Lowering Energy Intensity toward Sustainable Development*

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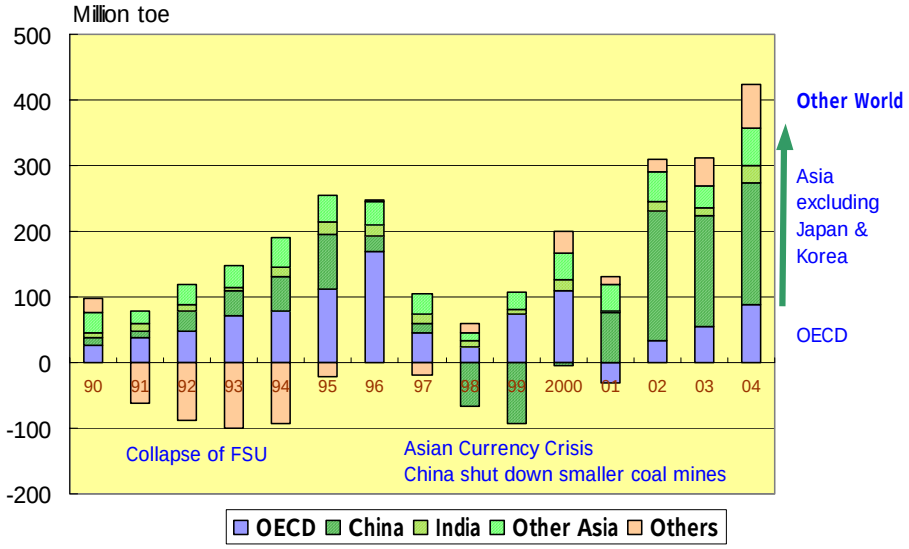
We have experienced very severe energy price hike in the past several years. This was brought by tightening global energy demand/supply balance owing to decreasing spare capacity on the supply side and abrupt consumption increase on the demand side. Among others, Asia excluding Japan and Korea has shared more than 75% of the world energy consumption increased between 2000 and 2004. Hence, we hear such words like "China Impact", or "Impact of Chindia" with some accusing sense in the market. However, it is quite natural that energy consumption increases as economy grows. Big increase of Asian energy consumption is in turn evidence that Asia is playing a big role driving world economic growth. On the other hand, however, it is true that tightening energy balance is threatening sustained growth of Asian countries. We need to find a feasible growth path resolving the energy issues facing the world.

Figure-1 Increase of World Energy Consumption by Region



Source: BP Statistical Review of World Energy 2005

To cope with the situation, it is important to increase energy supply capacity, on one hand, and to realize rational energy use on the other. In particular, energy conservation is very important in the sense that it creates negative energy demand. For example, Asia excluding Japan, Korea and the Middle East consumed 48 million barrels per day oil equivalent energy in 2004.[1] If the region could save 10% of this, it would amount to almost 5 million barrels per day equivalent of oil. Though not apparently noticeable, energy conservation can cumulatively bring a great effect on the world energy balance, which compares to discovering a number of giant oil fields.

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* Gist of this paper was presented at the China Montreux Energy Round Table II held on November 14-15, 2005 in Beijing.

1 BP Statistical Review of World Energy 2005. Energy consumption of Northeast Asian countries including Japan, Korea, China and Taiwan was 46 MMBD, while the world consumption was 210 MMBD.

As Japan is said to have established most energy effective economy in the world, this paper will review how Japan has implemented its energy conservation and seek for useful lessons to be applied in the efforts toward sustainable development.

1. Japanese experience

1-1 Diversification of Energy Supply

During 1960s, Japan recorded high economic growth promoting heavy industry such as steel and petrochemicals. Personal consumption of goods also increased substantially along with rapid growth of per capita income. Thus, oil consumption increased rapidly until 1973 when the world encountered the first oil crisis. Facing the panicky turmoil, Japan implemented various counter policies on supply side as well as demand side. They are summarized as follows.

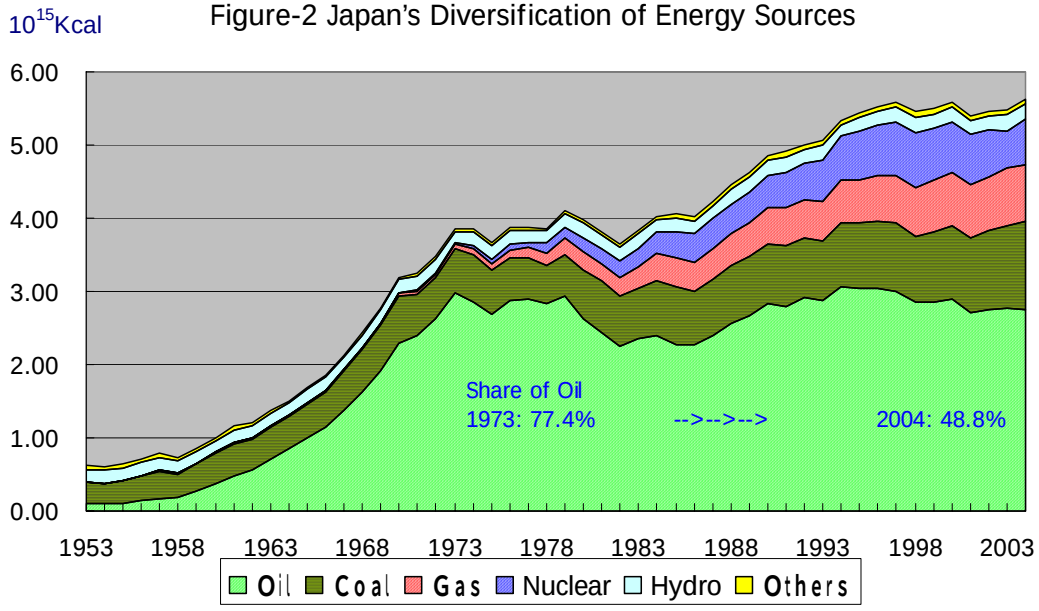
Supply: Reducing oil dependence

a) Diversification of energy sources by promoting natural gas and nuclear
b) Diversification of oil sources to decrease the Middle East dependence
c) Oil stock piping
d) Developing new and renewable energies (the Sunshine Project)

Demand: Converting to resource saving society

a) Structural change of economy from big and heavy to small and light industries
b) Rational use of energy and/or energy conservation
c) Improving energy efficiency (the Moonlight Project)
d) Social education to keep people conscious of energy conservation

