Japan Long-Term Energy Outlook

A Projection up to 2030 under Environmental Constraints and Changing Energy Markets

Kokichi Ito* Yuji Morita** Akira Yanagisawa*** Shigeru Suehiro***
Ryoichi Komiyama**** Zhongyuan Shen***

Introduction

The persistent trend of high oil prices since 2004 continues even today; despite brief rises and falls, the price remains historically high. Geopolitical risks in the Middle East have been increasing and new energy security risks are becoming manifest, such as an ever-increasing oil demand in China, India and other energy consuming countries along with economic growth, limited oil supply from non-OPEC countries, and unpredictable ability of Middle Eastern oil-producing countries to expand their supply. Concerning the problem of global warming, the Kyoto Protocol's First Commitment Period is fast approaching and therefore maximum efforts toward achieving the goals are required. The preparation of a "post-Kyoto" framework for the Second Commitment Period is another important challenge.

Looking at domestic trends of the economy, and of energy supply and demand, the Japanese economy is finally emerging from more than ten years of stagnation, and with the gradual solution of the "three excesses" (labor power, facilities and debt) in the business sector, conditions are ready for long-term stable growth. As changes in the social structure (characterized by population decrease, fewer children and an aging society) stimulate the pursuit of amenity and convenience, which is the norm in a mature society, and modify people's lifestyles and mindsets, energy needs are likely to change both quantitatively and qualitatively. On the other hand, while energy markets are being deregulated, we must deal with such issues as environmental protection and energy security that cannot be solved with "market principles" alone.

In view of Japan's future energy and environmental policies as well as corporate strategies, it is important to produce a long-term forecast of Japan's energy supply and demand based on the above views, in consideration of domestic and international changes in economic/societal trends and future uncertainties about technology development. In this study we gathered basic materials for such a forecast, and produced several scenarios for the period up to 2030, employing a quantitative approach and applying findings from experts inside and outside the Institute.

* Managing Director
** Director, The Energy Data and Modelling Center
*** Senior Economist, The Energy Data and Modelling Center
**** Economist, The Energy Data and Modelling Center

1. DETERMINATION OF CASES AND ASSUMPTIONS IN ANALYSIS

The energy supply and demand structure changes greatly with various factors such as economic and societal trends, international affairs and technology developments. Within a long time frame, such as the period up to 2030, significant changes are likely to arise. Therefore, it is important to analyze multiple scenarios assuming different sets of conditions. In analysis, we first assume the most probable "reference case", and then, by noting the trend of energy technology, we develop a case assuming a higher level of technology development. A number of factors are expected to greatly affect energy supply and demand but are difficult to forecast precisely. Among them, we chose economic growth rate and international energy price; we quantitatively evaluated their influence over the energy supply and demand structure by means of sensitivity analyses.[1]

1.1 Reference Case

The reference case represents the most probable state of energy supply and demand in the future using various assumptions based on currently dominant trends in such areas as economics and society, international affairs, and backed by current technology developments and taken energy policies. This report mainly focuses on prediction results from this reference case, which also serve as the basis of comparison when evaluating the case assuming progressive technology development and the results from sensitivity analyses are evaluated.

1.2 Technology development Case

It is very difficult to precisely predict the degree of technology development in future (including schedule of development, degree of technical progress, timing of commercialization, and schedule of market release). Therefore, the technology development case assumes that various energy technologies currently under development or in the initial stage of implementation will be introduced into the market more extensively than assumed in the reference case. We use this case to assess the impact of such extensive use of technologies.

1.3 Sensitivity Analyses

While a number of different factors influence energy supply and demand, we refer to two factors, namely, economic growth rate and international energy price, due to the importance of their impact on the supply and demand structure and the significance of their future uncertainty. We analyze how changes in these two factors affect energy supply and demand.

1.3.1 High economic growth case

The direction of macro economy may change substantially in a long term depending on

1 In a sensitivity analysis, a reference prediction result is compared with a prediction result produced by changing the value of a single exogenous variable. This enables quantitative assessment of how much a change in that variable affects the prediction result.

policies and international economic trends. The high economic growth case assumes that the global economy will develop more favorably and Japan's economy will grow faster than assumed in the reference case, thanks to the positive feedback cycle represented by export growth → production growth → investment growth → income growth → consumption growth → production growth.

1.3.2 High energy price case

It is very difficult to precisely predict changes of international energy prices such as for oil because they are heavily influenced by international political and economic affairs. The high energy price case assumes that the supply and demand balance of crude oil will become tighter than assumed in the reference case due to insufficient investment in oil development.

2. MAJOR ASSUMPTIONS FOR THE REFERENCE CASE

Before starting to forecast future energy supply and demand, we must make certain assumptions on the future of Japan's economic and social structure and international energy markets, as well as the trends of energy-saving initiatives and new energy technologies. The following subsections describe the concept of the major assumptions we made for the reference case.

2.1 Prospects for the Economic and Social Structure

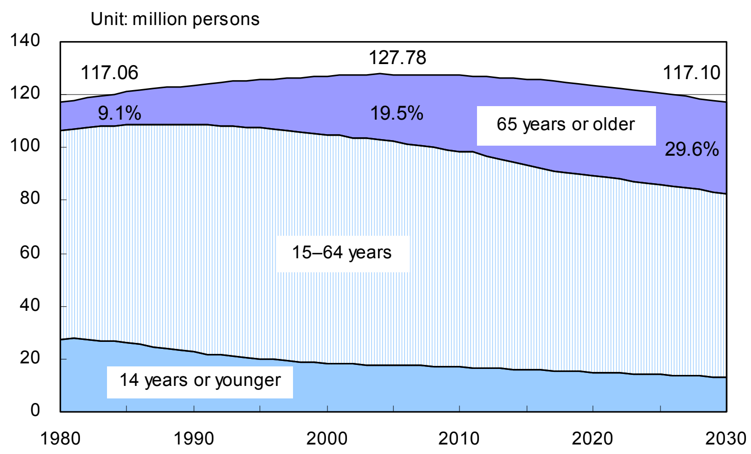
2.1.1 Economic growth in a population-decreasing society

Japan's population, an important factor in predicting future economic and social structure, peaked in 2004 and is starting to decline already. At the same time, the aging of society is progressing at a speed unparalleled elsewhere in the world. It may appear that a decrease in population would result in decreased demand for goods and services if expenditure per capita remains the same, and also result in a decreased supply of goods and services if labor productivity remains the same. However, if labor productivity increases due to such causes as technology development, thus leading to growth of income per capita, the expenditure per capita may also increase. In analysis, we assume, for the period up to 2030, that the Japanese economy will show moderate growth with a mean real GDP growth of around 1.5% per annum, in spite of a decreasing population and aging society. Assumptions on the future economic and industrial structure are explained in more detail below.

