Basic Strategy for Promoting the Development of Next-generation Low Emission Vehicles

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Next Generation Low Emission Vehicle Working Group

Committee on Comprehensive Strategy for the Development and Dissemination of Low Emission Vehicles

Introduction

The Japanese government is promoting a range of measures aimed at solving the problem of air pollution in the major urban areas, and achieving the CO_2 emission reduction targets set for the transport sector to meet the greenhouse gas reduction targets adopted by the Kyoto Protocol. These measures include toughening motor vehicle emission controls, improving motor vehicle fuel efficiency, promoting the greater use of LEVs, improving traffic flow, enhancing distribution efficiency, and encouraging the use of public transport.

Measures such as these, though, are not enough. To solve the problem of air pollution caused by motor vehicle emissions, and preserve the global environment so we can pass on an environment in which future generations can live in comfort, the government must also promote the development and commercialization of next-generation LEVs with zero or almost zero exhaust emissions and that cut CO_2 emissions drastically, and create a climate that facilitates the full-scale adoption and use of such vehicles.

It is therefore critical to find solutions to the technological challenges presented by next-generation vehicles so they can be running on our roads as soon as possible, and examine effective measures to this end.

To tackle these issues, the government established the Committee on Comprehensive Strategy for the Development and Dissemination of Low Emission Vehicles. The Next Generation Low Emission Vehicle Working Group set up within the Committee has been evaluating the various types of next-generation LEVs, and examining their fields of application, exhaust emission and other development targets, and policies for addressing development issues.

This report puts forward basic strategies for promoting the development of next-generation LEVs based on the results of these extensive evaluations and examinations.

The Low Emission Vehicle Working Group was also established under the Committee, and its role has been to examine strategies for the development and dissemination of LEVs currently at the practical use stage.

The term next-generation LEV referred to here indicates vehicles that deliver vastly improved exhaust emission performance and fuel efficiency compared to conventional vehicles through anticipated far-reaching technological breakthroughs from 2010, and not through merely an extension of existing technologies. It is not meant to indicate the use of any specific kind of fuel.

Here, hybrid vehicles, CNG vehicles, electric vehicles, methanol vehicles and certified fuel-efficient or low-emission vehicles currently being used are classified simply as LEVs.

Chapter 1 Environment Surrounding the Development of Next-generation LEVs

1. Air pollution and global warming

(1) Air pollution

Although vehicle emission monitoring stations throughout Japan have been showing steady improvements in the rates at which environmental standards for NO_2 and suspended particulate matter (SPM) have been met over the past few years, the rate is still quite low especially in the major cities (regions specified in the Motor Vehicle NOx and PM Law [1]).

Moreover, with air pollution litigation instituted in Tokyo, Nagoya and Osaka pointing to the liability of the state, air pollution has become a serious social issue.

(2) Global warming

CO_2 emissions from the transport sector accounts for about 20% (fiscal 1998) of Japan's total emission of 324 million tons (carbon equivalent), and of this, 90% is from motor vehicles. Considering substantial increases are expected in the future, more far-reaching measures to control transport-related CO_2 emissions are absolutely crucial.

The Kyoto Protocol adopted by delegates at the COP3 [2] held in December 1997 set greenhouse gas reduction targets for developed countries, and in it, Japan's target was set at a 6% reduction from the 1990 level of overall domestic greenhouse gas emissions by the period 2008–12. To achieve this target, the transport sector has to cut CO_2 emissions to the 1995 level (a reduction of 13 million tons from the amount expected to be emitted in 2010 if no effective countermeasures are enforced).

We must also keep in mind the need for ongoing measures that can bring about further cuts in greenhouse gas emissions beyond that period as well.

(3) Energy resources

World reserves of crude oil as at the end of 2000 were 1,028 billion barrels, and were expected to last 42 years. Japan depends almost entirely on imports for crude oil (99.7% in 1999), so a range of measures including energy conservation and adoption of alternative fuels are essential for Japan's future energy security.

