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Report

Policy Recommendations for Reducing Energy Consumption by the Building Sector

May 24, 2007

Committee on Civil Engineering and Architecture
Science Council of Japan

This repot makes public the results of deliberations of the Committee on Civil Engineering and Architecture of Science Council of Japan, Subcommittee on Construction and Society under the Committee, as well as Working Subcommittee on Consumers and Energy under the Subcommittee, which were compiled under the auspices of Committee on Civil Engineering and Architecture .

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Summary

1. Background

Energy consumption is categorized into the energy consumed by three sectors, namely, the consumer, industry and transport. Compared to the level of consumption in 1990, the baseline for the Kyoto Protocol, the energy consumed by the industry sector has continued to decline slightly over the past ten years, while that by the transport sector has remained fairly constant. On the other hand, energy consumption by the building sector (residential and commercial building sectors) has continued to increase, and it has become an urgent issue for Japanese society to try to reverse this trend. The rapid increase in energy consumption by the building sector has been observed in many countries around the world. Consequently, a special declaration was announced to enhance energy efficiency in buildings at the G8 Summit meetings held in the United Kingdom in 2005.

The report released by the Science Council of Japan in March this year, entitled “Energy and Global Warming ” discusses recommendations for a sustainable society from a broad perspective. However, the report does not identify any specific measures regarding the building sector.

In view of the foregoing, this report draws up recommendations to administrative bodies concerning policy issues judged to be urgent and feasible at this point to reduce energy consumption by the building sector in order to prevent global warming.

2. Current status and problems

The trend of increasing energy consumption by the building sector has not stopped even though many surveys and research studies have been conducted and measures implemented. Many causes for the increase that can be identified, but the main factor is the elevated standard of living in the broad sense of the term.

Each person is responsible for the increase in energy consumption by the building sector, and the need to reduce energy consumption is an issue common to everybody. It is essential that the civic, industrial, academic and government sectors each share a sense of urgency and take active measures appropriate to their respective roles. For this purpose, there is a requirement for collaboration among the related governmental offices and Ministries, the promotion of cooperation among the civic, industrial, academic and government sectors, and the sharing of social costs for implementing the necessary measures. Also, a reduction of energy consumption by the building sector will not automatically result in a lower standard of living. Enhanced efficiency makes it possible to reduce energy consumption but also provide economic benefits with lower utility costs. At the same time, the standard of living can be enhanced with greater comfort and improved levels of health. These benefits need to be communicated to all members of society.

It seems that the numeric targets for reducing greenhouse gas emissions stipulated in the Kyoto Protocol are very difficult to achieve. In view of the situation, the development of new technologies that provide an effective means of reducing energy consumption in the residential and commercial building sectors is needed. It is also necessary to provide policy measures to facilitate the creation of an accord on the need to provide effective measures among the civic, industrial, academic and government sectors.

3. Recommendations

(1) Recommendations relating to domestic measures

To facilitate reduced energy consumption by the building sector, an accord needs to be formed regarding the need for each of the civic, industrial, academic and government sectors to take active measures. At the same time, there must be greater communication to society about the need to create cooperative systems among members of the public. (Recommendations 1 and 2)

The measures for existing buildings and small building need to be improved, the regulations for insulation need to be enforced and social systems need to be established that include the granting of incentives. These are specific policy measures to promote energy conservation at residential and commercial building sectors. (Recommendations 3 to 7)

In addition, support measures need to be promoted for technological development relating to the integral operation of buildings, facilities and equipment. Support measures also need to be promoted for renewing insulation, for improving the capacities of traditional wooden houses, for developing houses that produce energy, and for the use of network sharing energy. (Recommendations 8 to 13)

Furthermore, there is a requirement for the development of databases and prediction methods for mid- to long-term energy consumption. These databases would function as tools to support administrative bodies in implementing the above three areas of policy measures. (Recommendations 14 and 15)

(2) Recommendations relating to international measures

When promoting energy conservation on a global scale, international cooperation is becoming increasingly important in order to ensure global equality. Energy conservation measures in Japan, where primary energy consumption as a percentage of GDP is among the smallest in the world, can serve as a model for energy conservation measures in various countries around the world, as a successful example of world’s best practice. While collaborating with the International Energy Agency (IEA) and the Intergovernmental Panel on Climate Change (IPCC), it is important to cooperate on an international level through the distribution of information and technological assistance under an international framework, along with contributions to

the action plans adopted at the G8 Summit. (Recommendations 16 to 18)

Furthermore, a supply-demand plan concerning energy for the consumer sector of Japan should be formulated, taking into consideration the mid- to long-term trends of global energy supply and demand. (Recommendation 19)

(3) Facilitating collaboration among governmental offices and ministries

To reduce energy consumption by the building sector, measures need to be developed across the boundaries of the existing administrative framework of ministries and agencies. As such, a heightened degree of collaboration among government offices and ministries is expected. Collaboration among the Ministry of Land, Infrastructure and Transport, the Ministry of Economy, Trade and Industry and the Ministry of the Environment, which are directly involved in reducing energy consumption by the building sector, needs to be augmented. At the same time, collaboration is also important with the Ministry of Agriculture, Forestry and Fisheries for lumber usage, with the Ministry of Finance and Financial Services Agency for environmental financing, with the Ministry of Foreign Affairs for international cooperation and with the Ministry of Education, Culture, Sports, Science and Technology for education concerning environmental issues.

Collaboration among the central government ministries and regional administrative bodies is also important when implementing the actual measures for energy conservation.

