

Low Carbon Technology Plan

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Council for Science and Technology Policy

Table of Contents

Introduction	1
1. Technological Strategy of Japan for Realizing a Low Carbon Society	4
(1) Technologies Required for Short and Medium-Term Measures (until around 2030)	4
(2) Technologies Required for Medium and Long-Term Measures (after the Year 2030)	7
(3) Deployment Measures for Society and the Necessary Institutional Reform	8
2. Contributing to International GHG Emission Reduction	11
(1) International Expansion and Contribution of Environment and Energy Technologies	11
(2) Contribution to Making an International Scheme	14
3. Promotion Strategy for Developing Innovative Environment and Energy Technologies	14
(1) Investment in R&D	15
(2) R&D Structure	16
Recommendations	17
Attachment 1: Development and Diffusion of Environment & Energy Technology	20
Attachment 2: Environment & Energy Technology Assessment	21

Introduction

In July 2008, Japan is hosting the G8 Summit in Toyako, Hokkaido with clear recognition on environment and climate change issues as part of the main agendas. As Japan has predominant technologies in this field, we should take the initiative in developing innovative technologies to reduce greenhouse gas (GHG) emissions, deploy them throughout our country and the international society and play a leading role in the challenge against climate change issues.

Japan has already announced its target of halving total emissions of GHGs throughout the world by 2050. In order to reach the fundamental solution of the climate change issues, there is no doubt that substantial reduction of GHG emissions and stabilization of the atmospheric concentration is needed in realizing a low carbon society.

In order to reduce GHG emissions, it is essential to 1) promote improvement and deployment of existing technologies with immediate policy support, and 2) steadily advance research and development (R&D) of innovative technologies. The latter is particularly important, taking into consideration the estimate that approximately 60 per cent of the energy-related CO₂ emissions to be halved by 2050 will depend on the development and introduction of innovative technologies.

In order to introduce and deploy innovative technologies, new approaches toward an institutional scheme are essential. Especially regarding the creation of a scheme for the Post-Kyoto Protocol, attention needs to be paid to the introduction and deployment of innovative technologies.

This plan not only aims at substantial reduction of GHG emissions but also gives extra consideration on important issues such as energy security, harmonization of the environment and economy and contributions to developing countries.

First, we rely on overseas countries for the major part of our energy resources - fossil fuels. Fossil fuels will remain as a major energy resource for the purpose of a stable supply of energy even when the utilization of renewable energy and nuclear energy shall be expanded upon. In addition, rapid increases in the energy demand by BRIC countries will likely cause increased global competition and conflicts in acquiring

resources, with a significant implication on the energy security of Japan. Accordingly the development and global diffusion of our excellent low carbon technologies will improve global energy efficiency, and contribute to stabilizing the international energy supply. In other words, research, development and deployment of the innovative low carbon energy technologies will contribute to energy security in both Japan and other countries in the world.

Second, becoming a low carbon society with drastically reduced GHG emissions will be a significant shift from our present society, which is dependent on fossil fuels. We believe that in a low carbon society innovative technologies will create new industries and bring about new wealth to the country and the world. Economic development since the industrial revolution to date has been achieved by new innovative technologies. Japan should lead the world in innovative low carbon technologies, hold to the firm belief of making a global contribution and propose new technological and institutional innovations to the rest of the world as well as boost the country's economy.

Third, developing countries contributing significantly in increasing GHG emissions are the key for stabilization of the global climate. Although 60 percent of current CO₂ emissions from energy sources come from developed countries whereas remaining 40 percent from developing countries, with the economic development of the developing countries in the future, it is estimated that the percentage of emission contributions from developing countries will be over 50 per cent by the year 2030. At the same time, many developing countries are extremely vulnerable to climate changes. It is expected that impacts of the climate change (flooding/drought, impacts on agriculture, industry and human health, and so forth) will last for a long time, even after GHG emissions have started to drop. Because of this, adaptation methods to the climate change are especially important. Japan has to make an effort to develop technology in the fields of adaptation as well as mitigation, try to conserve the ecosystem and promote international contributions through a system such as financial support.