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[1] Special Measures Law Concerning the Reduction of the Total Amount of Nitrogen Oxides and Particulate Matter Emitted by Motor Vehicles in Specified Regions

[2] Third Conference of Parties to the Framework Convention on Climate Change

2. LEV development and dissemination

(1) History of LEV development and dissemination in Japan

Japan was a world leader in introducing emission controls for gasoline vehicles from the latter half of the 1960s, and since then the range of vehicles and substances covered has been expanded while the controls themselves have steadily been made tougher.

The government also introduced a certified low emission vehicle system aimed at promoting the development and dissemination of vehicles with lower levels of exhaust emissions than the latest controls, and the technologies developed under this system have led to the development and dissemination of "super LEVs."

Japan has also long been involved in R&D for vehicles that use alternative fuels and power systems formed from a myriad of technological innovations. Growing demand for more environmentally friendly vehicles has seen the emergence of CNG and hybrid vehicles in the commercial market for passenger cars and other relatively light vehicles, and the development of various new technologies including fuel cell systems and dimethyl ether (DME) engines, though the spread of these vehicles and technologies is still quite limited.

(2) LEV dissemination

At the end of fiscal 2000 there were 570,000 certified fuel-efficient and low-emission vehicles (excluding light vehicles), about 50,000 hybrid vehicles, and a total of about 10,000 other LEVs such as CNG and electric vehicles.

CNG vehicles are mainly commercial vehicles such as city buses and courier vans, while hybrid vehicles are mainly passenger cars. Most certified fuel-efficient and low-emission vehicles are also passenger cars.

Fuel supply facilities for LEVs are on an upward trend. As of the end of November 2001 there were 148 natural gas supply points, 15 methanol supply points, 32 electricity supply points, and 1,865 LPG supply points.

(3) Current state of and future plans for international exhaust emission controls

Compared to the long-term controls currently in force (1997–99 controls), the new short-term controls (planned 2002–04 controls) for diesel vehicles require significant cuts in diesel exhaust emissions; e.g. about a 30% cut in NOx to 3.38 g/kWh and in PM to 0.18 g/kWh for vehicles with a gross weight of more than 3.5 tons. The new long-term controls (2005 controls), which have yet to be firmly set, will aim at reducing NOx by about half and PM by at least half from the levels set in the new short-term controls.

Similarly, new short-term controls (2002–04) are also planned for gasoline vehicles, and new long-term controls will set targets of at least a 50% reduction in the levels in the new short-term controls.

Europe and the U.S. are also planning to tighten controls in phases up to about 2010 through measures such as EURO5 (Europe) and 2007 controls (U.S.).

To date Japan has focused its controls on reducing NOx, while in Europe and the U.S. focus has been on PM, but from now on, Japan too will substantially toughen PM controls so they are generally at the same level as those in Europe and the U.S.

3. Current state of and prospects for next-generation LEV development

(1) Next-generation LEV development

Recent discussions with domestic and overseas vehicle manufacturers reveal almost all are engaged in further R&D and improvements to CNG and hybrid vehicles.

They are also looking into fuel cell vehicles as next-generation LEVs, and some are conducting road evaluations of passenger cars and route buses with a view to their market introduction. There are, however, many problems with fuel cell vehicles that need to be resolved, such as the performance of the fuel cells themselves, so a considerable amount of basic and elemental research still remains.

Few manufacturers have embarked on elemental technology or development research into GTL [3] or DME vehicles, but from the viewpoint of reducing the level of oil dependency and producing cleaner exhaust gases, these technologies show great potential.

(2) Technological issues facing the development and dissemination of next-generation LEVs

Technological issues facing next-generation LEVs include extending vehicle range and improving vehicle endurance and reliability. Reducing parts and vehicle costs is also a key challenge, and as well as incentives through the green tax system, the government must promote common use and mass production of parts by standardizing parts etc., and bringing CNG tank controls into line with international controls.

There are also other issues specific to vehicle types, such as designing smaller and lighter systems, reducing recharging times, and developing control systems.