2.1.2 Changes in the production and consumption structure

In a materially mature consumer society, people's attention turns toward services. Particularly in an aged society, the demand for services expands in such areas as health, medical care and welfare as well as education including lifelong learning. With fewer children in each family, there will be higher demand for housekeeping and childcare support services. Increased free time and varied lifestyles will produce demand for various other services. Concerning goods, the decreasing population and aging society may restrict the demand for daily necessities such as food and clothing. Moreover, as the holding of durable goods such as automobiles and household electric appliances appears to have reached the saturation level, further demand growth is unlikely. Nevertheless, even for such goods, we expect growing demand for more functional and value-added products, sold under pertinent catchphrases such as health, safety, healing, convenience, efficiency and environmental friendliness. Therefore, we assume that the *amount of purchase* of goods has a good chance of increasing even though the *quantity of purchase* may decrease.

Fig. 1 Prospects for the population structure by age group



Source: Derived based on mid-level estimates from the "Prediction of Japan's Future Population" produced in January 2002 by National Institute of Population and Social Security Research.

However, the decreasing population will impose limits on the expansion of the domestic market. Therefore, Japan will take advantage of its technological superiority to sustain economic growth, relying on overseas markets. Even though the economic growth of China and other Asian countries is expected to weaken Japan's relative competitiveness, the more functional and value-added Japanese products (mechanical products, in particular) will remain competitive, resulting in increased export. Japan will also have the upper hand with its high-efficiency energy-saving products and installations.

Domestically, on the other hand, investment will be made for saving labor (addressing reduced labor population), technological enhancement (addressing the need for maintaining competitiveness) and energy efficiency (addressing energy and environment issues). Demand for highly functional industrial machinery will remain firm. Investment in these fields will increase labor productivity, making it possible to maintain sufficient production capacity in spite of decreased labor population.

In the meantime, the supply of social capital infrastructures such as roads is reaching the saturation level. With the decreasing population, the construction of condominiums and offices will reach a ceiling. Therefore, the production of raw material products such as steel and cement will tend to decrease. With China producing more such raw material products, Japan's export of these products is expected to decrease, while imports are expected to increase. Nevertheless, a shift to more functional products is expected to take place in raw material industries as well. Market segregation may occur in such a way that, for example, the steel for construction and other general purposes will be supplied by China, while high-grade steel for automobile production (the demand for such steel is expected to grow) will be supplied by Japan. In the manufacturing industry, production is expected to continue growing with an accelerated structural shift from heavy/large to light/small industries.

Within Japan's industrial structure, the service sector will eventually attain a dominant position. The share of the manufacturing industry will decrease, but its production value will not decline. A structural shift from the raw material industry to the more value-added machinery industry, and a shift within the raw material sector toward higher-grade materials, will result in increased production value.

Table 1 Prospects for domestic production values by sector (%)

	1990	2004	2010	2020	2030
Primary products	2.2	1.4	1.3	1.0	0.9
Manufacturing – raw materials	12.1	10.2	9.7	9.0	8.6
Manufacturing – processing/assembling	13.4	14.7	16.3	17.9	19.4
Manufacturing – others	10.3	8.1	7.6	6.8	6.1
Construction and civil engineering	10.9	6.7	5.2	3.9	3.6
Public services	12.7	16.2	16.7	16.8	16.4
Other services	38.4	42.8	43.3	44.5	45.1

2.2 Prospects for Major Economic Indicators

Thus, even with the decreasing population and aging society, economic growth can be maintained through an increase in labor productivity and in income and expenditure per capita. The real GDP growth per annum is expected to be around 2% for the period up to 2010; however, in subsequent years, the growth rate will gradually slow down in accordance with population decrease and other factors: the mean growth rate is expected to be 1.5% in the 2010s and 1.1% in the 2020s. Nevertheless, the GDP per capita is expected to continue steady growth at a rate of approximately 2%. Private consumption is expected to continue increasing, although at a slower rate, through expanding service-related expenditure and growing demand for highly functional goods. Regarding private investment, investment for larger production capacity will decrease due to inhibited domestic market growth, but investment for labor saving and for technological enhancement will act as the engine for continuous general investment. As for public demand, even though the level of public investment will continue to be restrained, governmental expenditure such as for social security is expected to expand. Overseas demand, both for import and export, will grow steadily. When looking at the economic growth rate from the supply side, we may expect that, in spite of a decrease in labor input, the accumulation of social capital (facilities) through saving labor investment and the improvement of total factors in productivity (TFP) will sustain economic growth.

As for commodity prices, consumer prices will gradually start to increase, thanks to such factors as improvement of the supply-demand gap by continuous economic growth and the rise of wages; the mean rate of increase during the period up to 2010 will exceed 1%. During the subsequent years up to 2030, inflation will remain stable with the mean rate of consumer price increase at slightly less than 2%. As a result, the GDP deflator will also show stable growth with the nominal GDP growing at around 2.5% to the range of 3%. The primary balance, the target for which is to achieve a positive balance in the early 2010s, will turn positive in 2011, through reduced expenditure and increased tax revenue.