On the basis of the perspective mentioned above, this plan covers the following four aspects:

- 1) A full review of GHG emission reduction technologies available from the country

- 2) Technology deployment measures and the necessary institutional reform with consideration to the supply and demand of energy and the viewpoint and behavior of consumers
- 3) The potential of satisfying both economic development and emission reduction in developing countries based on the transfer and deployment of innovative technologies from Japan
- 4) The necessity of international financial support to underwrite the additional cost of reducing GHG emissions and realizing the leadership of our nation through proactive international cooperation

1. Technological Strategy of Japan for Realizing a Low Carbon Society

As the energy consumption rate by the manufacturing industry has been reduced by approximately half since the oil crisis of the late 1970's, Japan has put a lot of effort into energy conservation all over the nation and we need to make even more efforts in the future.

However, in order to significantly reduce GHG emissions in the future it will be necessary to develop innovative technologies that enable drastic reductions because it will be limited if we depend only on improving existing technologies. In addition, not only the actual development of technologies is important but also the deployment of them throughout the society is getting more important. That is to say, improving existing technologies and then diffusing throughout society over the short and medium-terms and developing innovative technologies over the medium and long-terms are the key to success.

(1) Technologies Required for Short and Medium-Term Measures (until around 2030) (Refer to Attachments 1 and 2)

On the energy supply side, securing a stable supply of energy resources and promoting a low carbon society is needed for the moment. On the energy demand side, in order to preserve consumers' quality of life (QOL) while reducing their demand for energy, with the deployment of existing technologies that can be expected to reduce GHG emissions over the short and medium-terms, the development of the technologies for improving efficiency, reducing costs and assessing the performance of individual technologies accurately will be promoted.

In addition, to achieve more significant emission reductions, it is necessary to take account of the effect of each individual technology, the institutional reform required for deployment, the cost etc. and pay attention to the appropriate timing of that introduction so as to enable optimizing the technology and the system architecture.

Furthermore, regarding large scale facilities such as power plants, it will be necessary to introduce the most effective reduction technology so that agrees with the timing of systematic updates. Regarding the commercial/residential sector where the amount of GHG being emitted is significantly increasing, it will be necessary to work on this together as the entire nation more proactively such as appropriately improving social infrastructures. On top of this, it will be necessary to develop and introduce technologies which enable further improved efficiency in the industrial sector such as manufacturing and processing.

Regarding biomass utilization, development of technology enabling ecosystem

conservation and sustainable production without compromising to food production will be promoted.

(a) Technologies with a Significant Reduction Effect

Regarding the energy supply side, in accordance with the expansion of usage in developing countries, it is required to make coal and natural gas fired power generation more efficient and to promote activities such as environmental arrangements for the steady use and expansion of nuclear power generation (light-water reactors) , which will have a significant reduction effect in the current situation. In addition, although the effectiveness in reducing GHG emissions is rather insignificant, in time with the renewal of electric power transmission cables that will commence in 2020, developing technologies for the high-efficiency superconducting power transmission, which is competitive in the international market, will be promoted.

Regarding the energy demand side, on the other hand, it is planned to deploy and expand use of more efficient heat pumps, and to increase the efficiency of and lower the cost of cooling mediums and heat exchangers in thermal fields; to promote electrification through the introduction of hybrid and electric vehicles and so forth in the transport sector; and to increase the efficiency of and deploy technologies that are very efficient in reducing emissions such as energy saving household appliances and Information Technology (IT) devices and other related power electronics.