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3	Presentation of specific measures for promoting energy conservation in numerous existing buildings and small buildings
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5	Introduction of regulatory measures for promoting further insulation in residential and commercial building sector
6	The provision of information and the granting of incentives in system design for promoting measures to conserve energy
7	Implementation of model projects to verify the effectiveness of energy conservation measures
8	Development of comprehensive energy conservation technologies that integrate the building shelter and frame with facilities and equipment, and the development of simulation tools for evaluating them
9	Support for the development of evaluation and construction technologies to promote retrofitting existing houses with thermal insulations and the dissemination and promotion of appropriate insulation methods
10	Technological development for enhancing energy efficiency suited to traditional wooden houses
11	Concept design and development of element technologies for converting zero-energy houses into energy-producing houses
12	Configuration of an optimum use of network sharing energy through the association of a distributed energy system and electricity supply network
13	Promotion of measures to enhance the energy efficiency of the entire urban block or city
14	Development of databases on energy consumption by the building sector and efficiency indices for evaluating policy measures
15	Development of mid-, long- and ultra long-term prediction methods for energy consumption by the building sector
16	Collection and compilation of successful examples from around the world through joint research with the IEA and activities at the IPCC, and information transmission for G8 Summits
17	Provision of advice on policies and technical assistance to Asian countries, and promotion of database development on energy consumption
18	Enhancing assistance to technologies on the users' side to promote the conservation of energy in Asian countries
19	Mid- to long-term prospects on energy supply and demand throughout the world and Japan, and study on appropriate domestic measures including the use of nuclear power

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Foreword

This external report summarizes the results of deliberations by the Civil Engineering and Architecture Committee of Science Council of Japan, the Working Group on Construction and Society of the Committee and the Subcommittee on Consumers and Energy of the Working Group, concerning the reduction of energy consumption by the building sector[*1] to prevent global warming. The report has been prepared, under the auspices of the Civil Engineering and Architecture Committee. The main points of the deliberations are summarized and recommendations for administrative bodies are presented in the external report from a domestic and international viewpoint. In the report, policy issues relating to energy conservation are presented initially from a broad perspective. Nineteen priority issues are then selected based on a consideration of their urgency, feasibility and benefits.

1. The Urgency of reducing energy consumption by the building sector and the needs for measures by the civic, industrial, academic and government sectors

(i) The urgency of reducing energy consumption by the building sector

At the G8 Summit held at Gleneagles in the United Kingdom in 2005, it was recommended that further enhancements to the measures for dealing with global warming be made. As part of the recommendations, the rapid increase of energy consumption in buildings was discussed as a priority issue, and a declaration was announced regarding enhanced energy efficiency. A decision was taken to draw up new measures at the G8 Summit to be held in Japan in 2008.

Energy consumption is generally categorized into that by the consumer, industry[*2] and transport[*3] sectors. In Japan over the past decade, energy consumption by the industry sector has tended to decrease slightly compared to consumption in 1990, the baseline for the Kyoto Protocol, while that by the transport sector has remained fairly constant. On the other hand, energy consumption by the building sector has continued to increase. Reversing this trend has become an urgent issue for Japan and other countries around the world.

(ii) Need for the provision of measures by each of the civic, industrial, academic and government sectors

Efforts to reverse the increasing trend of energy consumption by the building sector have

*1: Energy for the consumer sector refers to energy used in residential and commercial building sectors, such as offices, retail shops, schools, hotels, hospitals and welfare facilities.
*2: The industry sector includes manufacturing, agriculture, forestry, fishery, mining, construction and other industries. Service industries are included in the consumer sector.
*3: The transport sector includes passenger and cargo transport by car, railway, ship and aircraft. Privately-owned passenger cars are also included.

failed despite the numerous surveys and research studies conducted and the implementation of measures to reduce energy consumption. Many causes of the increase have been identified, but the major factor is the improved standard of living in the broad sense of the term. Energy consumption by the building sector is connected directly to people's everyday lives, and reduced energy consumption tends to give the impression that the standard of living is declining. As such, it has been difficult to provide decisive measures.

On the other hand, each member of society is responsible for the increase in energy consumption by the building sector, and reduced energy consumption is an issue common to everybody. It is essential that the civic, industrial, academic and government sectors each share a sense of urgency and provide active measures appropriate for their respective role. For this purpose, it is essential to achieve collaboration among the related governmental offices and ministries and cooperation among the civic, industrial, academic and government sectors needs to be promoted, while sharing the social costs of implementing policy measures. Also, it should be noted that reduced energy consumption by the building sector does not necessarily lead to a lower standard of living. Rather, improved energy efficiency not only enables energy consumption but also brings about economic benefits by reducing utility costs. Improved efficiency also improves comfort and health by renovating the indoor and outdoor environment. It is necessary to make it publicly known that energy conservation could enhance the standard of living.

It seems that it is quite difficult to achieve the numeric targets for reducing greenhouse gas emissions mentioned in the Kyoto Protocols. In view of the situation, new technologies for effectively conserving energy in residential and commercial building sector need to be developed, and policy measures for the purpose need to be proposed. In addition, there is a strong requirement for the civic, industrial, academic and government sectors to provide measures.

2. Overall structure of the policy recommendations

Figure 1 shows the overall structure of the policy recommendations for reducing energy consumption by the building sector.

The policy recommendations in this report comprise three categories: (1) recommendations related to domestic measures, (2) recommendations related to international measures and (3) promotion of collaboration among governmental offices and Ministries.

The recommendations for domestic measures are presented from four viewpoints, namely (i) increasing the level of information transmission to society, (ii) developing social systems, (iii) supporting technological development and (iv) developing support tools for administrative bodies to promote domestic measures. On the other hand, the recommendations for international measures are presented based on the two viewpoints,

namely (i) information transmission and technical cooperation for international measures and (ii) study on measures taking into consideration international trends.