Table 2 Prospects for major macro economy indicators

	Actual			Forecast			Mean annual growth rate (%)				
	1980	1990	2004	2010	2020	2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Nominal GDP (Unit: trillion yen)	244.1	446.5	496.2	590.8	836.3	1,110.3	6.2	0.8	3.0	3.5	2.9
Substantial GDP (Unit: trillion yen, value as in 2000)	303.8	448.7	526.4	593.1	687.4	769.6	4.0	1.1	2.0	1.5	1.1
Private consumption	168.9	243.6	297.9	327.1	376.9	419.8	3.7	1.4	1.6	1.4	1.1
Government consumption	44.9	63.4	93.8	101.9	114.9	124.3	3.5	2.8	1.4	1.2	0.8
Residential investment	18.5	26.1	18.7	19.9	20.5	20.6	3.5	-2.4	1.0	0.3	0.0
Private investment	38.1	82.5	78.1	104.7	135.2	163.9	8.0	-0.4	5.0	2.6	1.9
Public investment	27.2	28.7	24.6	20.8	18.3	17.0	0.5	-1.1	-2.7	-1.3	-0.7
Export	23.3	36.5	69.6	93.1	119.7	150.4	4.6	4.7	5.0	2.5	2.3
Import	17.8	33.8	55.8	73.3	97.0	125.2	6.6	3.7	4.7	2.8	2.6
GDP per capita (Unit: million yen)	2.60	3.63	4.12	4.66	5.56	6.57	3.4	0.9	2.1	1.8	1.7
Labor input contribution (%)							0.7	-0.5	-0.5	-0.6	-0.5
Capital input contribution (%)							1.8	0.5	0.9	0.8	0.6
TFP contribution (%)							1.5	1.2	1.6	1.2	1.0
Consumer price index (Year 2000 = 100)	76.4	92.9	98.0	105.1	128.6	154.3	2.0	0.4	1.2	2.0	1.8
Indices of industrial production (Year 2000 = 100)	67.5	101.2	100.6	112.3	126.0	138.4	4.1	0.0	1.9	1.2	0.9
Total population (Unit: million)	117.06	123.61	127.78	127.29	123.67	117.10	0.5	0.2	-0.1	-0.3	-0.5
Proportion of population 65 years old and older (%)	9.1	12.0	19.5	22.5	27.9	29.6					
Number of households (Unit: million)	35.83	41.16	49.84	51.41	51.70	50.45	1.4	1.4	0.5	0.1	-0.2

Japan's total population and the population structure by age bracket that we assumed in prediction on future economic and social structure were derived based on mid-level estimates from the "Prediction of Japan's Future Population" produced in January 2002 by National Institute of Population and Social Security Research. Along with the progress of population decrease and aging society, labor population will also decrease. Even though the number of households will fall, the decrease in the number of persons in each family will be faster; thus, the number of households may peak around 2017. With the increased number of unmarried and childless households, and of aged single households, the number of persons in each family will show a decreasing trend.

The global economy will continue to grow at an annual rate of about 3% because the United States and other major developed countries are expected to maintain stable economic growth while economies in Asian countries and BRICs (Brazil, Russia, India and China) are expected to move from the present stage of rapid growth into a stage of sustainable growth.

Japanese Yen to US Dollar currency exchange rate was assumed to level off at 110 yen to the dollar, which is close to the mean exchange rate in FY2003 through 2005. The price of oil, which has been continuously high in recent years, is assumed to drop temporarily from the present $60/barrel level due to such factors as increased production in non-OPEC countries. However, it is assumed that the supply will again be tight in the international oil market after 2010, followed by a moderate rise in price, reaching $45 (nominal price of $75) per barrel in 2030.

Regarding financial policies, we placed emphasis on improvement of the primary balance for the period up to the early 2010s, and successively focused on financial reconstruction and reduction of expenditures. As for monetary policies, following the discontinuation of the quantitative easy-money policy in March 2006, we assumed that the interest rate will gradually rise as Japan emerges from deflation.

2.3 Prospects for Major Activity Indexes

The following subsections describe the future trend of activity indexes, which are important when predicting future energy demand.

2.3.1 Production of raw material products

The energy demand from the industrial sector is closely related to production activities. Since energy consumption structures differ among industries, we have to predict production trends for different types of industries. Above all, the trend of energy-intensive raw material production activities (production of crude steels, cement, ethylene and paper/paperboard) is particularly important.

The volume of raw material production is expected to show a general decreasing trend as civil engineering and construction demands will reach a ceiling due to saturation of social capital infrastructures, residential housing and office buildings, resulting from the reduced population.

The production of cement, suffering continuous decrease, will show an even sharper drop due to such causes as restrained public investment. Private-sector demand for the construction of condominiums and office buildings, which contributes to the upkeep of production, is also expected to gradually decrease.

The production of crude steel will suffer from a drop in demand, particularly of steel construction materials. Moreover, as China expands its crude steel production capacity, the demand from overseas, which currently contributes to more than 30% of the total shipment, is also expected to decrease. It is even expected that general-purpose steel materials may be imported from China to Japan. Nevertheless, thanks to the expected increase in the demand for high-grade steel materials (e.g. steel sheets for automobile production), a crude steel production volume in the range of 90–100 million tons will be sustained in 2030.

The production of petrochemical products is expected to suffer a decrease in overseas demand, which currently contributes to about 30% of the total shipment, as new ethylene plants are operated newly in China and the Middle East. The domestic demand is anticipated to decrease slightly due to the increase in recycled products and in the import of half-processed products. The production of ethylene, which is a major raw material for petrochemical products, will decline to less than 6 million tons in 2030.

Among the four raw material products, paper/paperboard is the only product that is likely to achieve production growth. Paper production is highly correlated with economic growth, which will stimulate the demand for paper in the commercial sector for uses such as advertisement materials, catalogues and magazines. However, the demand growth will be restrained by the population decrease and the paperless trend promoted by the introduction of IT devices. Paperboard, on the other hand, is mostly used for producing packages (carton boxes) and its demand is highly correlated with freight transport, particularly by truck. Since transport by truck is expected to increase slowly, as will be explained later, the demand for paperboard is expected to show a similar upward trend.