Main Technologies:

(Energy Supply side) Advanced use of light-water reactors, High-efficiency fired power generation (coal and natural gas)

(Energy Demand side) Hybrid vehicle, Plug-in hybrid vehicle, Electric vehicle, Fuel cell vehicle, High-efficiency lighting, High-efficiency heat pump, High-efficiency home electronics and information devices

(b) Technologies to Reduce Greenhouse Gases in Entire Regions

In order to reduce energy demands even more, efforts will be made to improve energy efficiency not only at the equipment level but also at the region level including residences, offices, transportation facilities and lifelines utilizing IT, and so forth. In particular developing and maintaining a way of assessing and visualizing energy efficiency not only at residences and offices but also at the regional level and energy conservation technology and promoting the development and deployment of

technologies through the concept of environmental model cities will be important.

In addition, in order to reduce greenhouse gases through innovation of the social system and life styles, the development and deployment of the following technologies will all be promoted; increasing the efficiency of traffic and commodity distribution with an Intelligent Transport Systems (ITS); using natural energy through local production for local consumption; production and usage of biofuel from cellulosic resources; longer lifespan of and saving of energy at residences through the changeover to a stock style society; saving more energy in the public transportation system such as more efficient use of rolling stocks; and highly used technologies such as IT that enables telework.

Main Technologies:

(Commercial/residential Sector) Energy efficient housing, HEMS/BEMS, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)

(Regional and Local Area) Utilization of biomass fuel, High-efficiency rolling stock, Intelligent Transport Systems (ITS), Areal use of energy (Local area EMS, cascade utilization of energy) , Telework (advanced usage of IT)

(c) Linking Technologies to Enhance the Efficiency of Reducing GHG Emissions

Regarding technologies of which the efficiency of each elemental technology is increased through being linked with other technologies and that can be expected to be effectively diffused such as a combination of renewable energy and electric power storage, and a distributed thermoelectric supply (co-generation) system, the development and deployment of technologies while connecting multiple technologies will be promoted.

Main Technologies:

Renewable energy (photovoltaic power generation and wind power generation) and Electric power storage (secondary battery and capacitor), Stationary fuel cells, High-efficiency fired power generation (coal and natural gas) and Carbon dioxide Capture and Storage (CCS)

(2) Technologies Required for Medium and Long-Term Measures (after the Year 2030) (Refer to Attachments 1 and 2)

It is necessary to work on the R&D of strategic technologies that can be expected to greatly reduce GHG emissions in the future and that significantly change the social structure and drastically reduce emissions through their introduction.

(a) Innovative Technologies with a Significant Reduction Effect

R&D will be promoted on technologies that are still in the basic study phase but that will have a significant reduction effect after realization aiming at practical application around the year 2030.

On the energy supply side, in particular, the development of thin-film photovoltaic cells that can enhance generating efficiency and new third-generation photovoltaic cells will be promoted. In addition, the development and demonstration of next generation light-water reactors that will be used as replacements around the year 2030 and fast breeder reactors and electrical storage devices that aim at practical application no later than 2050 will be also promoted.

On the energy demand side, the development of iron and steel process using as reducing agent of a part of coal and the technology of innovative batteries that are the keystone to electric vehicles from the point of view of further reducing GHG emissions from the transport sectors will be promoted. Also, technology development related to energy generating residences will be promoted.

Regarding use of hydrogen, efficient hydrogen storage and transport technologies and lowering the cost of hydrogen production that does not depend on the fossil fuels and so forth will be required.

Main Technologies:

(Energy Supply side) Nuclear power generation (next generation light-water reactors and fast breeder reactor and its fuel cycle technology), Third generation photovoltaic cells, Hydrogen production technology

(Energy Demand side) Hydrogen reduction iron and steel making process

(b) Fundamental Technologies for Realizing the Breakthrough of Technologies

In order to make a new technology practicable it is first necessary to overcome many technical obstacles. For realizing breakthroughs with obstacles, research on

basic and fundamental techniques to develop new mediums and materials (heat-resistant and high-temperature materials, superconductive materials, platinum substitution catalysts and so forth) will be promoted.