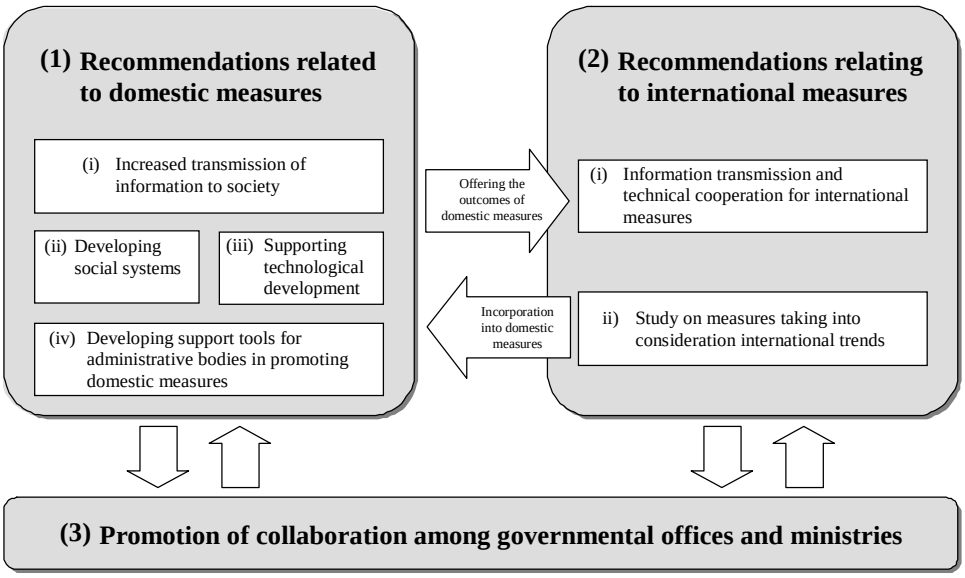

Figure 1: Overall Structure of Policy Recommendations

3. Policy recommendations

(1) Recommendations related to domestic measures

To reduce energy consumption by the building sector, it is important that an agreement be reached concerning the need for the civic, industrial, academic and government sectors to each provide measures and that the transmission of information to society be enhanced to promote cooperative systems among the people through the domestic measures. The need for specific policy measures to promote energy conservation in residential and commercial building sectors has also been pointed out. These include the introduction of regulations and standards, the development of incentives and other social systems and support for technological development. Furthermore, the development of databases and methods for making mid- to long-term predictions concerning energy consumption is needed for the implementation of the above three areas of policy measures as tools for supporting administrative bodies.

(i) Enhancing the transmission of information to society

Recommendation 1: The transmission of information relating to the urgency of reducing energy consumption by the building sector and the need for measures to be taken by each of the civic, industrial, academic and government sectors

It is important to communicate to all of society the fact that energy consumption by the building sector has increased, along with its causes, to enhance people's awareness of the urgent need to reduce energy consumption by the building sector. Also, the need for measures to be taken by each of the civic, industrial, academic and government sectors must be fully communicated through the common understanding that the increase in energy consumption by the building sector is closely related to the actions of each member of society. It is then recommended that a cooperative organization be configured to solicit participation by each of the sectors in an effort to reduce energy consumption by the building sector.

To obtain the understanding and cooperation of the people, it is necessary to provide measures that take into account their diverse lifestyles and the sense of value. For this purpose, systems to gauge the reactions of members of the public need to be configured instead of simply transmitting information one way. In other words, it is necessary to have bi-directional information exchange between ordinary members of the public and the administrative bodies and experts. In addition to reporting the urgency of the measures and requesting cooperation, it is important to present to members of the public examples of specific measures provided by the civic, industrial, academic and government sectors and their outcomes.

An example is that only an extremely small number of households are correctly aware that their hot water supply consumes the most energy, except in cold regions. On the other hand, many people incorrectly believe that air conditioning consumes the most energy, even though its energy consumption is one order of magnitude less than the hot water supply. As a result, some households with a high degree of awareness have adopted inefficient energy conservation behavior, such as by trying to reduce the use of air conditioning while not taking any measures to reduce the use of hot water. The distribution of appropriate information to enhance people's awareness and to provide guidance is necessary so that there is a high degree of awareness among people concerning environmental issues, thereby enabling them to adopt effective strategies to reduce energy consumption.

It is also necessary to formulate measures to cultivate awareness among the students of elementary, junior high and other schools concerning global warming issues and energy saving through the lifecycle of buildings. This should be accomplished through

collaboration with the Ministry of Education, Culture, Sports, Science and Technology and the others.

Recommendation 2: Clarification of the benefits resulting from the dissemination of energy conservation technologies and implementation of energy conserving actions, and the presentation of specific measures to eliminate impediments to them

(a) Clarification of the benefits resulting from dissemination and implementation

If many energy conservation technologies were to be developed and disseminated, energy consumption would be naturally reduced, and this could help prevent global warming. In addition, many other personal and social benefits would result. For example, personal benefits could be anticipated, such as a reduction in utility costs and the attainment of a comfortable environment with improvements in health that would result from highly insulated houses. In addition, there would be social benefits, such as the alleviation of the heat island phenomenon. It is now well known that the creation of sophisticated energy conservation technologies enhances the international competitiveness of industries and the economy. By presenting various benefits that result from energy conservation to a wide range of members of the public, along with many examples of success, energy conservation would become a reality.

A successful example is the case of the use of electricity when devices are in the standby mode. The fact that devices use a considerable amount of electricity when in the standby mode was communicated widely to members of the public, and it became common for users to pull out the plugs when electric devices were not in use. This led to a significant reduction in utility costs. Furthermore, the results were reflected in administrative policies and world's best practice has been achieved to reduce the use of electricity when in the standby mode.

(b) Elimination of impediments

There are various impediments to the dissemination and implementation of energy conservation technologies and activities. It is necessary to analyze the technical and social aspects of these impediments, clearly understand their nature and formulate measures to eliminate them.

A typical example is the discrepancy in incentives concerning energy conservation between the leased building owners and the tenants. In general, building owners prefer lower construction costs and have little incentive to adopt energy conservation technologies because they are costly. Energy costs become relatively high during operation, but most owners think this can be compensated by increasing the rent. On the other hand, tenants have little incentive to reduce costs because they are billed at

a flat rate according to the area of the leased premises. To resolve the discrepancy in incentives, it is recommended that a system of payment according to metered usage be formulated.

Another impediment to be pointed out is the rapidly increasing securitization of real estate properties in recent years. Securitized real estate properties are usually owned by an indeterminate number of people, and they tend to be interested only in the returns. As such, their incentive to enhance the environmental performance of the buildings tends to be minimal. A system is required to enhance the incentive to improve environmental performance of the building among the owners of securities when securitizing the building. For example, labeling buildings that clearly indicate their performance and providing incentives for evading large amounts of CO_2 emissions by increasing the tax rate are regarded as effective in promoting energy conservation in securitized real estate properties.