[3] Gas to liquid; Liquid composite fuel made from natural gas etc.

(3) Prospects for next-generation LEV development

Discussions with manufacturers indicated that R&D aimed at further expanding the range of CNG and hybrid vehicle types being sold will continue, and the broad expectation is that by 2020 large numbers of next-generation hybrid vehicles will be on the road.

Manufacturers are also planning to continue their research into fuel cell vehicles, and while many believe that fuel cells will play a key role in the future, mainly in passenger cars and light vehicles, there is also a widely held view that considering the great difficulty in establishing fuel supply systems and significantly reducing costs, their reach is likely to be still quite limited in 2020.

As for large vehicles, there is an urgent need to drastically reduce the level of diesel emissions, so some local and overseas manufacturers are moving ahead with the development of super-clean diesel vehicles and vehicles that run on alternative fuels, such as DME.

Chapter 2 Basic strategy for Promoting the Development of Next-generation LEVs

1. Basic strategy for the development of next-generation LEVs

As stated in the preceding chapter, to effectively resolve air pollution, global warming and other environmental issues associated with the motor vehicle, a basic strategy for the commercialization and widespread use of next-generation LEVs by 2020 is essential.

Passenger cars and small vehicles account for the majority of vehicles on the road, and most run on gasoline. Although their exhaust emission performance is outstanding, priority for development should be given to improving fuel efficiency in an effort to drastically reduce emissions of CO_2, a major factor in global warming.

Most large vehicles are diesel-powered and therefore one of the main causes of air pollution, so development should give priority to reducing exhaust emissions as a means of comprehensively solving the air pollution problem, while maintaining or even improving their present outstanding fuel efficiency.

There is also a need for measures that can facilitate a shift away from petroleum to ensure the effective use of finite oil resources and future energy security.

In this light, there is a need for strategies to develop LEVs that correspond to the characteristics of each motor vehicle type.

In particular, considering such factors as investment efficiency, it would be valuable to develop alternative fuel vehicles and low emission diesel vehicles that can use the existing infrastructure to replace large diesel vehicles, and the development of next-generation LEVs is expected to be further accelerated by the synergy arising from the parallel technological development of such diesel vehicles and vehicles that run on alternative fuels.

With their energy regeneration functions, hybrid systems are effective for route buses and city courier vehicles that travel at low speeds and stop frequently.

For the future, it would be beneficial to incorporate information technology into next-generation LEVs to further cut exhaust emissions and improve fuel efficiency.

2. Fields of application

A) Passenger cars

Passenger cars have the lowest power output and range requirement, and development is simpler than for trucks and other heavy vehicles, so fuel efficiency should be improved and CO_2 emissions reduced even further with the ultimate aim of an emission level close to zero.

Therefore fuel cell vehicles, hydrogen-powered vehicles that have no exhaust emissions when travelling, and next-generation hybrid vehicles with dramatically improved exhaust emission performance and fuel efficiency through precision controls are considered to be the most promising next-generation LEVs.

Electric vehicles can be adapted for common use limited to short distances within city areas by reducing vehicle size.

Diesel vehicles have great potential for improvement in limiting CO_2 emissions, and here the aim should be an exhaust emission performance on a par with the virtually zero emission gasoline vehicles.

B) Small and medium vehicles

Small and medium vehicles are and will continue to be indispensable for intra-regional goods distribution.

The requirement for power output and range is relatively low, so various kinds of LEVs can be considered, such as next-generation hybrid vehicles, next-generation natural gas vehicles with a fuel efficiency equal to that of diesel vehicles, next-generation LPG vehicles and fuel cell vehicles.

Next-generation natural gas vehicles show great promise from a low pollution and alternative fuel perspective, but there is a need to establish a network of natural gas supply points, so for the time being, their development should be carried out in parallel with next-generation hybrid vehicle development.

Diesel vehicles can be considered in measures for controlling emissions in small and medium vehicles provided an exhaust emission performance equal to that of gasoline vehicles can be achieved.