On these fundamental R&D, the government promotes cooperation between related institutions and research organizations internally and internationally, and support efficient R&D, for the purpose of fundamental research for clarification of principals and phenomena at universities and public research organizations that are participating in developing innovative technologies, and achieving the goal of reduce emissions.

(c) Technologies Whose Realization is Expected to Take a Long Time

Regarding technologies whose realization is expected in the year 2050 or later, long term R&D will be strategically promoted for the ultimate of zero GHG emissions as well.

It is also required to work on the technology development of nuclear fusion and space solar power systems, which are extensive energy sources that do not depend on fossils fuels, over the long-term.

(3) Deployment measures for Society and the Necessary Institutional Reform

A continuous implementation will take place not only with the deployment of products of high energy efficiency but also with reforming the social system to realize a low carbon society.

National policies affect the deployment of excellent technologies. Environment and energy technologies are not an exception to this so it will be necessary to enhance the ability to make propositions regarding policy options such as the best mix of technology development and deployment in order to apply technologies that are advantageous to the nation.

In addition, it is important that an institution and scheme that can effectively mediate between developments and deployments are in place since deployments are to make progress of the development of technologies.

(a) Deployment Measures for Society

With consideration to the fact that there are many technologies that are difficult to deploy if only the market is relied upon, promotion of deployment through economic incentives such as carbon pricing should be considered. In addition regulatory reforms and infrastructure construction will be promoted through amplification of objective products of the Top Runner Program, an investigation on preferential treatment for cars

that display appropriate environmental and energy performance, establishment of a financial institution when more effective GHG emission countermeasure technology is used by medium and small companies (domestic CDM and so forth) and realization of the scheme to increase investment and loans (Socially Responsible Investment (SRI) and so forth.)

In particular the aim is to promote the enforcement of various policies to enhance regulatory reform and infrastructure construction and the realization of self-directed diffusion of those technologies in their final form using a product performance display system to promote the introduction of low carbon technologies and to raise the awareness of the nation through the system for evaluating, indicating, and approving performance of energy efficient residences and so forth.

(b) Revolution of Social System

It is necessary to inspect the achievements of technology developments and institutions through implementing a pilot project utilizing ‘Super Area Initiative’ system to promote diffusion such as environmental model cities and technology demonstrations.

Regarding housing and building, improving and making more familiar indications and certificates in order to establish an evaluation technique for energy consumption and GHG emissions and visualize the energy efficiency when actually they are in use are necessary. Also provisions for enhancement of compliance to acts such as the Rationalization in Energy Use Law are to be planned and implemented.

Based on that, it is necessary to promote consumer behavior where technologies with high environment and energy conservation capabilities are chosen through enhancing a consciousness to restructure into a low carbon society by displaying carbon disclosure and energy consumption efficiency evaluated using the LCA method for household appliances, IT devices, cars and residences.

In the commercial/residential sector, specific countermeasures are urgently required as the increasing tendency for GHG emission continues. For instance, when a residence is newly constructed or rebuilt, consideration needs to be given to encouraging or requiring the glass windows to have an insulating effect, use of energy saving devices such as energy efficient fluorescent lights, heat pumps and so forth and new energy devices such as solar batteries, and to provide aid for use of products and buildings that fulfill certain levels of performance in addition to regulations related to improving the energy saving performance of residences.

It would be desirable to implement fiscal and financial measures to support

activities in improving energy saving performance that contribute to the point of view that reducing GHG emissions is of public benefit to the whole of society although they are carried out by individuals and the respective stakeholders. In this regard, however, it is necessary to form a preliminary national agreement in appropriate combination with the regulatory measures.

(c) Role Sharing between the Public and Private Sectors in Deployment

The appropriate division of roles between the public and private sectors is required, for example, in improving the environment so it is easier for business enterprises to act upon the enforcement of appropriate deployment and promotion plans at the demonstration and deployment stages as well as the government working on high risk R&D technologies.

Furthermore, the burden of cost for introducing and diffusion of technologies where financial incentives are ineffective at the moment, such as CCS and solar energy, needs reviewing.