Another example of impediments is the restriction imposed by the standard management regulations of existing condominiums. The impediments under these regulations include the prohibition on individual households replacing water heaters with more energy-efficient units and replacing window panes with those having improved insulation.

(ii) Development of social systems

Recommendation 3: Presentation of specific measures for promoting energy conservation in numerous existing buildings and small buildings

Energy efficiency has improved significantly in the case of large newly constructed buildings through the adoption of energy conservation measures such as the Energy Conservation Standards[*4] for residential and commercial building sectors, and the Top-Runner Standards[*5] for equipment. However, effective measures have yet to be formulated for existing buildings and small buildings. The reason is because of the large number of such buildings and the difficulty in ensuring the effectiveness of the measures implemented. To facilitate energy conservation in these buildings, numerous systems and mechanisms need to be adopted and established that fully take into consideration the

*4: The official title is “Judgment Criteria for Building Owners Related to the Rational Usage of Energy in Buildings and Judgment Criteria for Building Owners Related to Rational Usage of Energy in Houses” (Notification by METI and MLIT)

*5: The Top-Runner Standards “concern specific equipment designated in Energy Conservation Law, among equipment that consumes large amount of energy. (Automobiles, electric equipment, gas and petroleum equipment, etc.) The Energy Conservation Standards of the equipment are set above the capacities of the products with the highest energy conservation capacities among the commercialized products at the time of establishment of the Standards.”

feasibility of the applications in relation to the actual buildings.

(a) Measures for existing buildings

In the case of existing buildings, it is important to develop methods of renovation that do not require excessive spending. Therefore, renovation for energy conservation would not be prevented. Enhanced insulation in new buildings basically involves the provision of solid insulation measures throughout the entire roof, ceilings, walls, floors and openings. However, it is unrealistic to provide the same measures in renovated buildings. In existing buildings, for example, insulation can be enhanced only at openings, and facilities and equipment featuring high levels of energy efficiency can be installed at the same time. Feasible measures that consider for costs and construction methods also are important in the promotion of effective energy conservation.

(b) Measures for small buildings

There are two possible directions when it comes to promoting energy conservation in small buildings. One is to take the same approach for small buildings as with large buildings, where energy conservation measures are provided separately for individual buildings. The other direction is to improve the energy conservation attributes of building materials, facilities, equipment and other industrial products used in buildings and make the entire building energy-efficient by combining them. It is important to consider the feasibility and effectiveness of these measures, and to configure a mechanism that combines the two.

Measures for small buildings are costly for administrative bodies as there is such a large number of buildings and the energy consumption of each is small. Considering the impediments in this regard, it would be effective to utilize the capabilities of the civic sector, as exemplified by the utilization of private certification bodies, for the Housing Performance Indication System.

Many small buildings, including houses, waste energy because appropriate energy management has not been provided. It is important to adopt comprehensive energy conservation technologies and systems, including avoiding inefficient operation, by utilizing information technologies (IT), building energy management system (BEMS) and home energy management system (HEMS).

Highly effective measures are required for houses to reducing the energy consumed by water heaters, which consume the greatest amount of energy. These measures include the disseminating the use of highly energy-efficient water heaters, disseminating the use of solar heater and enhancing the insulation of bathtubs.

Recommendation 4: Improvement of measures for buildings with large unit energy consumption

In the case of buildings that consume large amounts of energy, such as retail shops, it is important that information regarding their energy consumption first be disclosed. Through the disclosure, we can expect that there will be greater demand from consumers for energy conservation.

Specific measures include the transition to partial and intermittent air conditioning, away from the air conditioning of the entire building for extended periods, the implementation of appropriate lighting plans, the adoption of energy-conserving equipment and enhanced insulation and air-tightness. These measures are expected to save significant amounts of energy. Therefore, it is imperative that immediate measures for energy conservation be implemented in relation to these buildings.

There are only a limited number of buildings that have large unit energy consumption. Therefore, the measures that can be taken in relation to these buildings are highly feasible compared to other types of buildings. It is therefore recommended that highly effective measures be promoted, including the enforcement of regulations.

Recommendation 5: Introduction of regulatory measures for promoting further insulation in residential and commercial building sectors

Twenty-seven years have elapsed since the Energy Conservation Law was enacted (the official title is “Law Concerning the Rationalization of Energy Usage,” Law No.49 of June 22, 1979). This law stipulates the energy conservation standards for residential and commercial building sectors. The law was amended and tightened up in 1992 and 1999, and there is now common understanding established among members of the public concerning the standards. On the other hand, there are some buildings that have not been provided with adequate insulation measures or highly energy-efficient facilities, even though such measures seem feasible. As such, regulatory measures should be introduced to further promote improved insulation. It is important to set the level of regulations taking into consideration the scale and uses of the buildings and whether they are new or renovated after carefully studying the technical and economic feasibility.

To ensure the proliferation of insulation measures in the market, it is important to facilitate a simple and highly reliable means of evaluating insulation performance. Furthermore, adequate information should be provided to people when adopting regulatory measures to ensure consensus. The granting of technological and economic incentives should be promoted in an integral fashion.

Recommendation 6: The provision of information and the granting of incentives in system design for promoting measures to conserve energy

(a) Importance of the provision of information concerning measures to conserve energy

To ensure the smooth introduction of measures to promote the conservation of energy, it is important for consumers, expert engineers, builders, real estate agents, the personnel of financial institutions and other people to be correctly aware of the current status and importance of energy conservation measures for buildings as well as the personal and social benefits from greater energy efficiency. If members of the public are provided with accurate information, they can be expected to cooperate enthusiastically in energy conservation.

Therefore, it is very important to enhance the level of social awareness concerning energy conservation measures. Efforts should be directed in many ways to achieve this objective. Possible measures include the visual representation of building performance using the Comprehensive Assessment System for Building Environmental performance (CASBEE), as well as the guidance for and mandating of reporting and display of energy efficiency.

