trends in NOx Averages of Subaru Vehicles



Notes:
＊The figures calculated from the regulation values (10・15 mode and 11 mode) at the time of shipment.
＊Going back to fiscal 2000, calculations were made with regulation or conversion values for the new test mode. The new test mode is a combined mode, where the regulation values set individually for the 10・15 mode and 11 mode are integrated.
＊Until fiscal 1999, the figures were calculated from the regulation values for the 10・15 mode.

Clean Energy Vehicles

Clean energy vehicles have such features as emitting fewer global warming substances (carbon dioxide) and air pollutants (carbon monoxides, hydrocarbons, nitrogen oxides, etc.) and have less environmental impact than gasoline engine vehicles. However, there are technical problems related to cost and driving distances. Subaru has been developing its unique clean energy vehicles that have the gasoline engine vehicle-level performance and utility.

Development of Secondary Batteries (Chargeable Batteries) for Hybrid Vehicles, Electric Vehicles, and Fuel Cell Electric Vehicles

In May 2002, Subaru established NEC Lamilion Energy, Ltd., jointly with NEC Corporation (NEC) and since then has advanced the development of secondary batteries, which could become the world standard for vehicles, by combining laminated manganese lithium-ion battery cell technology and Subaru's automotive battery packs technology.

As a result, we succeeded in developing a prototype secondary battery for hybrid and electric vehicles, with superior durability of 10 years or 150,000 miles (240,000 km). This prototype has received highly-favorable evaluations from more than 20 domestic and overseas companies such as automakers and electric manufacturers. At the same time, we were able to arrive at our goal of developing practical batteries for mounting on vehicles. Although this partnership with NEC was amicably terminated in March 2006 following the success of the prototype development, in order to advance the development of commercial battery packs for vehicles, we continue to maintain a cooperative relationship with NEC in the field of development and production.

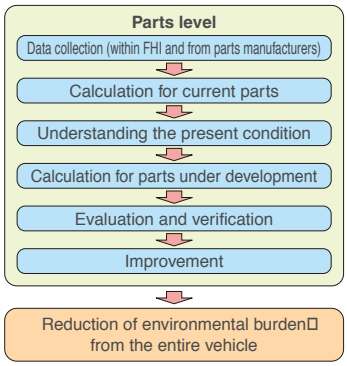
New Capacitor — Development of Lithium-Ion Capacitor

Employing our unique technologies to use environmentally friendly materials, Subaru has been developing the Lithium-ion Capacitor, a new capacitor which can directly store almost the same amount of electrical energy as lead batteries. This capacitor has high power and superior durability and is ideal for the next generation clean ECO cars and for the storage of energy from renewable sources, such as wind and solar power. We now see the possibility of replacing lead batteries with this capacitor and will continue to work towards its practical application and commercialization.

Joint Development of Energy-Saving Gasoline Engines by Industry, Academia and Government

Recently, the importance of creating new intellectual properties through industry-academia-government collaboration has been gaining recognition. Subaru, together with Chiba University and Nihon University, has been involved in the Energy Use Rationalizing Technology Strategic Development Project organized by the New Energy and Industrial Technology Development Organization of Japan (NEDO) since 2003, and has developed breakthrough technology to improve thermal efficiency by 6 to 11% by avoiding knock with a compression ratio of 14 to 1. In 2005, we designed a new mechanism to smoothly rotate up to high rpm while maintaining this high efficiency and reducing friction and vibration. We have made great strides toward the practical application of this simple and low cost mechanism. We will aim for the realization of a new gasoline engine that emits fewer pollutants yet is as efficient as a diesel engine.

■Concept of LCA application at the development stage



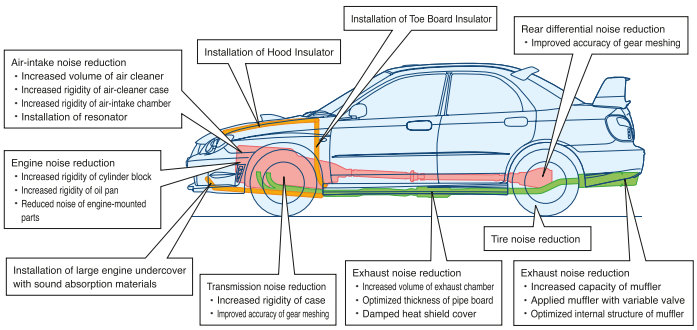
LCA Activities

Life Cycle Assessment (LCA) is a method to numerically evaluate the environmental burden over the product lifecycle starting from resource collection and manufacture, to use and finishing at the disposal stage. Recognizing that LCA is a useful tool for evaluating product environmental performance, Subaru has been conducting activities to advance the utilization of LCA. In fiscal 2005, we improved the database and expanded the application range. Spreading the LCA concept through these activities, we will continue to improve the database and study LCA applications to further reduce the environmental burden over the automobile lifecycle.

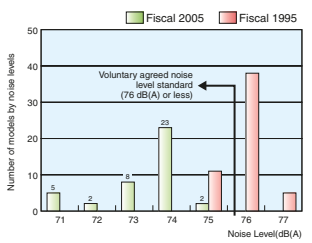
Noise

Subaru has been actively working to reduce the automobile noise generated from the engine, transmission, air intake and exhaust, tires and so on, even the noise from AWD differential system. In fiscal 2005, the noise was further reduced in the Impreza by significantly reviewing its air intake and exhaust system. Also for other models, Subaru is promoting the reduction of noise by increasing the volume of exhaust system and by adopting larger engine undercover.

■Main Measures to Reduce Noise



■Distribution chart of pass-by noise (passenger cars/Japan)



∗1: For the CO_2 conversion factor used in calculating CO_2 emissions, please refer to footnote ∗4 on page 16.

∗2 : FHI independently calculates emissions of other greenhouse gases as well. Emissions in fiscal 2005 were; HFC134a: about 297 ton-CO_2, CH_4: about 79 ton- CO_2, SF_6: 3 ton-CO_2. Emissions are calculated by multiplying the amount emitted by the global warming potential.