(d) Social Enlightenment

In order to enhance the awareness of the nation on energy saving and promoting their understanding of the situation regarding environment and energy in Japan and all over the world, efforts need to be made to enable understanding and dissemination of knowledge on the situation with energy, resources and energy consumption, the current situation and future vision of sustainable energy systems targeting those that are conducive to countermeasures against global warming (for example, the usability and issues of nuclear power generation and natural energy).

In addition, providing energy and environment education to children through to adults is needed to nurture a culture that values global environmental protection.

(e) Development of Human Resources

As well as cultivating human resources whose priority is the environment and energy field, it is required to nurture a research environment that will attract a lot of human resources to the field. In addition, in order to accelerate R&D of environment and energy technologies further, the national awareness of these technologies and strengthening basic research at universities and public research organizations needs to be deepened.

Accordingly, the development of excellent human resources can create innovative technologies and nurture those of the next generation. In addition more

researchers and engineers from all over the countries including Asian countries, will be encouraged to participate.

2. Contributing to International GHG Emission Reduction

In order to enable all countries to work on reducing GHG emissions using a variety of approaches, increasing use of the environment and energy technologies of the nation will be necessary in a timely manner.

Especially, as well as taking advantage of achievements made in international partnerships and so forth, it is necessary to improve energy efficiency globally through the diffusion and transfer of technologies to developing countries in cooperative sector oriented approaches such as the Asia-Pacific Partnership on Clean Development and Climate (APP).

In addition, an international collaborative research will be proactively promoted from the point of view of generating excellent results via gathering technologies from all countries as well as contributing to the activities of international organizations such as IEA, IPCC and so forth.

(1) International Expansion and Contribution of Environment and Energy Technologies

(a) Expansion of Technologies Effective in Foreign Countries

Regarding technologies that are expected to be effective in GHG reduction in foreign countries, for example developing countries (such as a combination of highly-efficient coal fired power generation and CCS), it is required to promote the transfer of technology through financial aid and international expansion, along with using the practice of reducing national emissions as a model for developing countries.

To developing countries whose energy demands are expected to increase, with nonproliferation, nuclear power safety and nuclear security as the base premise, it is necessary to proactively contribute to the infrastructure development of those countries and to expand use of the excellent nuclear power technology (next generation light-water reactors and small & medium sized reactors) of the nation internationally for the smooth introduction of nuclear power generation.

In addition, international expansion is being proactively planned to promote the introduction of excellent Japanese technologies such as utilizing solar energy in areas with a lot of sunny days in the year, high-efficiency home electronics and information devices, high-efficiency heat pumps and so forth.

It is also very important to strive to protect intellectual property with an appropriate method from the point of view of developing industry in Japan and then diffusion to the world.

Furthermore, technologies not only to reduce emissions but also to adapt to a changing climate are important in order to respond to accelerating climate change. For example, reforestation is effective as an act of adaptation to global warming such as restoring vegetation in dry areas. As a technology that can be expected to be adopted by developing countries, the development of new breeds tolerant to droughts and so forth will be promoted.

(b) Infrastructure Development for International Expansion

In order to develop a foundation for the introduction and application of brilliant technologies from individual countries all over the world, the government should promote international standardization (energy saving standards, emission assessment criteria and so forth) and proactively establish global standards and international rules for appropriately evaluating the effect of reductions in GHG emissions.

In addition, global application of them will increase through the provision of information on countermeasures that are effective in reducing GHG emission nationally, such as with the Top Runner Program and the knowledge gathered therein.

Meanwhile, regarding large scale technology developments that require long periods of time for R&D, international cooperation with developed countries is promoted proactively in order that they can share the financial resources and spread the merits internationally by sharing technologies.

Furthermore, it is necessary to take national measures from the viewpoint of promoting the reduction of GHG emissions in other countries with a financial support scheme related to the reduction in developing countries based on the fact that there is a way of thinking of having a surcharge for reductions adding up to the total reductions in the nation by supporting reductions in developing countries financially.