Table 3 Prospects for major activity indexes

	Actual			Forecast			Mean annual growth (%)				
	1980	1990	2004	2010	2020	2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Crude steel production (Unit: million tons)	107.39	111.71	112.90	107.85	97.67	90.34	0.4	0.1	-0.8	-1.0	-0.8
Ethylene production (Unit: million tons)	3.87	5.97	7.56	6.94	6.27	5.71	4.4	1.7	-1.4	-1.0	-0.9
Cement production (Unit: million tons)	85.88	86.85	71.68	69.39	65.77	61.25	0.1	-1.4	-0.5	-0.5	-0.7
Paper/paperboard production (Unit: million tons)	17.53	28.54	30.87	32.61	34.99	36.39	5.0	0.6	0.9	0.7	0.4
Transport machinery production (Year 2000 level = 100)	83.5	109.8	118.7	126.1	134.8	141.2	2.8	0.6	1.0	0.7	0.5
Electric/electronic equipment production (Year 2000 level = 100)	4.1	62.4	104.3	136.7	177.0	218.5	31.4	3.7	4.6	2.6	2.1
General machinery production (Year 2000 level = 100)	73.5	118.4	103.6	127.9	143.3	158.4	4.9	-1.0	3.6	1.1	1.0
Commercial floor space (Unit: million m2)	936	1,285	1,742	1,830	1,932	1,964	3.2	2.2	0.8	0.5	0.2
Passenger transport demand (Unit: billion passenger-kilometers)	891.1	1,298.4	1,418.4	1,466.1	1,492.8	1,450.9	3.8	0.6	0.6	0.2	-0.3
Freight transport demand (Unit: billion ton-kilometers)	439.8	546.8	570.0	577.3	581.4	570.2	2.2	0.3	0.2	0.1	-0.2

2.3.2 Production of non-raw material products

The majority of non-raw material products are machinery products. Industries producing electric/electronic and transportation machinery manufacturing industry will enjoy an increase in demand for highly functional, value-added household electric appliances, automobiles, communication devices and other items. Since such products are internationally competitive, overseas demand will expand as well. As the production for such products grows, investment for saving labor (addressing the decreased labor population) and for technological enhancement (addressing the need for higher competitiveness) will rise, resulting in increased purchase of highly functional industrial machinery. Moreover, industrial machinery with state-of-the-art energy-efficient technologies is likely to be exported to China and other Asian countries that are lagging behind in environmental efforts.

2.3.3 Gross floor space for commercial sector

The gross floor space for commercial sector takes into account not only office and commercial buildings, but also schools and hospitals, with various business activities. While the indexes for such business activities include statistical indicators such as commercial sales volume and tertiary industry activity index, it is known from past statistical validation that energy demand in the commercial sector is highly correlated with the amount of floor space for business operations.

With the shift to a service-oriented economy, gross floor space for commercial sector has increased faster than GDP growth. Even though the amount of floor space is expected to keep expanding, the growth rate will slow down due to such factors as population decrease. Focusing on specific types of business operations, the growth of office building floor space, accounting for 26% of total floor space, will reach a ceiling because of decreasing labor population, etc. The floor space of retail shops, which currently constitutes 25% of gross floor space, is expected to continue growing, benefiting from an increase in large-scale suburban retail shops. The floor space of schools, representing 20% of gross floor space, will virtually level off due to fewer children, while the floor space of hospitals and welfare facilities (included in the category of miscellaneous service industry) is expected to increase due to the aging of society.

2.3.4 Transport demands

Activity indexes important for the prediction of energy demands from the transportation sector include passenger transport demand (passenger-kilometers) and freight transport demand (ton-kilometers). In the past, passenger transport demand has increased along with the increasing number of privately owned automobiles. For the present, however, the growth rate of the passenger transport amount has been less than that of the number of privately owned automobiles. This reflects the fact that most newly owned automobiles are used as families' second cars, with less travel distance or fewer passengers in each car. Furthermore, the stagnant economy and peaking population growth have contributed to the recent leveling off of passenger transport. For a while, passenger transport will show a slight increase due to economic recovery and increase in privately-owned automobiles; however, after reaching a peak around 2020, the growth will turn negative due to such factors as population decrease and stagnant number of privately-owned automobiles.

Freight transport demand, which is closely related to production activities, will remain level or decrease, because the expected increase of production activities will be offset by such factors as downsizing of manufacturing industries and the shift to a service-oriented economy. Due particularly to a drop in the production of raw materials such as crude steel and cement, marine transport (coastwise transport) will decrease. Truck transport, in the meantime, will surge until around 2020 along with the spread of value-added services (e.g., home delivery and refrigerated delivery).

2.4 Prospects for International Energy Prices

2.4.1 Crude oil price

In recent years, the price of crude oil has been shifting within a historically high range due to the following factors: swift increase in oil import by rapidly growing major Asian countries such as China and India; unstable political situation in the Middle East; revival of the state-controlled economy in Russia; and insufficiency of refinery capacity in the United States. These factors that result in tight and unbalanced oil supply and demand were combined with the influx of speculative money into the oil futures market, producing a record-breaking oil price. Even though it is difficult to imagine a major drop in demand within the short- to mid-term future, we assume that the present high price, uncorrelated with the actual demand, will gradually be corrected by the following factors: more favorable conditions for upstream development produced by a higher oil price; increased output from non-OPEC countries; and withdrawal of speculative money triggered by tight-money policies of developed countries. In the mid- to long-term, the price of oil is expected to rise gradually as developing nations, particularly in Asia, increase their demand for oil as they grow economically, while such factors as the following will contribute to gradual rise of crude oil prices: slower production speed in non-OPEC countries; shift in production basis from less costly huge oil fields to smaller fields; and stagnation or loss of efficiency in upstream development due to the emergence of energy resource nationalism particularly in OPEC countries.

While the quality regulation over petroleum products will become stricter, the diminishing conventional oil resources and increasing dependency on non-conventional resources such as oil shale and oil sand, which are characterized by higher production costs and lower quality, will raise the base oil price through the application of premium prices to higher-quality oil and the cost increase for processing lower-quality oil.

2.4.2 LNG and coal prices

When compared on the basis of heat value, LNG prices in the past have generally been equivalent to or slightly higher than oil prices. Presently, however, LNG is cheaper than oil due to the skyrocketing oil price. LNG prices, which are affected by the low steam coal price a little, will rise in the mid- to long-term led by the following factors: upward trend of oil price in the mid- to long-term; tight supply-demand balance due to increased global demand for LNG; depletion of existing huge gas fields in Russia, the world's largest gas producer; and increased production cost with the development of new gas fields in the Arctic. Also, the relative price against crude oil will eventually result in an equivalent heat value.