Figure-2 Japan's Diversification of Energy Sources



Source: METI/IEEJ

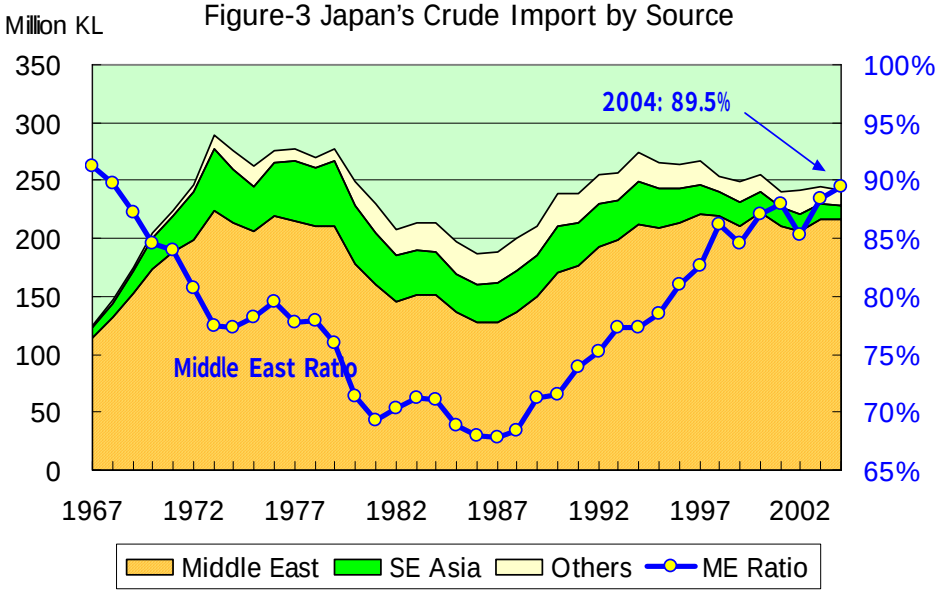
Regarding diversification of energy sources, Japan has successfully controlled its oil consumption below the level of 1973 promoting natural gas and nuclear. While Japan's energy consumption increased 46% during the past three decades, oil consumption decreased 8% from 286 million kiloliter

in 1973 to 274 million kiloliter in 2004. The share of oil has decreased from 77.4% to 48.8%. Use of imported coal is also increasing in recent years. However, the same policy would not bring such remarkable effect to Asian countries as Japan experienced, since their oil dependence is substantially lower than that of Japan. For example, oil ratio over the total primary energy supply was 23% in China and 32% in India in 2004.

1-2 Oil Security

Diversification of crude oil supply sources was also successful up until late 1980s. Japan increased crude oil import from China and Southeast Asia and opened a new supply channel from Mexico across the Pacific Ocean. However, because of their limited supply potential and severe market competition, oil import from these newly explored sources decreased through 1990s. The Middle East dependence has increased again reaching almost 90% now. The Middle East being the only reliable mega supplier for Asian countries, this tendency may apply to all the Asian countries pending exploration of new supply sources.

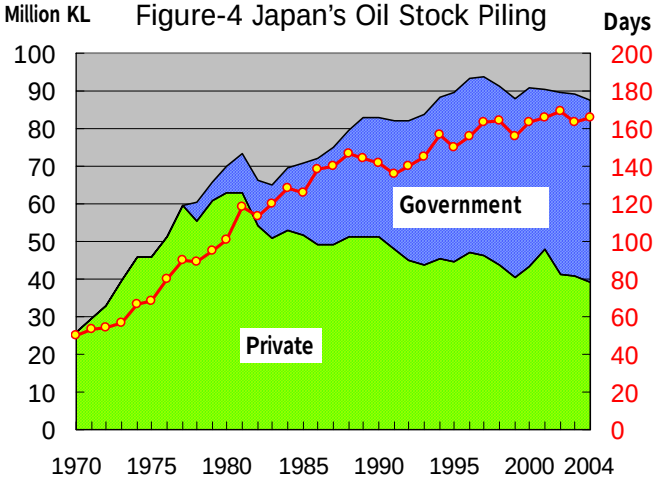
Figure-3 Japan's Crude Import by Source



Source: METI Statistics

In order to mitigate impact of unexpected supply disruption, OECD countries started oil stock piling under the IEA regime. Japan's oil stock piling has reached the level of almost 170 days now, which worked as a very strong force to keep people calm during several Middle East wars occurred after the oil crisis. While stock piling has verified as a very effective measure against short-term turbulence, it cannot solve longer-term energy security issues facing Asian countries.

Figure-4 Japan's Oil Stock Piling

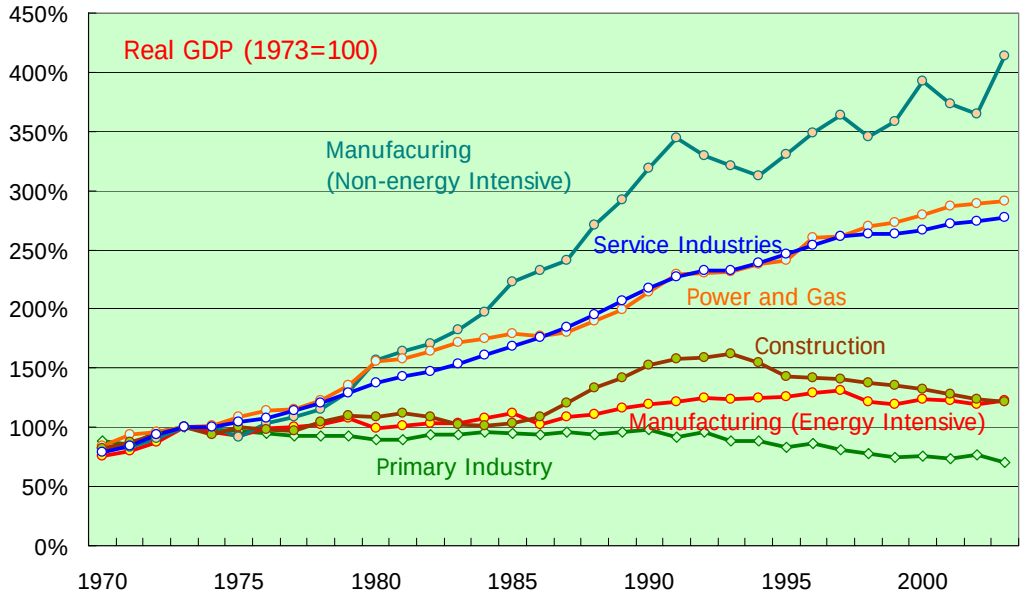


Source: METI

1-3 Energy Efficiency

On the demand side, Japan developed nationwide campaign of energy conservation and rational use. At first Japan went for nationally united actions of government and private sectors and started two projects to implement this; the Sunshine Project in 1974 to develop alternative energy sources and the Moonlight Project in 1978 to develop energy conservation, recovery and efficient use technologies. The Energy Conservation Law (Law concerning the Rational Use of Energy) was enforced only in 1979. Facing substantial energy price hike, energy intensive heavy and big industries could not continue to be the main engine of the Japanese economic growth any more. In place of them, non-energy intensive industries, which produce so to speak light and thin products with high-tech, and service industries became the main driver of the economy. While the GDP of the energy intensive manufacturing industries remains at almost the same level of 1973, the GDP of the non-energy intensive manufacturing industries increased four-fold and service industry three-fold in the past three decades. Although the total energy consumption increased only 40% in the same period, power consumption increased 2.4 times and city gas 4.3 times; GDP of the power and gas industry increased almost three times, accordingly.