It is important that buildings that are highly energy efficient be evaluated and appropriately recognized, and selected by consumers. For this purpose, there is a requirement to develop methods for evaluating energy efficiency that reflect the actual energy consumption. Significant benefits can be expected if energy efficiency is evaluated based on data obtained from actual measurements and surveys and if the results are clearly presented to consumers. In Europe, the Energy Performance of Buildings Directive that went into effect in January 2003 mandates that building owners indicate energy efficiency based on the energy consumption and CO_2 emissions to their clients when selling or leasing the building.

The reduction of CO_2 emissions is important not only during operation but also during construction. A mechanism for calculating and making public the reduction in CO_2 emissions based on a lifecycle assessment of the building ($LCCO_2$: Lifecycle CO_2) should be established, taking into consideration the extension of service life of buildings and the use of recycled building materials. In this way, further enhancements in the environmental performance of buildings should be promoted.

To provide information on energy conservation appropriately, expert knowledge is needed at each stage of the design, construction and operation. It is important to train experts that have the necessary levels of expertise and to clearly indicate their roles and positions. For this reason, there is also a requirement to develop systems for the purpose.

(b) Granting of incentives in system design

To facilitate the dissemination of energy conservation technologies and practices after providing adequate information, it would be effective to configure a system to provide incentives to the related parties. Specifically, the granting of incentives to reduce energy consumption would be effective through the adoption of preferential treatment systems, including subsidies, low-interest loans, reduced rates and exemptions from fixed property taxes and Eco-points. Also significant would be the study of reverse incentives in case energy consumption has not been reduced to the levels intended. An example of a reverse incentive would be a surcharge on the fixed asset tax.

Recommendation 7: Implementation of model projects to verify the effectiveness of energy conservation measures

When new systems and standards are introduced to conserve energy, building owners, tenants, manufacturers and local administrative bodies are usually asked to bear significant burdens. As such, it is not easy to obtain the understanding of the relevant parties when introducing new systems and standards. For this reason, prior verification of the benefits of energy conservation under the new systems and standards would not be enough. It is important to clearly identify the issues and problems to be resolved by verifying the effectiveness of the energy conservation measures taking into consideration the technical impediments for manufacturers, the understanding of the building owners and tenants and the circumstances concerning the implementation and management of measures by local administrative bodies. Good cooperation by the relevant parties can be expected through the joint participation in the verification processes.

It is therefore recommended that a demonstration project be implemented beforehand at model regions where agreement has been obtained when introducing new policy measures, instead of applying them nationwide from the onset. In this way, the policy measures can be adopted after confirming their feasibility.

(iii) Support for technological development

Recommendation 8: Development of comprehensive energy conservation technologies that integrate the building shelter and frame with facilities and equipment, and the development of simulation tools for evaluating them

(a) Development of comprehensive energy conservation technologies that integrate the building shelter and frame with facilities and equipment

After the measures for energy conservation for the building, building frame, facilities and equipment have progressed to a certain degree, it would be effective to integrate them to achieve further energy conservation. In this case, even greater benefits can be obtained by utilizing IT, BEMS and HEMS.

Many element technologies have already been created, such as devices for automatically turning off the lights and air conditioners in unused rooms, and automatically shielding the sunlight with a screen. However, the technology has not yet been developed for controlling these elements in an integrated manner, autonomously but harmoniously. The optimum and integral operation of windows, screens and other facilities and equipment in a building would result in significant benefits through energy conservation if suited to the climate conditions and residents' particular circumstances. As such, policy measures need to be developed in association with Recommendation 5, including regulations that take into consideration the points mentioned.

(b) Development of simulation tools for energy consumption

Facilitating the integral operation of the building shelter, the building frame, facilities and equipment assumes that it is possible to quantitatively evaluate its energy conservation benefits. Therefore, a numeric simulation tool needs to be developed that accurately analyzes energy consumption during integrated operation. The development of comprehensive energy conservation technologies that utilize economically efficient and operable IT, BEMS and HEMS becomes possible only after the simulation tool is developed.

Recommendation 9: Support for the development of evaluation and construction technologies to promote retrofitting existing houses with thermal insulation and the dissemination and promotion of appropriate insulation methods

The number of uninsulated and insufficiently insulated houses, as well as those with old and decrepit insulation performance, is believed to be large.

To promote the refurbishment of insulation measures in these houses, it is important to quantitatively assess the insulation performance and to clearly indicate the level of deficiencies in construction work and the level of dereliction. However, a simple and highly accurate evaluation method has yet to be developed. The prompt development of non-contact measurement and evaluation methods is recommended, which enable the quantitative evaluation of insulation performance without damaging the building.

When retrofitting existing houses with thermal insulation, the interior and exterior finishes usually need to be destroyed. The need for temporary relocation and the increase

in the renovation costs has significantly hindered such renovations. Therefore, it is important that the insulation can be renovated without destroying the interior and exterior finishes. Thus, technological development to be applied to existing houses is recommended, including applicable building materials and components and technologies that significantly reduce the construction period.

It is also important to convey accurate information on insulation methods to designers, construction workers and consumers. Dissemination of accurate information should be promoted at the same time.

Recommendation 10: Technological development for enhancing energy efficiency suited to traditional wooden houses

Traditional wooden houses are preferred by many Japanese people. The use of lumber offers many advantages in terms of land conservation, as well as the benefits resulting from carbon neutrality.[*6] On the other hand, traditional wooden houses are neither well-insulated nor airtight. The following recommendation has been made from these viewpoints.

(a) Development of insulation technologies for wooden houses

The cross-section of walls in houses that have wooden frames is highly irregular, and it is not easy to insulate them accurately. In addition, the skills of house builders in Japan vary widely, and insulation work is not a part of the traditional construction technology. In fact, insulation technology has yet to be established. In view of these circumstances, it is important to develop simple, effective and highly reliable insulation techniques and building materials.