Coal prices in the past have fluctuated much less compared with the prices of oil and LNG. Even though the price of coal is currently rising due to temporary, short-term supply-demand imbalance resulting from growing demand, it is expected to only rise slowly in the future in spite of the expected global rise in demand for coal particularly for power generation and iron manufacturing. This modest price rise will be attributable to the following factors: coal, as a natural resource, is much more plentiful than oil and natural gas; coal is available from diverse countries; and substantial supply is available from politically stable regions of the world.

Table 4 Prospects for primary energy prices (CIF-based import price)

			2004	2005	2010	2020	2030
Crude oil	**$/bbl**	**(Rreal price)**	**39**	**54**	**40**	**42**	**45**
		(Nominal price)	39	55	45	58	75
LNG	**$/t**	**(Rreal price)**	**277**	**319**	**286**	**317**	**364**
		(Nominal price)	277	325	322	435	609
Steam coal	**$/t**	**(Rreal price)**	**56**	**64**	**49**	**50**	**51**
		(Nominal price)	56	65	55	69	85

(*) The real prices are based on FY2004 values, with an annual inflation rate of 2%.

2.5 Demand-side Measures for Energy-saving

2.5.1 Environmental Voluntary action plan of Nippon Keidanren

Nippon Keidanren (Japan Business Federation) has announced the goal of "Striving to decrease CO_2 emissions in FY2010 from the industrial sector and the energy transformation sector at least to the FY1990 level." According to a follow-up survey conducted in FY2005, 35 industries from the industrial and energy transformation sectors, and 23 industries from the residential, commercial and transportation sectors, are participating in this voluntary action. The CO_2 emission reduction goals are set differently for different industries, and annual follow-ups ensure effectiveness and objectivity. Efforts made in various industries are producing results, as the improvement in decreasing CO_2 emission intensity for a standard amount of production activities exceeded the increase of production activities. Several industries have already achieved the FY2010 goal, including the pulp and paper industry having now set a new goal.

Table 5 CO_2 reduction goals for main industries according to the environmental voluntary action plan implemented by Nippon Keidanren

	Target year	Goal (over FY1990 level)
Overall (Nippon Keidanren)	FY2010	Decrease CO_2 emissions from the industrial and energy transformation sectors at least to the FY1990 level.
Steel (Japan Iron and Steel Federation)	FY2010	Decrease energy consumption by 10%. Further reduction of 1.5% through additional efforts.
Chemicals (Japan Chemical Industry Association)	FY2010	Decrease energy intensity by 10%.
Pulp & Paper (Japan Paper Association)	FY2010	Decrease fossil energy intensity by 13%. Decrease CO_2 emission intensity by 10%.
Cement (Japan Cement Association)	FY2010	Decrease energy intensity by 3% in the area of cement manufacturing.
Electric/electronic equipment (four electric/electronic industry associations)	FY2010	Decrease CO_2 emission intensity by 25%.

We assume that the energy conservation and CO_2 reduction initiatives based on the voluntary action plan will prove effective in the years up to 2010, followed by a modest and continuous improvement of energy efficiency.

2.5.2 The Top Runner Program

The Top Runner program is based on the concept, introduced upon revision of the Energy Saving Law in 1998, that energy efficiency standards shall be imposed in such a way that energy consumption efficiency be as good as or better than that of the most efficient product available in the market at the given moment. This program, by covering the majority of appliances in the market and encouraging improvement of efficiency, helps users practice energy-saving even unconsciously. The target products are specified based on a policy to include widely used machinery products and appliances that consume a considerable amount of energy. The range of target products is being extended gradually.

Table 7 lists Top Runner standards for major machinery and appliances.

Table 6 Products covered by Top Runner standards

Passenger vehicles, air conditioners, fluorescent lights, video tape recorders, television sets, copiers, computers, magnetic disk units, freight vehicles, electric refrigerators, electric freezers, space heaters, gas cooking appliances, gas water heaters, oil water heaters, electric toilet seats, vending machines, and transformers.

Table 7 Top Runner standards for major machinery and appliances

	Unit	Target year	Energy efficiency improvement
Refrigerator	kWh/y	FY2004	Approx. 30% improvement from the FY1998 level
CRT-type TV	kWh/y	FY2003	Approx. 16.6% improvement from the FY1997 level
Air conditioner (cooler/heater)	COP	FY2004 for refrigeration and A/C industries	Approx. 63% improvement from the FY1997 level
Gasoline-powered passenger car	km/L	FY2010	Approx. 22.8% improvement from the 1995 level
Gasoline-powered small truck	km/L	FY2010	Approx. 13.2% improvement from the 1995 level
Diesel-powered small truck	km/L	FY2005	Approx. 6.5% improvement from the 1995 level

Since the Top Runner standards are enforced by law, we assume that the stipulated improvements in energy efficiency will take place in the years up to the target year. We also assume that, in subsequent years, energy-saving efforts will continue at a moderate pace.

2.5.3 Clean energy vehicles

The term “clean energy vehicles” (CEVs) refers to hybrid vehicles, electric vehicles, fuel cell vehicles, natural gas vehicles and LPG trucks. Strictly speaking, not all CEVs contribute to energy-saving. Natural gas vehicles (CNG trucks), for example, consume more fuel than diesel trucks, but are considered to be CEVs because they emit less CO_2.

Table 8 Prospects for market penetration of clean energy vehicles (Unit: million vehicles)

	Actual		Forecast		
	2003	2004	2010	2020	2030
Hybrid vehicles	0.13	0.20	0.70	3.14	10.67
Fuel cell vehicles	0.00	0.00	0.01	0.03	0.07
Natural gas vehicles	0.02	0.02	0.04	0.13	0.34
LPG trucks	0.03	0.03	0.06	0.11	0.15
(All CEVs)	0.18	0.25	0.81	3.41	11.24

Energy-saving and environmental countermeasures in the automobile sector will continue to focus on improved fuel economy of conventional vehicles. CEVs running on alternative fuels (fuel cell vehicles, natural gas vehicles and LPG vehicles) in particular, are not expected to penetrate the market beyond a limited number of environment-oriented corporations and municipalities because these vehicles are much more expensive than conventional vehicles, and moreover, they require the development of supporting infrastructures. On the other hand, hybrid vehicles are already available in the market, they do not have infrastructure-imposed restrictions, and the difference between their price and that of a conventional vehicle is getting smaller. Therefore, hybrid vehicles, passenger vehicles in particular, are expected to further penetrate the market with the number exceeding 10 million in 2030.