In order to realize a low carbon society, technologies with brilliant environmental performance will be utilized to the utmost extent when implementing projects in developing countries. In addition, an international approach is required to enhance in cooperation with the other related countries in order to include highly effective technologies for use in reducing GHG emissions such as nuclear power generation and CCS in the subject of the CDM projects.

In order to smoothly transfer excellent national technologies to developing countries, it is necessary to take advantage of the vitality of private companies, remove

any obstacles to technology transfers and promote their sale in that the government and the industrial world have worked together and based on the fact that these technologies would have been mainly developed and reserved by private companies. In the case that low carbon devices are sold to developing countries through doing business, problems such as the size of the market, the understanding of consumers and equipment costs will arise. In cases like that, it is necessary for the government to take the initiative in preparing incentives in order for private companies with leading-edge environmental technologies to maintain their edge and motivation to make an international contribution with consideration given to autonomous activities related to the technology transfer of private companies as a public activity that helps solve the global environmental issues. The government provides support including the provision of public funds if necessary in order to secure appropriate consideration for private companies.

As stated above, brilliant environment and energy technologies of the nation need to be considered as new global intellectual assets that work to reduce GHG emissions with the cooperation of all countries. In this case, however, it is difficult to work on the activities mentioned above without the cooperation of private companies because they have retained the actual effective environment and energy technologies and product manufacturing ability, knowledge and intellectual properties.

It is necessary to promote fair international activities in utilizing global intellectual assets effectively with the cooperation of developed countries and avoid private companies of any unfair trading penalized country in order to apply globally the technologies and intellectual properties that private companies have made the effort to develop in the midst of hard international competition.

It is also necessary to reinforce strategies for the provision of technological information to developing countries, and select the appropriate technologies based on the actual situation of each country and to combine them. Along with that support will be enhanced to improve the conflict-resolution skills through developing human resources and so forth in order to promote settlement of the technologies in developing countries.

(c) Promotion of R&D through International Links and Cooperation

It will be necessary to set the security of the technological rights of Japan as a precondition, apply the financial resources of foreign countries and proactively promote international cooperation in R&D that is of high risk and needs massive investment over a long term of period that our nation cannot take care of independently (nuclear fusion,

CCS, space solar power systems and so forth). Regarding nuclear power, international cooperation will be promoted through a scheme involving countries such as the Generation IV International Forum (GIF). Regarding third-generation photovoltaic cells, international cooperation should be promoted in order to hasten R&D.

(2) Contribution to Making an International Scheme

(a) Technology Development that Corresponds to a New Reduction Scheme

It is required to promote technology development of ships and aircraft of low-fuel consumption to reduce GHG emissions from the international ships and aircraft because a new target has been discussed for reducing carbon dioxide emissions in an international agreement. In addition Japan will play an active role in making international schemes such as the establishment of international standards related to international lines and waterways, and an approach to evaluating forests and soil as carbon sinks.

(b) International Contribution to Earth Observation, Climate Change Projection and Impact Assessment

International climatic stabilization policy is formulated based on scientific knowledge related to the climate and scientific achievements represented by IPCC are making main stream for policy foundation. It is important to promote excellent climatic science of the nation and secure a unique policy foundation. Observation and accuracy of regional climate change predictions will be improved to contribute more for the IPCC fifth assessment report and provide useful information and knowledge for use in establishing an international scheme.

In addition, it is also necessary to contribute internationally by providing earth observation data and results of environmental assessment and predictions for regional areas to foreign countries including developing countries.

3. Promotion Strategy for Developing Innovative Environment and Energy Technologies

R&D of environment and energy technology will be promoted more than ever in order to realize brilliant technologies and R&D capabilities and lead the world in fundamentally reducing GHG emissions.