(b) Appraisal of environmental performance of wooden houses and the development of appropriate construction technology

Traditional wooden houses have excellent environmental performance in Japan's hot and humid climate. In view of this situation, it is important to promote technological development for constructing wooden houses that can contribute to the formation of high-value social assets, by largely enhancing energy conservation efficiency and other aspects of the environmental performance of traditional wooden houses. In developing the next generation of traditional wooden houses, attention also needs to be paid to comfort during summer. Technological innovation in design and construction is needed to reflect the progress in environmental symbiosis

*6: Even though lumber and other biomass emit CO_2 when incinerated, the plants absorb CO_2 from the atmosphere through photosynthesis as they grow. As such, the emission and absorption are in balance. The term "carbon neutral" refers to the balance between emission and absorption.

technologies in recent years. It should be pointed out that technical maturity has been reached in making this possible. The achievements obtained through these initiatives will revitalize Japan's traditional housing culture, and could serve as an effective technical supporting tool for Asian countries where lumber is frequently used.

Recommendation 11: Concept design and development of element technologies for converting zero-energy houses into energy-producing houses

The zero-energy house has already been stipulated as a topic for technological development, and studies have already begun to achieve it. The next topic to be studied is the energy-producing house that produces energy for other uses though thorough energy conservation and the active use of natural energy. The energy-producing house is a totally different concept, and the ways that energy is used in the conventional energy-conserving and zero-energy houses need to undergo fundamental technological and social innovation. It is therefore recommended that the concept design to achieve an energy-producing house be promoted.

To create an energy-producing house, many technologies that transcend conventional common knowledge need to be developed. Current candidates for technological development include the highly efficient use of solar heat, as well as solar light, wind power, biomass and geothermal energy as well as other renewable energy. Other candidates for technological development include the multi-functional heat pump, the water heater with a CO_2 refrigerant heat pump and other highly efficiency equipment for houses. There is also a requirement to develop innovative passive control technology. These technologies can also be applied to existing houses, and the ripple effects for energy conservation would be quite significant.

Recommendation 12: Configuration of an optimum use of network sharing energy through the association of a distributed energy system and electricity supply network

To disperse the energy supply, it is important to promote the use of solar heat and solar light, wind power, biomass, geothermal energy and other renewable energy sources that suit the regional characteristics. An energy management system for the consumer sector needs to be developed to optimally combine renewable energy with a cogeneration system equipped with fuel cells, a electricity storage system and other highly efficient distributed energy usage technologies. By introducing and disseminating these distributed management systems suited for the region, highly energy-efficient communities can be built that remain self-sufficient in the event of a disaster.

If the distributed power sources described above are not widely adopted, the stability of

the power supplied by the existing electricity system may be affected adversely. On the other hand, adopting distributed power sources helps to level the loads on electricity supply systems. As such, efforts should be made to achieve enhanced efficiency and supply stability through the use of network sharing energy by configuring an optimum network based on a combination of a distributed energy system with the existing electricity grid.

Recommendation 13: Promotion of measures to enhance the energy efficiency of the entire urban block or city

(a) Enhancement of energy efficiency for the entire urban block or city

Urban sprawl significantly affects the efficiency of energy usage. In general, energy efficiency is high in cities of high density while it is low in sprawling cities. It is recommended that studies be undertaken on the city scale and aggregation that suit the region from the viewpoint of energy conservation, taking into consideration the conditions of the natural environment, society, industry and the economy of the region.

In view of the efficient usage of electricity and heat, it is important to promote the use of a network sharing energy, exemplified by multi-stage energy usage and district cooling and heating system, in a manner that is closely aligned to the location of the demand, as discussed under Recommendation 12. In this regard, a compact city is desirable where diverse energy demands are aggregated in close proximity. In other words, enhanced efficiency that cannot be accomplished by a single building can be achieved by operating several facilities owned by many buildings through an optimum combination utilizing BEMS, HEMS and other information systems. In this way, extra heat and electricity can be mutually passed on while using heat and electricity storage, thereby avoiding the inefficient operation of facilities at partial loads. In addition, economizes of scale can be adopted to introduce highly efficiency equipment and to break up capacities, thereby expanding the range of choices for enhancing efficiency. It is recommended that technological development and the expansion of systems be promoted to contribute to network sharing energy management for the entire urban block.

The use of network sharing energy is a new area of technology, and systems have not yet been established to deal with it. There needs to be collaboration between energy-related industries, national government agencies and regional administrative bodies to establish the systems.

(b) Studies on the scale and configuration of the city with superior energy efficiency.

When planning a compact, highly energy-efficient city, an organization for regional energy that can appropriately deal with the regional characteristics, as well as the plans and operation methods of urban infrastructures for making effective use of wasted heat, also need to be studied in conjunction with other factors.

The so-called symbiosis architecture mainly concerns the proactive usage of natural energy in its design. Its performance, however, is largely affected by the conditions of the natural local environment. If the conditions of the natural environment in the region are not favorable, only a limited number of passive control methods can be adopted for symbiosis architecture. On the other hand, the profile of building clusters significantly affects the natural environment of the region in many cases. An example is the blocking of the passage of the wind by a cluster of buildings that act like a screen. Therefore, it is necessary to review the plans of urban blocks and cities formed by building clusters from the viewpoint of the effective use of natural energy, and to provide measures to improve the urban environment.

(iv) Development of support tools for administrative bodies to promote domestic measures

Recommendation 14: Development of databases on energy consumption by the building sector and efficiency indices for evaluating policy measures

When studying long-term energy conservation measures for the consumer sector, it is necessary to determine the results of energy conservation for the various measures and to predict future energy consumption by the building sector on a nationwide scale. To achieve this objective, the fundamental task is to determine in detail the actual energy consumption in existing buildings. However, this has not been adequately performed. Prompt configuration of databases for the purpose is recommended.

Since the pattern of energy consumption changes each year, it is important to continually update the databases of energy consumption statistics continually. In the future, it is also important to improve the reporting system for energy consumption and CO_2 emission, and to disclose the data on websites and other media.

It is important to develop efficiency indices that can help evaluate and judge the effectiveness of the measures and the progress in implementing them based on the databases developed. Therefore, it is recommended that such indices be developed. To establish appropriate efficiency indices, periodic surveys need to be performed on the energy consumption data for each building, at different times and seasons and for different energy types and usages so that the data is accumulated.