2.5.4 Other major energy-saving measures

Other major energy-saving measures that concern the residential, commercial and transportation sectors include the following:

[Decreasing standby power consumption]

With enhanced functionality and convenience, standby power consumption by various appliances has increased. With the increased number of electric appliances in each household, standby power eventually amounted to about 10% of the total electricity consumption of a household. From the latter half of the 1990s, the issue of standby power began attracting attention and in 1999, the Top Runner standard was established to enforce the reduction of standby power consumed by video players. Even though the reduction of standby power consumed by other types of appliances depended on voluntary efforts by industries, the Japan Electronics and Information Technology Industries Association (JEITA) and the Japan Electrical Manufacturers' Association (JEMA) achieved the goal of "1W or less" by the end of FY2003. The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) achieved the goal of "1W or less" by the end of FY2004. The Japan Industrial Association of Gas and Kerosene Appliances announced their goal to "reduce the standby power consumed by a fan heater to 1W or less, and the standby power consumed by a water heater to 2W or less by the end of FY2008."

[High-efficiency water heaters]

Oil-fuelled and gas-fuelled water heaters were covered by Top Runner standards in 2003, setting goals to achieve thermal efficiency of about 85% with oil-fuelled water heaters, and thermal efficiency of about 81% with gas-fuelled water heaters. Even with those appliances that meet these Top Runner standards, 15 to 20% of energy is not used effectively and is lost as waste heat. High-efficiency water heaters, however, achieve an even higher efficiency by utilizing latent heat or the heat pump principle.

Latent heat retrieval type high-efficiency gas-fuelled water heaters ("Eco-Jozu") achieve thermal efficiency as high as about 95% by preheating the supplied water using the latent heat in exhaust gas. Heat-pump type high-efficiency electrical water heaters ("Eco-Cute") utilize the principle of the heat pump, a device often used with air conditioners, to make available thermal energy that is approximately three times as large as the electric power consumed. It is expected that successive technology developments will result in an even higher efficiency.

[High-efficiency lighting]

High-efficiency lighting uses a technique whereby light-emitting diodes (LEDs) effectively convert electric power into light, reducing losses from converting electric power into heat. The luminous efficiency of LED lamps is currently at the level of fluorescent lamps, but the improvement of efficiency will continue. However, LED lamps are unlikely to become popular as general lighting appliances in the immediate future because LED lamps are expensive; the light produced looks cold and hard; the color rendering properties[2] is poor; and the directivity is too strong for general lighting.

More realistic options for efficient lighting at present include ball bulb type fluorescent lamps, inverter type fluorescent lamps and high-frequency (Hf) lighting type fluorescent lamps. For traffic signals and similar applications, however, more LEDs are being introduced due to their longer life and higher visibility. In the Tokyo Metropolis, where LEDs are used for this purpose most extensively, LED lamps were installed in 28.3% of the traffic signals for vehicles by the end of FY2004. The plan is to install LED lamps in all traffic signals in the Tokyo Metropolis by the end of FY2011.

[Energy management]

The Home Energy Management System (HEMS) and Building Energy Management System (BEMS) utilize information technology (IT) and other technologies to achieve remote and automatic control of lighting, air conditioners and bathroom appliances, as well as the supply of information. While the HEMS is still in the testing stage, the BEMS has already been installed in a number of buildings.

The energy-saving effect achievable by a BEMS depends on the installed system's

[2] Color rendering is an indicator of how an object's colors will look different under the given light, in comparison with sunlight. (In other words, it is an indicator of the reproducibility of colors.)

performance. A high-efficiency BEMS improves energy efficiency by approximately 10%, and under favorable conditions, may even achieve as much as a 20% improvement. In contrast, a system designed mostly for remote control and/or automated metering, or a system operation scheme focused more on amenity than energy-saving, will result in energy efficiency improvement of 0 to 3%.

[Heat-insulating efficiency of residential buildings and general energy efficiency of larger buildings]

Concerning the heat-insulating efficiency of residential buildings, the “1992 Standards” were replaced by the latest stricter standard, “1999 Standards”, generally equivalent to those adopted by developed countries in the West. While the assessment criteria used to focus mostly on heating, the newly adopted standards focus on space cooling efficiency as well. However, unlike the Top Runner standards applicable to household appliances, these standards are more like targets for efforts. The goal is to have at least 50% of newly constructed buildings comply with the standards starting in FY2008. A long life of residential buildings is one of the factors that prevent the improvement of mean efficiency, averaged over all residential buildings, except in a gradual manner.

For larger buildings (including residential buildings) with a floor space of 2,000 m^2 or more, it is mandatory that the building’s efficiency be improved in a more general manner; energy utilization must be rationalized not only by higher insulation performance, but also by preventing heat loss and seeking higher-efficiency energy used for air conditioning, ventilation, lighting, water heating and elevators. The goal is to have at least 80% of newly constructed buildings comply with the standards starting in FY2006.

[Improvement of automobile traffic flow]

Efforts to improve the automobile traffic flow aim at resolving traffic jams to enable smooth flow of automobiles, and thereby contribute to the reduction of noise and air pollution from exhaust, as well as to the reduction of fuel consumption. Generally, an automobile uses fuel most efficiently when traveling at speeds of 50 to 90 km/h; however, the mean travel speed, averaged over Japan, is less than 40 km/h. In metropolitan areas, the mean travel speed is as low as 20 km/h. One of the measures for improved traffic flow is the establishment of the Intelligent Transport System (ITS). The ITS resolves road traffic constraints through the application of information technology, and is built with several technological components such as advanced VICS (vehicle information and communication systems) that have access to traffic jam information, and ETC (electronic toll collection) systems. ETC systems are already in practical use; ETC units have been installed in about 10,300,000 automobiles as of March 2006 and 57% of vehicles use ETC systems for toll payment.