This plan is a part of the ‘Strategy for Revolutionary Technology’ and R&D on reducing GHG emissions will be effectively promoted based on policies that promote R&D within the strategy through the following;

(1) Investment in R&D

(a) Acceleration of Innovative Technology Development

Improvement of conventional technologies is the main method of reducing GHG emissions over the short-term; however, it will reach the critical limit in the case of aiming at drastic reductions needed in the future and it will be important to develop innovative technologies that lead to drastic reductions in emissions over the medium to long-term.

Therefore, regarding investment in R&D, it is concentrated to improve existing technologies over the short-term, then to emphasize the development of innovative technologies with a view to long-term stabilization of the climate in the future. In this case, it will be important to review the development of individual technologies at the appropriate time and consistently promote the most effective R&D. It will also be necessary to clearly reveal a future energy system and technical road map through sufficient investigation in advance and to promote that R&D in order to make steady achievements.

(b) Prioritizing of R&D by the Government

The government emphasizes a plan of diffusion promotion plan of the technologies while practical R&D are carried out in the private sector. However, the government will need to emphasize technologies of high risk in their R&D (mainly innovative technologies).

The government shall invest concentrating heavily on technologies with significant reduction effects from the viewpoint of fundamentally reducing GHG emissions. In addition, emphasis shall be placed on R&D with high usability by industry, society and the world. On this occasion, it will be necessary for our nation to cultivate human resources based on the long-term strategy as well as increasing the international standard. It will also be important to promote basic research so as to create innovative technologies simultaneously.

For this reason, the Council for Science and Technology Policy, Cabinet Office decides a resource allocation policy every year and related ministries and agencies will distribute resources based on it, and will be based on the government line of investing approximately US 30 billion dollars over five years on R&D in the fields of the environment and energy.

(c) Incentive for Private Sector R&D

Considering the fact that smooth formation of an early market would be a great incentive for technology development, priority will be given to technologies that lead to significant reductions in GHG emissions in procuring them nationally after sufficient early evaluation of the possibility of realizing positive effects on the economy and reduction effects.

In addition, unifying the different industries and fields will be promoted as well as sharing goals, objectives and overall vision of the main bodies that carry out R&D through the establishment and continuous review of a road map related to research, development and preeminence of the market.

(2) R&D Structure

(a) Establishment of a National R&D System

It is essential to realize more innovative technologies early on by integrally promoting basic research through to application and development research of innovative technologies.

For this reason, it will be necessary to establish a research system that can quickly combine the collective efforts of industry-academia-government within the framework of the relevant ministries and agencies and a scheme to put together the knowledge of research organizations that belong to it. On this occasion, it will be important to aim at solidarity of the goal and the direction using a technology road map and establish an uninterrupted system by centralizing management for the R&D project on a large scale.

In addition, considering the fact that it requires long-term R&D to introduce innovative technologies into the market, the schedule includes promoting a long-term overview of appropriate early assessment and corresponding stable policies as well as establish a scheme for contiguous supply of financial resources for use in R&D through the cooperation of funding organizations.

(b) R&D Management

From the point of view of promoting R&D in an effective manner, it is very important to set clear midterm and overall goals, strictly evaluate them with international R&D trends taken into consideration, review the road map while R&D is underway according to any changes in the surrounding environment and quickly distribute resources.

Recommendations

We need not only to make this low carbon technology plan as a strategy for reducing the GHG emissions of the nation, but also to share with the many other countries in the world the way of thinking of this plan. We then contribute to developing and diffusing climate change countermeasures in the world through the excellent innovative low carbon technologies of the nation and be a leader in use of them. In order to realize this, the government should release the following strategies as a message to the international society.

Strategy 1: Japan will lead the world in the development of low carbon technologies and associated international cooperation and proactively diffuse their achievements to the international society.