Recommendation 15: Development of mid-, long- and ultra long-term prediction

methods for energy consumption by the building sector

Measures for reducing energy consumption by the building sector involve many factors that extend over a long time scale, such as population dynamics and the service life of buildings. In many cases, an extended period is needed before the measures start to produce effects. As such, predictions concerning energy consumption by the building sector spanning several years, several decades and more than 50 years are needed when introducing systems and standards for energy conservation and for making judgments on policies, for example by providing support on technological development.

To promote mid-, long- and ultra long-term energy conservation measures for residential and commercial building sectors, databases need to be configured to capture the changes in population and the number of households, the progress of the ageing of society and the decline in the number of children, changes in family units and lifestyles, changes in climate, changes in the industrial landscape, innovations in energy conservation technologies, demand for building construction and renovation, and other factors. Based on the databases, highly accurate simulations need to be performed on energy consumption so that the effects of energy conservation can be predicted for each measure. Therefore, it is recommended that predictive techniques for energy consumption by the building sector that can fulfill the objectives be developed. The development of these techniques should assume that highly accurate numeric simulation tools for the prediction of energy consumption in buildings, which is discussed under Recommendation 8, have been developed.

It is also necessary to strive to improve the prediction accuracy through continuous comparison of the results of prediction with the actual data.

(2) Recommendations for international measures

To promote energy conservation in different countries around the world, international cooperation has become increasingly important in securing global equality. The increase in energy consumption by the building sector has become a serious issue not only in Japan, but also in other developed and developing countries alike. Energy conservation measures in Japan, where primary energy consumption as a percentage of GDP is the smallest in the world, can serve as a model for energy conservation measures in various countries around the world, as a successful example of world’s best practice. Therefore, the transmission of information and technical cooperation should be promoted in an international framework. It is also important for successful examples in other countries to be incorporated into domestic measures, taking into consideration the international trends in discussions at the International Energy Agency (IEA), the Intergovernmental Panel on Climate Change (IPCC), and others.

(i) The transmission of information for international measures and technical cooperation

Recommendation 16: Collection and compilation of successful examples from around the world through joint research with the IEA and activities at the IPCC, and information transmission for G8 Summits

(a) Collection and compilation of successful examples from around the world through joint research with the IEA and activities at the IPCC

At the G8 Summit held in the United Kingdom in 2005, a declaration was announced regarding improvement of energy efficiency in buildings. International studies for the purpose were delegated to the IEA. On the other hand, Working Group III (WG3) of IPCC has studied measures to prevent global warming, in relation to buildings. Measures to conserve energy can be promoted significantly on a global scale if successful examples from various countries are shared at international meetings of the IEA and IPCC. Information on measures to conserve energy and prevent global warming that have been provided in Japan so far, their outcomes and successful examples should be communicated to the world through activities with the IEA and IPCC. It is also recommended that successful examples from various countries be surveyed and considered for adoption as part of the domestic measures.

(b) Information transmission for G8 Summits

At the G8 Summit to be held in Japan in 2008, the outcomes of the Gleneagles Action Plan of 2005 are to be reported. As such, it is necessary to compile a wide range of materials relating to energy conservation activities by Japan's building sector, including the matters discussed above.

Japanese people have traditionally accumulated wisdom in relation to conserving energy in relation to architecture, their lifestyles and work, by making use of resources found in the natural environment. Typical examples include passive ventilation, cross ventilation and solar shading technologies that are suitable for Japan's hot, humid climate. Also, highly efficient, world-class facilities and equipment have been successfully developed in Japan through the adoption of the Top-Runner Standards pursuant to the Energy Conservation Law. Japan has a plethora of technical and design capabilities that can contribute to the world, and this should be communicated to the international representatives at the G8 Summit and on other occasions.

Recommendation 17: Provision of advice on policies and technical assistance to Asian countries, and promotion of database development on energy consumption

It is the responsibility of Japan to provide advice on policies and technical assistance to Asian countries to contribute to the improved energy efficiency throughout the entire Asian region.

To promote international cooperation in Asia in reducing energy consumption by the building sector, it is essential to create the Asian version of the energy consumption database. It is recommended that Japan take a leadership role in developing the database. As part of the process, it is essential to clearly identify consumption and to provide explanatory variables that enable an analysis of the pattern of energy consumption, such as livelihood and housing conditions.

To promote technical assistance for the conservation of energy appropriately, the development of human resources who are able to implement the initiatives is important. To transfer useful knowledge from Japan to developing countries, studies should be conducted on organizations for managing the database on consumer sector energy through cooperation with Asian countries.

In the process, it is important to offer advice and assistance while fully respecting the circumstances surrounding energy consumption by the building sector that are unique to each of the Asian countries, as well as the traditional lifestyles and technologies of the region.

Recommendation 18: Enhancing assistance to technologies on the users' side to promote the conservation of energy in Asian countries

In many cases, international cooperation related to energy issues requires financial assistance through Official Development Assistance (ODA) and suchlike. In the assistance provided so far to developing countries for energy, the financial assistance tended to focus on the energy supply side. Examples include projects to construct power plants and dams. These initiatives came about due to the needs of developing countries. Today, however, the technical cooperation needed in Asian countries in relation to the consumer sector energy is more inclined toward the users' side. As has become evident through the social experiment related to the dissemination of fluorescent light bulbs in Vietnam conducted with assistance from Japan, enhanced energy efficiency of lighting fixtures on the users' side contributes greatly to reducing the demand for power generation on the supply side.

To promote energy conservation in Asian countries, greater financial assistance is required on the users' side, as mentioned above. It is essential to have close cooperation

with the Ministry of Foreign Affairs when deciding on policies for financial assistance through ODA. As such, an approach that transcends the boundaries separating governmental offices and Ministries are needed here, just as with domestic measures.

(ii) Policy studies that consider international trends

Recommendation 19: Mid- to long-term prospects on energy supply and demand throughout the world and Japan, and study on appropriate domestic measures including the use of nuclear power

(a) Mid- to long-term prospects for energy supply and demand throughout the world and Japan

The recoverable reserves of petroleum and natural gas as fossil fuels are estimated to last for another 40 to 70 years. Japan depends on imports for 80% of its energy requirements, and the use of these fossil fuels may become untenable for political reasons before this period expires.