Figure-5 Structural Change in Japanese Economy

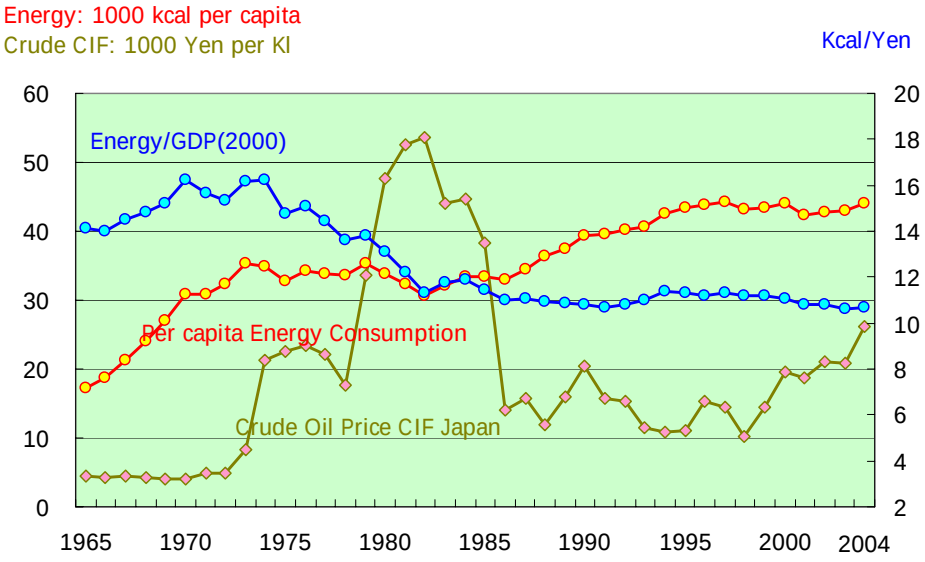


Source: ESRI "National Accounts of Japan"

As a result, Japan's energy intensity per GDP, peaked in 1973, decreased substantially through structural changes of economy and energy conservation efforts across the country. In 2004, it was at 66.1% of the level of 1973. Japan has realized most energy efficient economy in the world. However, this process slowed down since middle of 1980s reflecting lowered energy price, and per capita energy consumption continued to increase until mid-1990s reflecting the bubble economy boom. Since then, both indices are leveling off.

History and current status of the Japanese energy conservation policy will be reviewed more in detail in the later section.

Figure-6 Japan's Energy Efficiency

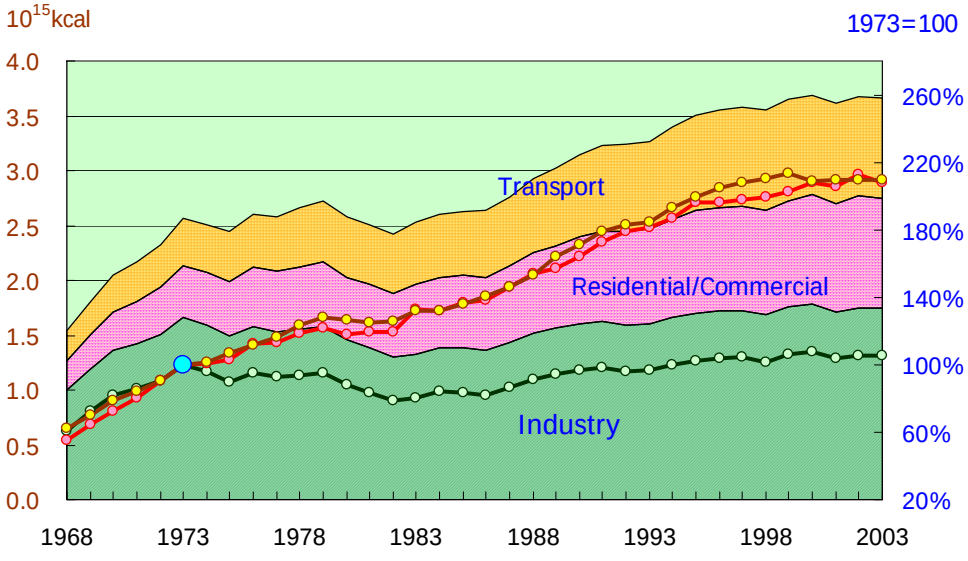


Source: METI/IEEJ

1-4 Final Energy Consumption

In 2004, the final energy consumption of the industrial sector remained at 105.7% of that of 1973. However, energy consumption of residential/commercial and transport sectors has steadily increased and reached the level more than double in the same period. Such increases were caused mainly due to increase of personal consumption along with growth of individual income, for example, such as bigger refrigerators, TVs and cars and full air-conditioned houses, although unit energy efficiency of individual equipments and appliances has improved substantially. Now, tempering such propensity is the most important objectives of Japan's energy conservation policy.

Figure-7 Final Energy consumption of Japan



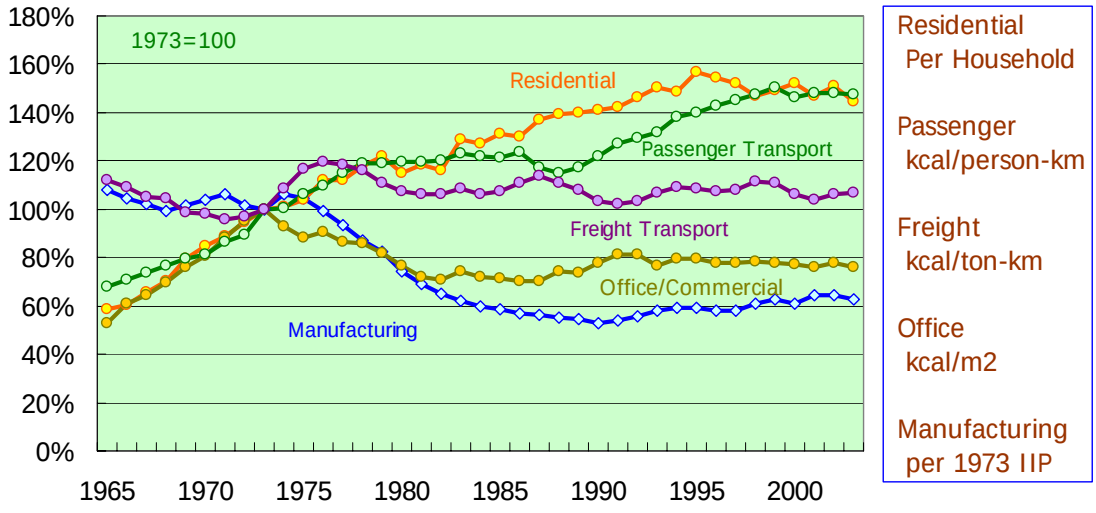
Source: METI/IEEJ

1-5 Unit Energy Consumption

In Japan, unit energy consumption in industrial and business sectors has steadily improved as shown in figure-8. However, it has deteriorated in the household and passenger transport sectors, since, with income growth, people tends to go for larger houses with more of modern appliances and longer driving by bigger cars. A good sign is that unit energy consumption per household started decreasing since late 1990s. Especially to cope with the GHG issues, contrivance to curb energy consumption in these sectors is getting more important now.

It should be noted that the unit consumption of the freight transport sector is on the improving trend, in principle, but the overall figure is affected by the increase of air cargo.