- 1) While Japan is the world's second largest economy and accounts for 8 to 9 per cent of global GDP, its GHG emission is approximately 5 percent in the world. This energy efficiency has been realized primarily through the two oil crises in 1970s, because of which Japan had to come up with new energy efficient technologies in order to overcome the critical problem of its low self sufficient ratio of energy supply. Since then Japan has developed energy efficient and low carbon technologies of the world's highest standard through the R&Ds under the public and private coordination. In order to cope with today's serious situations of the environment and energy issues, however, Japan should continue to improve existing technologies and to initiate the development of innovative technologies. In order to accelerate technology developments as a global commitment it needs to establish a global long-term roadmap for technology development. Moreover, it will promote the international cooperation that secures enough investment for low carbon R&D in major countries. Furthermore, it needs to make the best effort to deploy low carbon technologies throughout the world promptly so as to overcome these global issues. Japan will play a leading global role in this area including technology transfer to other countries in the world.
- 2) Environment and Energy technologies are required globally, regardless of being a developed or developing nation. Regarding the promotion of world-wide deployment of environment and energy technologies, aiming at the situation

where they will be capable of supporting the preservation of the global environment in the future, the government shall pay attention to securing the intellectual property rights of private companies, lead the appropriate implementation of smooth and quick technology transfers and develop the appropriate environment such as putting the relevant structures and institutions in place.

- 3) Regarding the United States, which is economically three times bigger than Japan but discharges four times the amount of the energy derived CO₂, discussions shall take place to include the United States in consideration to the new policy issued in April this year, set by the Bush administration, that targets being low carbon societies and sets technology innovation as the main instrument in doing so. Japan shall clearly mention that we will strengthen international cooperation in developing environment and energy technology and its deployment in its relationship with the United States. Using existing frameworks such as the Global Nuclear Energy Partnership (GNEP) and APP. It is required to establish a scheme for the fair transfer of environment and energy technologies involving the major developed countries, which includes the United States and the developing countries that will receive them and to promote prompt effective deployment of the same.

Strategy 2: The main actors to transfer Environment and Energy technologies shall be private companies while the government provides indirect support.

- 1) Environment and energy technology for short and medium-term diffusion can be expected to include nuclear power generation, high-efficiency power generation using coal and natural gas, means of transportation such as hybrid vehicles with low CO₂ emissions, heat pumps, high-efficiency home electronics and information devices. These technologies are to be mainly developed and owned by private companies, and hence the main leader in transferring technology shall be the private sector.
- 2) In the case that the economy of the destination country where a technology is to be transformed rather poor or with an underdeveloped market, the government will promote support that includes the application of public funds if necessary by keeping in mind that private companies will hesitate to transfer technologies if

there is no guarantee of consideration being given to that transfer.

Strategy 3: International cooperation in environmental model cities shall be used as the effective method to transfer technology in the commercial/residential sector.

- 1) The amount of CO₂ being emitted by the commercial/residential sector is increasing not only in our own country but all over the world. As environment and energy technology for the commercial/residential sector, heat pumps, stationary fuel cells, high-efficiency home electronics and information devices, high-efficiency lighting and an integration of them all will be included. This needs to be executed with greater development of a systematic scheme for improving the energy saving performance of new buildings and reformed buildings and energy saving initiatives in whole areas by considering buildings as a group will be promoted simultaneously. Policies, like with environmental model cities that promote energy saving from the side, are effective and will enable the realization of low carbon urban lifestyles through utilizing various technologies and social systems.
- 2) In order to stimulate the incentive of citizens in the promotion of environmental model cities, it is required to review allowing preferential treatment for low emission economical cars, a support system for the establishment of heat pumps and fuel cells and the development of a social system with the institution that efforts made by individuals are awarded with eco-points in certain areas.
- 3) From the point of view of transferring technologies to reduce GHG emissions internationally, the establishment of environmental model cities is considered to be effective. If it is possible to put in place an international cooperation scheme with environment model cities all over the world, including other Asian countries that share a similar climate to Japan, it would enable the founding a plan for environment model cities to be shared and stimulate the transfer of technology that conserves energy.