There is also a need to continue pursuing the development of hybrid and fuel cell technologies to facilitate the shift to fuel cell vehicles and other ultimate clean vehicles from 2020.

C) Large vehicles

Technological development of next-generation LEVs with almost zero emissions that can replace the current range of high-polluting large vehicles must be given a high priority.

Next-generation LEV types considered suitable are those with a drastically improved exhaust emission performance while maintaining the traditional advantages in fuel efficiency, such as next-generation natural gas vehicles, next-generation hybrid vehicles, DME vehicles, and super clean diesel vehicles.

Many issues need to be resolved before alternative fuel vehicles will be used extensively in this area, including the development of the necessary infrastructure that can support long distance transportation, so super clean diesel vehicles incorporating advanced electronic control technology, highly efficient exhaust after-treatment systems and high quality fuel that can completely transform the conventional image of diesel vehicles should also be developed in parallel.

Limitations such as the requirement for range and power output are lower for buses than they are for trucks, so as well as the vehicle types mentioned above, there is also a need to develop fuel cell buses with zero or almost zero exhaust emissions and greatly reduced levels of CO_2.

3. Exhaust emission and fuel efficiency targets for next-generation LEVs

The development of next-generation LEVs must take into account the need for safety, reliability, comfort, convenience, and economic efficiency, and strive for the following environmental performance targets appropriate to these vehicles.

(1) Exhaust emissions targets

Next-generation LEV exhaust emission targets should move away from the idea of control values with clearly defined achievement periods, and be set at the ideal considering not merely extensions of existing technologies but technological break-throughs, and the complete achievement of environmental standards.

Emission targets should therefore be either zero, or extremely close to zero.

Fuel quality has to be improved to achieve zero emission, so next-generation LEV development should be premised on drastic improvements in fuel quality through cleaner fuel, such as sulfur-free or low-aroma [4] fuel, appropriate distillation properties, development of CHF [5], and the formulation of quality standards for DME and CNG.

Specifically, passenger cars and small and medium vehicles should maintain exhaust emission values at the new long-term control level of almost zero emission.

The ultimate target for large vehicles, which pose the main exhaust emission problem, should be to cut nitrogen oxides to less than one tenth the level of the new long-term controls, and particulate matter emission to zero or close to zero. Development must also

[4] Aromatic organic compounds such as benzene.

[5] Clean hydrocarbon fuel — refined fuel without impurities.

take into account measures to control PM2.5 [6], whose effect on health is currently being studied, and unregulated substances.

(2) Fuel efficiency targets

Measures to improve the fuel efficiency of passenger cars, which account for the majority of vehicles on the road and are responsible for more than half of the CO_2 generated by the transport sector, are essential.

It is more effective to give priority to achieving significant improvements in the fuel efficiency of passenger cars and small and medium vehicles, while maintaining exhaust emission values lower than the level of the new long-term controls.

Specifically, considering the energy efficiency of fuel cell vehicles is 2–3 times as great as that of gasoline vehicles, and the level of CO_2 emission is generally correlated to fuel efficiency, development should aim at about half the current level of CO_2 emissions.

For large vehicles, development should aim at maintaining and improving upon the current outstanding levels of fuel efficiency of diesel vehicles.

In using alternative fuels or improved quality fuels, well to wheel [7] comparisons that include CO_2 emissions at the fuel production and refining stages should be examined.

(3) Other environmental performance targets

Next-generation LEVs must deliver outstanding performance not just in exhaust emissions and fuel efficiency, but in other environmental aspects as well, such as low noise and recyclability.

(4) Comprehensive environmental performance indicators

In addition to the conventional assessments of environmental load during vehicle operation, it is desirable to establish development and design methods that can minimize the environmental load over the life cycle of the vehicle through the introduction of processes for assessing environmental load at the time of vehicle production and disposal using the LCA[8] concept, and exhaust emission and fuel efficiency corresponding to the various vehicle use patterns, e.g. during high-speed driving or traffic congestion.