Figure-8 Japan's Energy Efficiency



Source: METI/IEEJ

1-6 Summary of the Japanese Energy Policy

The above observation on the Japanese energy policy since the 1973 oil crisis can be summarized as follows:

Supply Side

a) Diversification of energy sources: Oil ratio was successfully decreased below 50%
b) Diversification of oil supply sources: Deteriorating after temporary success because of lack of alternative sources
c) Oil stock piling: Successful but it is effective only against short-term turbulences
d) New and renewable energies: Supply has doubled in the past three decades but remains at only 1.3% of the total primary energy supply

Demand Side

a) Structural change of economy: Progressed substantially
b) Improving energy efficiency: Energy intensity per GDP (2004) has decreased down to 2/3 of the 1973 level, which mainly reflects improving efficiency in the manufacturing industry and office/commercial buildings.

c) Energy conservation: Successful in heavy energy use sectors. In other sectors, however, energy consumption has increased more than double although unit energy efficiency of individual products has improved substantially.

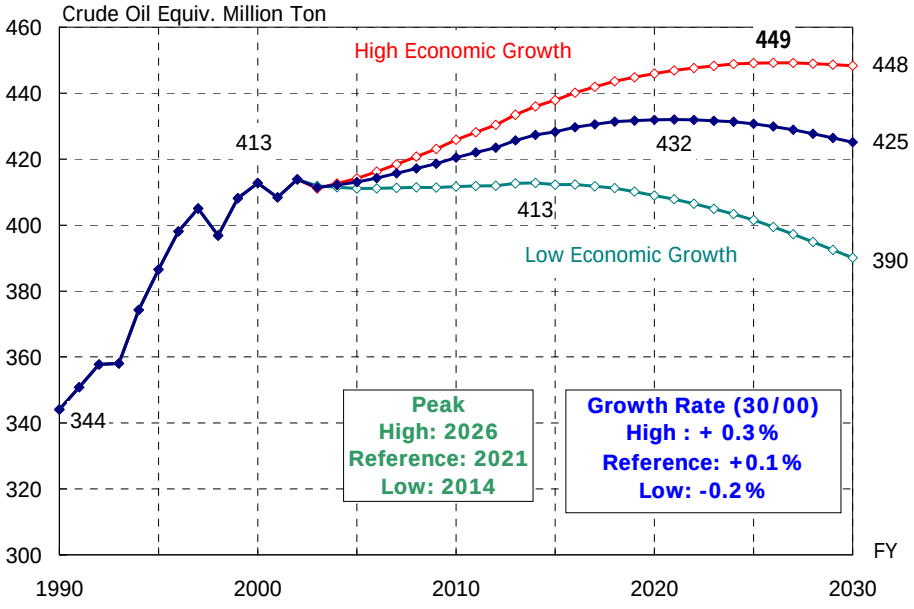
In summary, supply side policies and industrial policies in Japan have been successful in curbing the energy consumption except that the Middle East dependence has deteriorated now. On the demand side, rationalization of energy use has been successful by and large in the industrial and business sectors. However, people's admiration toward better standard of living is continuously putting greater pressure on the energy use in the non-industrial sectors. Overall energy consumption as well as unit energy consumption at household for residential appliances and personal cars has continued to increase, though unit consumption indicates improvement trend in recent years. In summary, we should carefully cope with the tendency that, in the advanced stage, free increase of energy use in personal consumption, if not carefully tempered, would undermine efforts in the industrial and business sectors.

2. Energy Outlook of Japan and Concerns on GHG Emission

2-1 Energy Outlook of Japan

According to the forecast made by METI in 2004, without progress in the spread of energy conservation technology, the Japanese energy demand in the reference case would increase moderately toward 2030, peaking around 2025 as shown in Figure-9, mainly due to higher consumption in the household sector. However, even in the high economic growth case, the future incremental demand would be less than 10% in the coming three decades. In the low economic growth case, the energy demand would start decreasing around 2015 and be about 5% lower in 2030.

Figure-9 Energy Outlook of Japan



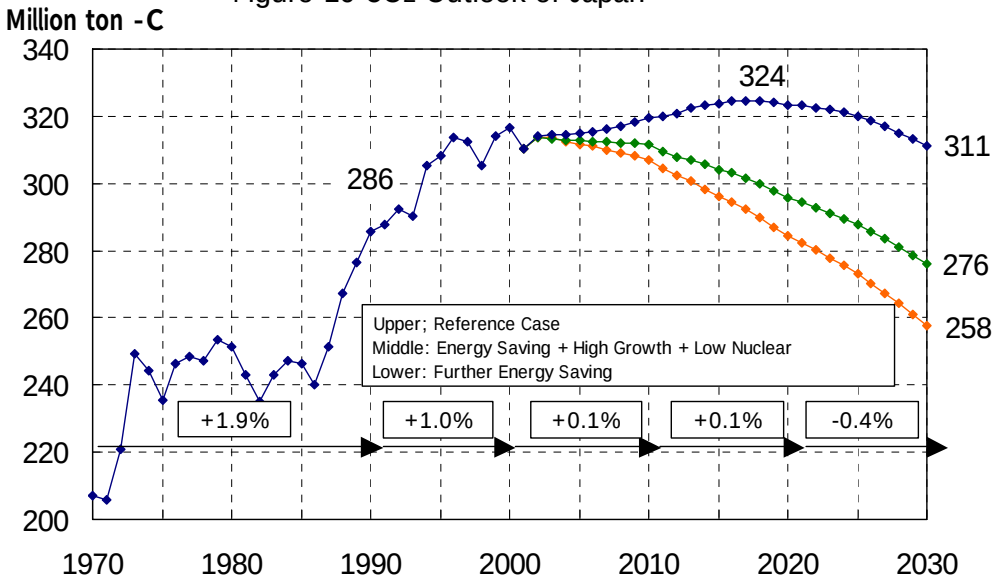
Source: METI

In addition, with full use of the existing energy conservation technologies, the reference case energy consumption for 2030 (425 million tons) could decrease down to 392 million tons oil equivalent. The forecast also projects that energy saving technologies would advance in the coming decades curbing the energy consumption further down to 377 million tons oil equivalent. It should be noted that this forecast was made with an assumption on the crude oil prices to be $21/Bbl for 2010, $25/Bbl for 2020 and $29/Bbl for 2030 in year 2000 equivalent US dollar. The current higher oil price, almost double of the assumption, may further enhance energy conservation and development of related technologies. Though not quantitatively assessable immediately, we should not underrate the possibility that doubling energy price would open up new windows for totally innovative technologies, social concepts and work/life style that were not conceivable at the lower prices prevailing in the past decades. They could only come up with time lags, as R&D or changes in social paradigm take time from seeding to full bloom.

2-2 CO_2 Outlook of Japan

In the same forecast, METI also says that it is possible to control GHG emission with energy conservation and promotion of nuclear and renewable energies. Compared with the reference case, full use of the existing energy conservation technologies could curb the CO_2 emissions for 2030 by 11% and advance of technology another 6% as shown in Figure-10.