[Avoiding Idling]

The practice of not idling (stopping the engine) even at temporary halts at red signals or in congestion saves considerable energy. However, this practice is not voluntarily followed by most drivers because it may affect battery and cell motor durability, and also because even a slight delay in restarting the car may cause congestion. To make the practice widely accepted, devices on the vehicle itself are required.

2.6 Assumptions on the Future of Supply-side Technologies

2.6.1 Assumptions on nuclear power generation

Concerning nuclear power generation, against the backdrop of increasing demand for electricity, we assume that seven new reactors will be built between FY2006 and FY2020, and three additional reactors in the subsequent period up to FY2030. This assumption would mean a stable increase of installed generation capacity. Regarding decommissioning, we accounted for the FY2010 termination of commercial operations at Tsuruga Unit 1 (357 MW, run by the Japan Atomic Power Company). Concerning other nuclear power plants, we assume that appropriate measures against plant aging will enable their extended operation over a period of about 60 years, and therefore, we did not account for the termination of their operation or decommissioning.

Even though the capacity factor is presently at a low level due to the prolonged shutdown of some nuclear power plants, we assume that the figure will gradually be restored to a normal level in future. As the 13-month interval for periodic inspections is currently under government review, we assume that the capacity factor will increase up to 88%, with an extension of each operation cycle from 13 months to at least 20 months.

Table 9 Assumptions on nuclear power generation

	1980	1990	2004	2005	2010	2020	2030
Installed generation capacity at the end of the fiscal year (Unit: MW)	15,510	31,480	47,120	49,580	50,140	58,720	62,860
Capacity factor (%)	60.8	72.7	68.9	71.9	88	88	88

2.6.2 Prospects for the introduction of new energy sources

The introduction of new energy sources is accelerated in the context of saving and effectively utilizing non-renewable energy sources, and alleviating global warming.

[Electric power]

In the area of electric power generation, the increase of photovoltaic and wind power generation projects is particularly eminent in recent years. Regarding photovoltaic generation, technology developments are progressively improving generation efficiency while the increase of production volume is reducing the manufacturing costs of photovoltaic. Through efforts to decrease the total cost of building a house with a photovoltaic system by introducing a roof-integrated design, the number of installations is growing. In addition, the development of non-silicon dye-sensitized solar cell is expected to lower the raw material cost, and moreover, enable installation on surfaces other than roofs. We assume that these factors will contribute to continued rapid growth of photovoltaic installations in the future.

In the area of wind power generation, an increase in the size of wind turbines has made wind power sufficiently economical, resulting in a sharp increase of installed capacity. More installations, including offshore, are expected in the coming years. We also expect more installations of small- to medium-sized wind turbines that have less siting restrictions. While photovoltaic are used mainly in self-sufficiency oriented applications, wind turbines are usually grid-connected. With increasing penetration of wind power, it is essential that appropriate interconnection measures be developed.

Even though waste-burning power generation currently produces more electrical output than any other form of new energy utilization, its growth potential as a new energy source is small because the three R's of reducing, reusing and recycling waste have become a predominant trend in society.

The use of biomass generation is gradually being extended as utilities start using biomass for multi-fuel firing with fossil fuels. However, with geographical restrictions on the supply of biomass, its growth potential as a new energy source is also small.

[Heating applications]

With the exception of black liquor and scrap wood, the progress in using new energy sources for heating applications is slower than that for electric power generation. The use of waste for heating applications, even though it is currently producing more thermal output than any other form of new energy utilization, has only minor growth potential due again to the trend of the three R's mentioned above. Regarding solar heat as a major form of new energy utilization at home, there is a trend of shifting from conventional solar water heaters to solar systems that provide both water and space heating. However, there is a larger trend of shifting from such active solar systems to passive solar systems, which are configured to function with various designs in terms of materials and construction of the building itself. As a result, solar heat utilization as such will show a decreasing trend.

The use of biomass for heating applications will increase with the introduction of bio-fuel for automobiles ("E3" gasoline fuel containing 3% ethanol). With other applications, however, supply and demand will be contained in each separate locality (local production and consumption) due to geographical restrictions on supply as well as economic restrictions.

While untapped energy sources, such as the heat (coldness) of snow and ice, have a large supply potential, their utilization is expected to be very gradual because their energy density is quite low, and also because their utilization will require costly infrastructures for transformation and transportation.

Table 10 Prospects for the use of new energy sources

(Unit: 10^{10} kcal)

	Actual			Forecast			Mean annual growth rate (%)				
	1980	1990	2004	2010	2020	2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	477	6,067	8,688	10,207	13,489	16,557	29.0	2.6	2.7	2.8	2.1
Photovoltaic generation	0	0	255	761	1,922	3,353			20.0	9.7	5.7
Wind power generation	0	0	349	562	1,128	2,112			8.3	7.2	6.5
Waste-burning power generation	107	407	1,482	1,916	2,404	2,803	14.3	9.7	4.4	2.3	1.5
Biomass generation	0	0	216	255	350	438			2.8	3.2	2.3
Solar heat utilization	370	1,167	528	378	270	253	12.2	-5.5	-5.4	-3.3	-0.6
Untapped energy sources	0	0	37	79	116	152			13.5	3.8	2.8
Waste utilization for heating	0	0	1,533	1,542	1,553	1,546			0.1	0.1	0.0
Biomass utilization for heating	0	0	0	188	907	808				17.0	-1.1
Black liquor, scrap wood, etc.	0	4,493	4,287	4,525	4,841	5,093		-0.3	0.9	0.7	0.5

(*) Electric power conversion per 1 kWh = 2,150 kcal

2.6.3 Prospects for the penetration of distributed generation

Distributed generators (mainly conventional auto power generators and cogeneration systems) have rapidly penetrated the market against the backdrop of low fuel price and high electricity price. However, growth is now slowing down due to the sharp rise in the cost of oil and other fuels; a decrease in the electricity price with further deregulation of the electricity market; and various restrictions stemming from environmental concerns. Even though cogeneration systems will continue to be installed by those customers who expect to utilize the waste heat efficiently, the increase in the proportion of autoproducers is expected to slow down due to the preference for grid power with fuel prices fixed at a high level and the drop in electricity price, and also to the leveling out of electricity demand, particularly in raw material industries that often use large monogenerators.