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[6] Particulate matter of 2.5 microns or less; poses a greater health risk than SPM of 10 microns or less. Its effects are currently being studied.

[7] Assessment method based on the required energy efficiency from fuel production through distribution to consumption.

[8] Life cycle assessment. All-inclusive assessment of environmental load from production, to use and final disposal.

4. Government role in development and dissemination of next-generation LEVs

Next-generation LEVs are currently at the research stage, so there is a need to clarify the roles of the industrial, government and academic sectors, and systematically create an environment that can facilitate their efforts in their respective areas of technological development and promotion.

The government through close cooperation among the relevant ministries and agencies should promote the early development of next-generation LEVs and create an environment that will facilitate their widespread acceptance and use.

Large next-generation low emission trucks in particular is a field in which it is difficult to expect a great deal from independent development because of the high development costs and limited market size. The government should therefore extend financial support for developing next-generation LEVs, open the R&D processes and the results to the public, and make the basic technologies developed from this as widely available as possible. This will enable motor vehicle manufacturers to use intellectual resources effectively and avoid overlaps in their development investments, resulting in a shortening of development time and lower costs, which in turn will accelerate the development of the necessary technologies.

At the same time, the government should provide support for establishing fuel supply facilities, for reducing parts and vehicle costs, and for implementing field trials of prototype vehicles.

The government must also consider the need for next-generation LEV guidelines and technological standards covering safety and environmental preservation (exhaust emission and fuel efficiency targets and measurement methods, and safety of equipment and systems that are not used in present-day motor vehicles, such as reformers in fuel cell vehicles).

In the future, the government should look into making the use of fuel of at least a certain quality obligatory in an effort to eliminate the use of improper fuel and facilitate the introduction of low emission technology that is premised on improved fuel quality.

Chapter 3 International Initiatives

1. Basic idea

To promote the development of next-generation LEVs, it is both beneficial and necessary for countries to engage in active exchanges of information and technologies, and search for common areas of policy cooperation, such as promoting joint research and uniform standards.

The open exchange of information among countries can be expected to have a significant effect in the prompt introduction of appropriate measures to facilitate the development and dissemination of next-generation vehicles using financial support and various kinds of incentives.

It is also important to carry out basic research on the basis of common technological targets agreed upon by governments and private-sector vehicle manufacturers, and to share the achievements of that research.

2. International conferences

To ensure all countries are heading in the same direction, there is a need hold international conferences on next-generation low emission technology where countries can exchange information on national measures and strategies, and, where necessary, examine technological or policy aspects that may require a joint approach. Care must be taken to ensure these conferences do not overlap with other conferences, and where possible, every effort should be made to utilize existing conferences (e.g., WP29 [9] etc.).

This will accelerate the technological development of vehicles, while the lower development and production costs will be reflected in cheaper parts and vehicles. It will also result in the more economical usage of community resources relating to technological development.

3. Standardization

To promote the world-wide spread of LEVs, national standards should be uniform so that resources can be more effectively channeled into technological development with no divergence of any individual country's development effort. In this light, when a certain direction for technological development becomes clear, frameworks such as the effective WP29 should be utilized to promote uniform standards.

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[9] World Forum for Harmonization of Vehicle Regulations, United Nations Economic Commission for Europe

4. Technical cooperation for developing countries

To solve air pollution and global warming issues in the developing countries of Asia where motorization is expected to move ahead at a rapid pace, there is a need to extend technical cooperation and support relating to LEV technology, checks, maintenance and management technology, and the know-how to use these technologies.

Through cooperation in this field, Japan can make an important international contribution toward addressing some of the various problems facing the global environment.

Conclusion

This report discusses basic strategies for promoting the development of next-generation LEVs with a view to their commercialization and widespread use by 2020.

We hope the strategies highlighted in this report together with the LEV development and dissemination strategies raised by the Low Emission Vehicle WG will help to promote the development and dissemination of next-generation LEVs more efficiently now and into the future.