Figure-10 CO_2 Outlook of Japan



Source: METI

Note: Figures in the boxes show average annual growth rates for the reference case.

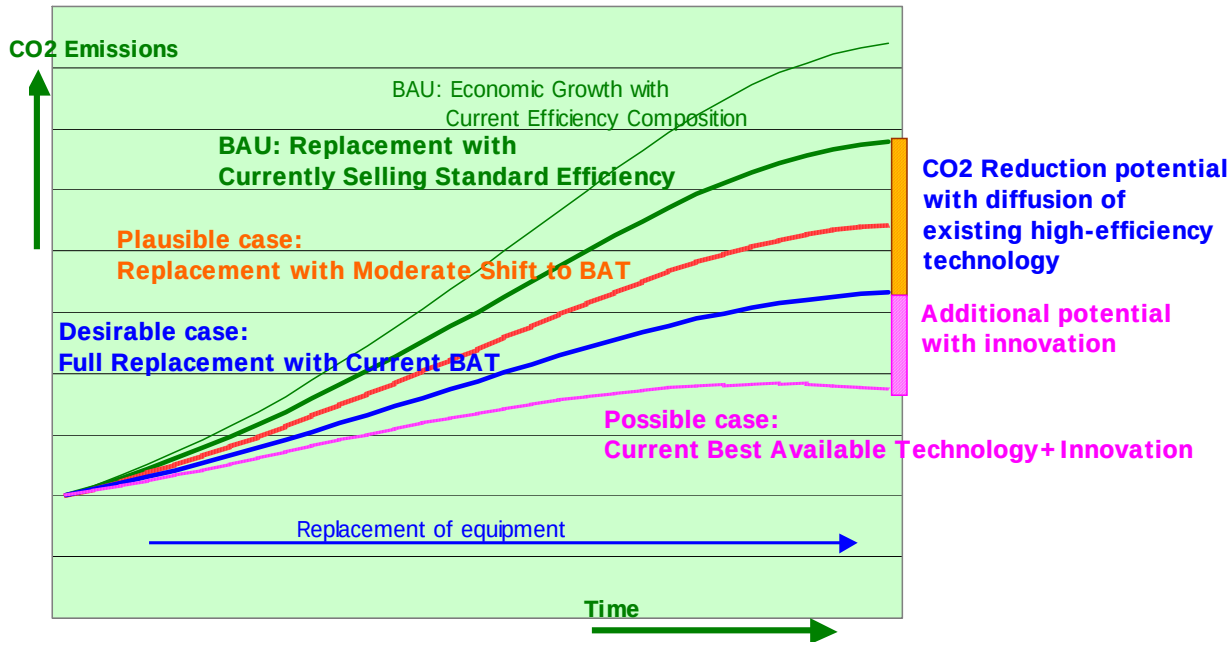
As shown in the chart, Japan may be able to control the CO_2 emissions below the mandate under the Kyoto Protocol in the long run, though it is not easy to realize this independently in the near term.

2-3 Energy Conservation Potential

Theoretically speaking, energy conservation potential by introducing the best available technologies (BAT) may be illustrated as shown in Figure-11.

Compared with the upper-most fine line that represents the energy consumption with the current efficiency composition, the BAU case may be shown with the bolder green line where replacement of equipments occurs with currently selling standard efficiency. The plausible case may be the red line where shift to BAT occurs moderately, and the desirable case is full replacement with current best available technologies. In the possible case, innovative technologies will reduce energy consumption further. As illustrated here, potential of energy conservation is huge in the long run as they proceed with time lag but cumulatively. Here, we should be careful that economics of replacement investment would be controlled not simply by energy saving effect but more dominantly by the overall economics where depletion and obsolescence plays greater role. In promoting energy conservation, technology development, economic policy and social willingness are also the important factors.

Figure-11 Concept of Energy Conservation Potential with BAT



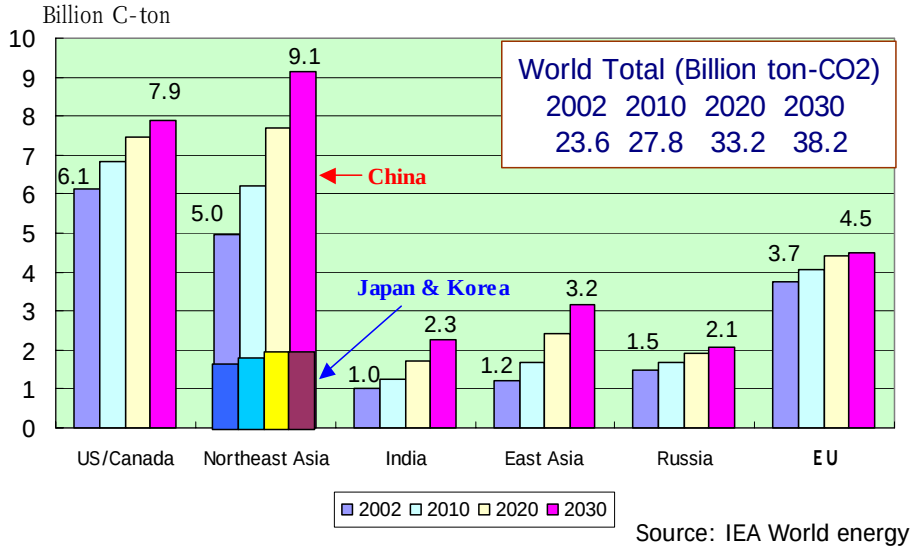
Note: The above chart is the one modified from the concept developed by Kanako Tanaka, Global Environment Unit of IEEJ, in "CO_2 Reduction Potential with BAT (in Japanese)" (IEEJ Home Page, October 2005)

2-4 Potential of CO_2 Reduction by BAT

According to IEA World Energy Outlook 2004, the global CO_2 emission will increase by 10 billion tons by 2020, which would cast a great burden for the sustained growth of the world. Among others, increase of CO_2 emission by emerging Asian countries is large, while it is generally understood that energy efficiency in these countries are far behind the developed countries.[2] Therefore, it is essential to introduce efficient energy use technologies and social system in these countries in order to solve GHG problems sustaining stable development of them at the same time.

[2] It should also be noted here that the 2004 projection of IEA is based on the actual data up to 2002 and therefore substantially undershoots the recent trend brought by the abrupt increase of energy consumption occurred in following years. See: K. Kanekiyo "Energy Outlook of China and Northeast Asia and Japanese Perception toward Regional Energy Cooperation" (October 2005, IEEJ Homepage, http://www.eneken.ieej.or.jp)

Figure-12 CO_2 Emission by Region (IEA 2004)



Source: IEA World energy Outlook 2004

IEEJ's research group as sited above recently calculated the possible CO_2 deduction of the world as shown in the Figure-13. This study suggests that, applying the currently available energy saving technologies, the world could reduce CO_2 emission by 3.83 billion tons in 2020 in the plausible case. Although this calculation includes many preliminary assumptions, they are mostly put on the conservative side. Nevertheless, the potential reduction amounts to more than 10% of the CO_2 emission in year 2020, which will be much greater for developing countries. Also, as explained in the previous section, this potential now may be much greater with much higher energy prices emerging recently. And, this could be cumulatively larger for year 2030.