The demands on energy by the building sector accounts for a little over 30% of overall demand in Japan, and the trend has been persistently increasing. Therefore, in the long term, it is also necessary to promote the use of renewable energy in addition, of course, to the conservation of energy. For this purpose, it is recommended that mid- to long-term measures be clearly established for energy for the building sector.

With respect to renewable energy, technological development and dissemination have progressed in relation to solar heat and solar light, wind power, biomass, geothermal energy and so forth. The cost effectiveness for consumers largely affect whether these technologies will be disseminated. How much of these renewable energy can be used in the future as energy sources needs to be clearly determined for the consumer sector, taking into consideration future trends in energy consumption.

(b) Study on appropriate domestic measures including the use of nuclear power

The degree of energy self-sufficiency needs to be increased in Japan in view of energy security. In this regard, people have placed considerable expectation on nuclear power generation as a means of Japan achieving self-sufficiency in the future. Although discussions on nuclear safety are likely to continue, IEA has changed its policies and decided to promote the use of nuclear energy. The future direction for nuclear energy usage needs to be clearly set, and appropriate information must to be conveyed to society, taking into consideration the trends in imported energy, the trends in energy consumption and assurances for energy security. It is important to even out the load when using nuclear power. Therefore, a means of associating the nuclear power facilities with the distributed energy system mentioned in

Recommendation 12 should be pursued for the building sector.

Based on the above studies, it is recommended that mid- to long-term action plans be formulated in relation to the supply and demand for consumer sector energy, taking into consideration the targets set out in the New National Energy Strategies.

(3) Promotion of collaboration among governmental offices and ministries

Collaboration among governmental offices and ministries is always necessary. However, global warming is a difficult issue that we have never experienced before. Reduction of energy consumption by the building sector, which is the major countermeasure against global warming, is an urgent policy challenge. To facilitate the reduced use of energy, the expertise of the civic, industrial, academic and government sectors needs to be aggregated. It is necessary to implement extensive measures that go beyond the existing administrative framework of the ministries and agencies. The need for collaboration deserves special emphasis.

(i) Collaboration among governmental offices and ministries and the Science Council of Japan

When developing measures to reduce energy consumption by the building sector, to prevent global warming, it is prerequisite to have greater collaboration among the Cabinet Office, the Ministry of Land, Infrastructure and Transport (MLIT), the Ministry of Economy, Trade and Industry (METI) and the Ministry of the Environment. In this regard, the Recommendations themselves are part of the efforts toward collaboration among the Cabinet Office, to which the Science Council of Japan belongs, and other ministries and agencies. The Science Council of Japan is expected to assume an active role in promoting collaboration among governmental offices and ministries.

(ii) The multi-faceted promotion of collaboration among governmental offices and ministries

The ministries involved directly in reducing energy consumption by the building sector include MLIT, METI and the Ministry of the Environment. Efforts have been made to facilitate collaboration among the ministries and agencies, as exemplified by the enactment of the Energy Conservation Law (1979) and its Amendments (2005) jointly pursued by MLIT and METI. However, the results obtained so far have proved inadequate.

When developing measures to reduce energy consumption by the building sector, it is more effective to promote collaborative efforts in many cases than to pursue an

independent agenda, as is often the case with environmental measures. When attempting to conserve the energy used in houses, for example, it would be more effective if the measures were studied for the building and air conditioners, water heaters and other facilities and equipment in an integrated manner. However, these measures have conventionally been pursued separately by the ministries, for example by MLIT who is in charge of buildings and by METI who is in charge of equipment. As such, measures that treat the two factors in an integrated fashion have not yet been adequately developed. Further collaboration among the ministries and agencies is essential in order to overcome the urgent policy challenges of reducing energy consumption by the building sector.

Collaboration with the Ministry of Agriculture, Forestry and Fisheries is also needed in view of the importance of the lumber usage, and collaboration with the Ministry of Finance and Financial Services Agency is necessary in view of the importance of environmental financing that supports energy conservation. There is also a need for collaboration with the Ministry of Foreign Affairs for international cooperation measures related to energy conservation, as well as with the Ministry of Education, Culture, Sports, Science and Technology for environmental education.

(iii) Collaboration among ministries and agencies of the national government and local administrative bodies

In the course of developing measures for reducing energy consumption by the building sector, there are many factors that come under the direct control of local administrative bodies, such as inspections of building performance. Therefore, when measures are formulated by the ministries and agencies of the national government, they need to be feasible initiatives that consider the actual circumstances of the local administrative bodies that implement them, as mentioned in Recommendations 7 and 13. In this regard, greater collaboration among the ministries and agencies of the national government and local administrative bodies would be important.

Closing remarks: towards the formulation of action plans

This report presents nineteen policy recommendations for administrative bodies deemed as urgent and feasible from the domestic and international viewpoint to reduce energy consumption by the building sector to prevent global warming. In reality, however, it is difficult to implement all nineteen policy recommendations at the same time. Therefore, ministries and agencies implementing the measures should determine the priority with which the recommendations are to be implemented and formulate specific action plans based on more highly detailed studies on the urgency and feasibility, as well as analyses of their effectiveness and cost-benefit analyses.

Working Group III (WG3) of the IPCC adopted the Fourth Assessment Report in May 2007. WG3 has studied measure to mitigate global warming, and Chapter 6 of the Report discusses the technologies relating to buildings for mitigating climate change. Some of the members who prepared this report also actively participated in the preparation of the IPCC report. The IPCC reports compile and analyze the latest information from around the world. Consequently, domestic and international measures need to be reviewed based on the IPCC Reports when studying measures relating to energy consumption by Japan's building sector.

It is important to implement the measures at the earliest possible time because there is an urgent need for reducing energy consumption by the building sector. The earlier these measures are implemented, the greater the benefits and the smaller the costs. It is sincerely hoped that the civic, industrial, academic and government sectors collaborate to achieve measures to reduce energy consumption by the building sector, and that effective measures are promoted through the understanding and cooperation of the members of the public.