Figure-13 Potential CO2 Reduction in 2020 (Plausible Case)

Unit: billion t-CO_2/year

Industry	Iron & Steel	.12
	Cement	.67
	Paper/Pulp	.14
EP	Coal	1.42
	Oil	.02
	Gas	.23
Transport	Personal Car	.54
Household	Refrigerator	.24
	Air-con	.15
	Lighting	.23
	Insulation	.07
Total		3.83

3 Energy Conservation Policy of Japan

3-1 Energy Conservation Law of Japan

Facing the oil crisis of 1973, Japan considered that most important energy strategies are shifting from oil to other energy sources on the supply side and promotion of energy conservation or rational use on the consumption side. At first, Japan sought for direct measures and launched two projects; the Sunshine Project and the Moonlight Project as mentioned earlier. The Energy Conservation Law was legislated much later in 1979. The chronicle of the Law as shown below summarizes evolution of the Japanese government led energy policies relating to energy conservation.

1974 *Sunshine Project*

Launching R&D and projects to develop new and renewable energies.

1978 *Moonlight Project*

Launching R&D and projects to develop energy conservation, recovery and efficient use.

1979 *Energy Conservation Law* ("Law concerning the Rational Use of Energy")

The first Japanese law distinctly aiming at promotion of energy conservation and rational energy use, setting forth guidelines for energy conservation at large scale factories and provision of supporting measures.

1993 *Amendment of Energy Conservation Law*

Setting policy guideline and obligations for designated large factories to nominate energy manager and report energy consumption record.

Law for Energy conservation and Recycling Support

Promotion and support for energy conservation and resource recycling.

1999 *Amendment of Energy Conservation Law*

Amendment to incorporate the outcome of the COP-3 meeting and the Kyoto Protocol. Major new contents are

a. Top Runner Program
b. Large size factories to report medium/long term energy conservation plan
c. Medium size factories to nominate energy management officer and report energy consumption record

2003 *Amendment of Energy Conservation Law*

Incorporating energy management at large office buildings and energy conservation at medium size non-residential buildings

2005 *Amendment and Integration of Energy Conservation Law*

Integrating regulations on factories, incorporating energy conservation in transport and building construction sectors and legislating the Top Runner Program and consumer information system.

Since the Energy Conservation Law was enacted in 1979, it has been amended several times as shown above. In the early stage, it concentrated on controlling the energy consumption of large industries showing guidelines and obligating report of energy consuming record. The information collected under the Law was effectively used as the basis of direct government surveillance. Major amendment was made in 1999 to incorporate the outcome of the Kyoto Protocol agreed at COP-3, widening the coverage and introducing various measures especially to reduce GHG emission. The Law was again amended in 2005 to more thorough contents.

Figure-14 shows the latest structure of the Energy Conservation Law amended in 2005. Major components of the latest law are legislation on factories, transportation businesses and buildings that are large or medium size energy consumers, and manufactured products. In the industry sector, it covers about 13,000 factories all over Japan in 2005.[3] METI shall set forth guidelines for them in improving energy efficiency on the following items; a) rationalization of fuel burning, b)

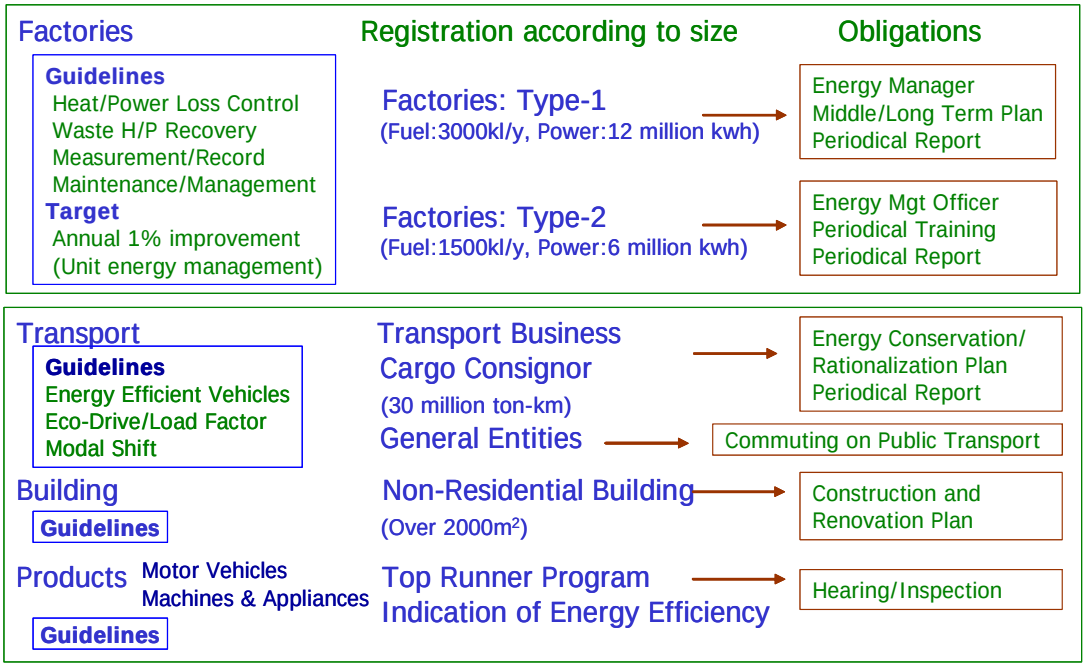
[3] As at March 2005, Type-1 companies for heat management were 2,952 and electricity management 4,722, and Type-2 companies were 2,185 and 5,170, respectively. As the simple sum of them amounts to 15,029, many of large factories come under both categories.

rationalization of heating, cooling and heat conduction, c) recovery and re-use of waste heat, d) rationalization of converting heat to power, e) prevention of energy loss via radiation, conduction, resistance and etc., and f) rationalization of converting electricity to power and heat. Type-1 factories (consuming over 3000kl fuel or 12 million kwh electricity per year) are requested to nominate qualified Energy Manager, to submit middle-term plan for improving energy efficiency regarding the foregoing items and to report energy consumption, efficiency and CO_2 emission record. Type-2 factories (consuming over 1500kl fuel or 6 million kwh electricity per year) are requested to nominate qualified Energy Management Officer and report energy consumption, efficiency and CO_2 emission record.

In the transportation sector, thresholds are for railway companies having more than 300 cars, truck and bus companies 200, taxi companies 350, shipping companies total 20,000 gross tons and airlines total 9,000 tons of taking-off weight. Consigners moving cargo more than 30 million ton-km per year (which roughly corresponds to fuel consumption of 2300 kl per year) shall be requested to report energy consumption and efficiency (as of April 2006). Also, business entities are requested to recommend employees to commute on public transport. In the building sector, buildings with an area of 2000 square meters or more are covered under the law.

With this going-down-to-street coverage, the system aims at very fine energy management across the country. The intention is to ask as much people as possible to keep record and be conscious of energy conservation.[4]

Figure-14 Energy Conservation Law of Japan (Amended in 2005)



[4] For more detail information on the Energy Conservation Law and related actions, please visit the homepages of The Energy Conservation Center, Japan (http://www.eccj.or.jp) and METI (http://www.meti.go.jp).

3-2 Energy Conservation Measures

Energy conservation is promoted in Japan through multiple policy approach by the government and voluntary actions of the private sector. A typical example of the latter is the action plan initiated by Nippon Keidanren (Japan Business Federation), which will be referred to in the next section. Principle measures being developed backed by the law and government support/guidance are as follows.

a) Industrial Sector: Manufacturing Factories/ Business Establishments

Energy conservation is promoted, monitored and enforced through the following procedure.

Compilation of energy conservation plan
Supervision by Energy Manager or Energy Management Officer
Periodical report of the record on energy facility, consumption and efficiency
On-site investigation
Inspection
Rationalization plan guidance
Public disclosure/ Compliance order

b) Commercial/Residential Sector

Top Runner Program

This program was introduced in 1998 to set forth target standard of energy efficiency or conservation for a designated year. Currently it covers 18 items including motor vehicles and home/office appliances. METI plans to add four more items this year. Under the program, manufacturers are requested to improve energy efficiency of their products to the top level of the one available in the base year within a specified period. For example, the target for gasoline driven passenger cars (as a weighted average of a manufacturer) is to improve fuel efficiency by 23% by 2010.

The Top Runner Program is designed to promote voluntary competition and is run in package with labeling and commendation system. Compared with bottom cutting approach, this program will provide greater incentive for technology innovation.

Energy-saving Labeling system

On the 13 items colored in Figure-15 should carry Energy-Saving Label to inform consumers of the efficiency and the improved ratio. Labels should be colored green if the efficiency is achieved and, if not, red to give caution to consumers.

Energy efficient product Retailer Assessment system

Retailers of home appliances are encouraged to promote sales of more energy efficient goods. Top ranking retailers are commended every year and authorized to carry a special logo.

Other Measures

Subsidy for high efficiency water heaters
Request of voluntary reduction in Standby Power consumption of electric appliances

Figure-15 Top Runner Standards

		Base Year	Target Year	Conservation Target
1	Passenger Vehicles (Gasoline and LPG)	1995	2010	Gasoline 23% LPG 11.4%
2	Passenger Vehicles (Diesel)	1995	2005	15%
3	Freight Vehicles (Gasoline)	1995	2010	13%
4	Freight Vehicles (Diesel)	1995	2005	7%
5	Air conditioners (Cooling & Heating)	1997	2004-2007	63%
6	Air conditioners (Cooling only)	1997	2007	14%
7	TV sets	1997	2003	16%
8	Video Cassette Recorders	1997	2003	59%
9	Fluorescent Lights	1997	2005	17%
10	Copying machines	1997	2006	30%
11	Computers	1997	2005	83%
12	Magnetic Disc Units	1997	2005	78%
13	Electric Refrigerators/ Freezers	1998	2004	30%
14	Space Heaters	2000	2006	Gas 1% Oil 4%
15	Gas Cooking Appliances	2000	2006	14%
16	Gas Water Heaters	2000	2006	4%
17	Oil Water Heaters	2000	2006	4%
18	Electric Toilet Seats	2000	2006	10%
19	Vending Machines	2000	2005	30%
20	Transformers	1999	2006-2007	30%

Source: METI

c) Building/houses

Superior energy conservation of residence/building

Under the Energy Conservation Law, owner of the specified buildings with area of over 2000 m^2 are required to notify energy conservation measures to the government.

For new construction, conformity ratio to energy-saving standard is set at 50%+ for residence from 2008 and 80%+ for building from 2006.

Home-building energy management system with IT

Promotion of ESCO (Energy Service Company) business

At many not-energy intensive business entities, energy consumption is given relatively smaller priority compared with main business objectives. They merely cannot afford to nominate experts on energy management although they have substantial potential of energy conservation. ESCO business is designed to offer them comprehensive energy conservation services with expert technologies and skills. The business is run in two forms; “Guaranteed savings agreement” where clients cover the cost and gain the fruit and “Share savings agreement” where ESCO covers the cost and ESCO and clients share the fruit.

d) Transportation Sector

Idling stop of cars

"The idling stop 2002 caravan" verified 5.8% fuel saving as an average of the nationwide survey. The effect was much greater, 13.4%, in city areas where frequency of halt is greater while driving. Partial subsidy was introduced in 2003 for cars equipped with idling-stop system.

Traffic management by intelligent transport system such as ETC and VICS

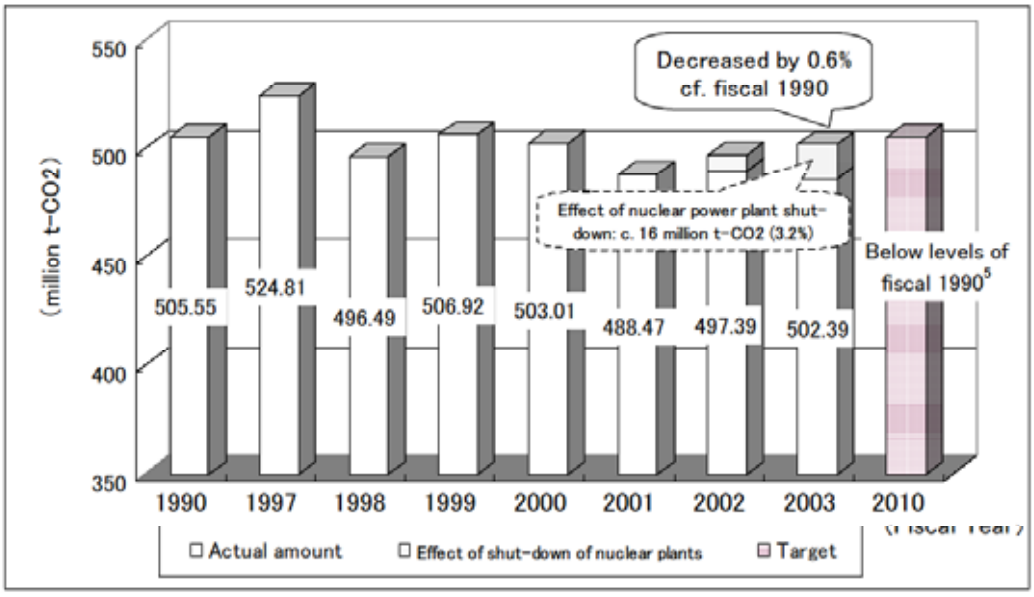
ETC stands for Electric Toll Collection system on toll road and VICS stands for Vehicle Information and Communication system that advises drivers of road information such as congestion via radio network. Both of them are a part of Intelligent Transport System intended to smooth road traffic.

3-3 The Keidanren Voluntary Action Plan

Among various efforts, voluntary action plan of Nippon Keidanren, or Japan Business Association, should be given specific attention.

Keidanren announced "Appeal on Environment" in July 1996 with an anticipation that environment issues would become serious constraints to sustained development. Following this, Keidanren compiled and announced "Voluntary Action Plan" on the Environment in July 1997, to which 137 industry associations and unions from 36 sectors participated including non-members of Keidanren. This plan was announced well before the agreement on the Kyoto Protocol in December 1997. Under the plan, a goal was set to reduce the aggregate CO_2 emission of the participants in 2010 below the level of 1990.

Figure-16 Keidanren Voluntary Action Plan



Source: Nippon Keidanren (http://www.keidanren.or.jp)

The Keidanren annual report explains how each sector strived in reducing GHG. According to the 2004 survey, out of 34 sectors, 19 reported reduction of CO_2 emission below the level of 1990 and 8 reported below the 2002 level. Reviewing the favorable progress, Keidanren is now confident in achieving the goal.

Another prominent work of Keidanren is compilation of "600 hints on reducing GHG" which is disseminated all over Japan. The paper provides a lot of valuable knowledge and hints on rational energy use.

Regarding the GHG reduction policy, Keidanren views as follows. Annex-I countries of the Kyoto Protocol cover only 30% of the world GHG emission. To realize the ultimate purpose of the Kyoto Protocol, participation of the major emission countries such as the United States, China and India is essential. Then, considering different energy backgrounds of these countries, it will be more appropriate to consider incentive approach rather than punitive approach. The latter may only lead to non-productive dispute on setting equitable ceilings while the former would provide greater incentive for innovation. *Pledge and review* system based on voluntary declaration will create more positive action and be suitable for the post-Kyoto arrangement. Another important policy is to promote *sectoral approach* to organize energy conservation activities across industrial and international borders. Sectoral approach sets forth target unit efficiency for individual industry, under which it is easier for business entities to identify feasible path, technically and financially, and draft practical schedule toward the target.

4. Energy Conservation toward Sustainable Development

Today, energy issues are threatening sustainable development of the world. Energy conservation is one of the most important answers to this challenge, since it is as valuable as discovering a number of giant oil fields. However, while talking about energy conservation is comfortable, practicing it is not easy. Keeping this in mind, policies and programs should be carefully formulated.

As reviewed in this paper, Japan has been relatively successful in curbing energy consumption in the industrial sector, where consciousness on cost and environment can prevail according to economic rules governing corporate management. However, it is not that straight out in the individual consumption sector, where the rising income effect generally overcomes the price effect. For example, therefore, Japanese energy conservation policy is designed mainly through improvement of manufactured products. Nevertheless, social education is deemed also important to keep people conscious of energy saving.

4-1 Classification of Energy Conservation Measures

In approaching energy conservation, we should keep in mind two principal points under which policies and implementing systems should be considered and aligned. They are, firstly, the roles of the government and private sectors, and, secondly, classification of stock and flow in assessing energy conservation measures.

Firstly, energy conservation brings us direct commercial profit plus substantial social benefit. To enhance commercially viable projects, we need to set up proper policy, institutions and social systems to guide economic entities toward energy conservation, that is, proper market designing under which economic entities naturally act for energy saving according to economic principles.

In addition, we need to consider that energy conservation brings us substantial social benefit such as improved energy security, stabilized price and cleaner environment. Despite proper market designing as above, various social benefits or external economy could not be assessed or incorporated by contemporary corporate accounting rules that control action of business entities. Many potential projects would fall in a sub-commercial range if we should count in the direct proceeds only. Hence, there is an important role of society or the government sector. It is quite reasonable that the government sector should provide due support through direct action or subsidy corresponding to the social benefit of the activities.

In the context, energy conservation program should be slated distinctly defining the roles of the government and private sectors. Market rules should be set forth in an equitable manner eliminating free riders nullifying voluntary efforts of others. In addition, government action should be designed under due balance of social benefit and social cost.

Secondly, as energy conservation is generally made by modifying stock of equipment as well as flow of daily work or daily life, nature of approaches on stock and flow are different.

Everybody looks into a matter carefully when he or she decides on energy conserving investment or purchase of durable goods. Then, once new equipment or apparatus is installed, its improved energy efficiency will be built-in in the manufacturing system or daily life. In such decision making, important factors are cost/benefit balance, availability of fund, repayment period and/or consumer preferences. These are the factors to be considered in formulating energy conservation policies and supporting system for the private sector. It is important, however, to note that such investment shall be controlled by the overall economics of investment, rather than energy efficiency only, where depletion or obsolescence of the existing facilities/equipments dominates in principle. Sometimes, incentives need to compensate more than the energy efficiency.

Energy conservation can also be implemented through improving daily practice as business style or life style. Even when efficient facility is installed, fine contrivance at operation site plays important role. Our experience indicates that keeping the machine at best efficiency is very important. If workers were indifferent, machines would be operated below the designed efficiency, while, if they were devoted, operation could be improved day to day to materialize better efficiency than expected. Then, some of energy conserving practices can be economically assessed and purposely kept in mind. But, since effect of additional efforts becomes marginal year-to-year, it would become increasingly difficult to prioritize such activities in daily life, although cumulative effect of them is tremendous. It is again the role of the society to remind people continuously that energy conservation is very important, through thorough corporate social responsibility and social education activities.

In this context, approaches on energy conservation should be designed in different manners against stock of equipment and flow of daily work.

4-2 Formulating Energy Conservation Policy toward Sustainable Development

Summing up the foregoing observation, in an early stage when rational energy use is not well recognized in a society, people may be uncertain about benefit of energy conservation or merely in short of capital. Then, directive/regulative approach on large-scale energy consuming industries may be effective, which should be backed by clear rules and fair enforcement. Financial support should also be considered to encourage investment in rationalization and integration. The latter will be effective especially when economics of scale is expected. For the purpose to keep people conscious of energy conservation, compulsory planning/reporting system is also effective.

In this stage, primary technologies and know-how of developed countries are available free of charge or at cheap price. Technology transfer through ODAs should be fully utilized. It is important, however, to note that, as globalization develops worldwide, advanced class technology may be needed in new facility investment even in developing economies to survive in the globalizing market. Then, energy conservation technologies combined with such top-notch technology would not be available free of charge, as they constitute core competence of the technology holders. In such case, *cost for value approach* should be considered as appropriate.

In the advanced stage where wasteful energy use has been mostly squeezed, we should expand coverage all over the society. Then, on the supply side, guideline/incentive approach such as *Top Runner Program* rather than bottom cutting one will be effective, especially to explore for potential innovation of technology and/or reform of social system. On the demand side where mass consumers play dominant role, social determination and incessant publicity activities on energy conservation is very important, which should be supported by promotion of *Corporate Social Responsibility* on the business side and *Social Education* of individuals on the consumers side. We should seed and grow social culture to seek for rational use of energy.

In conclusion, *energy conservation, which creates substantial negative demand of energy, is essential for the sustainable development of our society*. However, energy conservation does not have a single immediate cure. To date, therefore, various countries have applied multiple policy approach, while roles and effectiveness of individual policy are not well sorted out. Policies and systems should be appraised and aligned identifying their effects and costs more clearly applying the basic principles as hinted above. And, in formulating them, a very simple principle to be applied from economic point of view may be that *we should create a society where energy conservation generates money*.

All in all, cumulative effect of energy conservation is huge; that is, we have a number of giant oil fields hidden in our daily life. Let us explore for them hands in hands for the sustainable development of our society.

End

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