Table 11 Prospects for power generation capacity
from cogeneration and fuel cell systems

(Unit: MW)

		1990	2004	2010	2030
Cogeneration	Industrial use	1,673	5,481	6,595	9,653
	Commercial use	281	1,457	1,825	2,987
	Total	1,954	6,938	8,420	12,640
Fuel cell	Commercial use	0	0	7	63
	Residential use	0	0	9	82
Total		1,954	6,938	8,436	12,785

Fuel cells for stationary applications are presently installed only for trial use. Even in the future, installation will be limited unless the technology develops rapidly and the installation cost, as well as the fuel cost, is reduced. In particular, if a fuel cell system is operated in electrical-load-following mode, it may be difficult to use the heat effectively except in cold localities, resulting in an increase, rather than decrease, of energy costs with additional energy loss.

3. PROSPECTS FOR ENERGY SUPPLY AND DEMAND (REFERENCE CASE)

Using the assumptions described in the previous section, we predicted changes in the energy supply and demand structure for the period up to 2030. This section describes estimations concerning the reference case.

3.1 Prospects for the Primary Energy Supply in Japan

In the 1980s, due to the combined effects of an increase in final energy consumption and a shift in demand to electricity, growth in Japan's primary energy supply continued to be about half the growth of the GDP. After the collapse of the bubble economy, while economic growth remained very stagnant, the growth of energy consumption in the residential, commercial and transportation sectors, and the shift in demand to electricity, among other factors, resulted in the worsening (increase) of energy consumption per GDP. From around the end of the 1990s, however, growth in the increase of Japan's primary energy supply began to slow down, thanks to such factors as the materialization of new energy-saving measures, employed for the purpose of cost reduction or in consideration of regional and global environmental issues, and the shift to an economic and social structure more oriented to "soft" industries and services.

Figure 2 Prospects for primary energy supply, final energy consumption and CO_2 emissions from fuel combustion in Japan

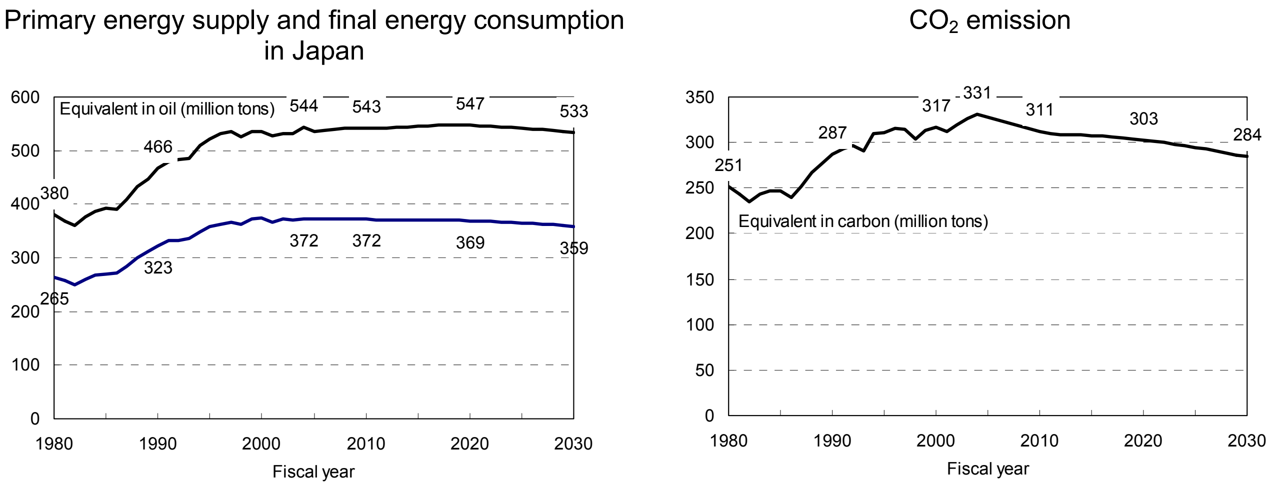


Table 12 Prospects for primary energy supply in Japan

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Coal	**80**	17.3	**118**	21.7	**104**	19.2	**104**	19.0	**98**	18.5	2.8	-2.1	0.0	-0.5
Oil	**264**	56.6	**256**	47.1	**241**	44.4	**220**	40.3	**198**	37.2	-0.2	-1.0	-0.9	-1.1
Natural gas	**49**	10.6	**78**	14.4	**84**	15.5	**92**	16.7	**95**	17.8	3.4	1.2	0.9	0.4
Nuclear	**46**	9.8	**61**	11.2	**83**	15.3	**97**	17.8	**104**	19.5	2.1	5.4	1.6	0.7
Hydro and geothermal	**21**	4.5	**22**	4.0	**21**	3.8	**20**	3.7	**21**	3.9	0.3	-1.1	0.0	0.1
New energy	**6**	1.3	**9**	1.6	**10**	1.9	**13**	2.5	**17**	3.1	2.4	2.8	2.8	2.1
Total primary energy supply	**466**	100.0	**544**	100.0	**543**	100.0	**547**	100.0	**533**	100.0	1.1	0.0	0.1	-0.3
Real GDP(trillion yen)	449		526		593		687		770		1.1	2.0	1.5	1.1
Energy consumption per GDP (over FY1990)	100		99		88		77		67		0.0	-2.0	-1.4	-1.4
CO_2 emission (carbon equivalent, in units of million tons)	287		331		311		303		284		1.0	-1.0	-0.3	-0.6
(over FY1990)	100		115		109		105		99					

The reference case assumes the following: stable economic growth; change in economic and industrial structure with orientation toward higher added value and "soft" industries and services; fewer children in each family, aging society and population decrease; and the effects of existing energy-saving measures (the voluntary action plan of Nippon Keidanren, the Top Runner approach, etc.) and moderate continuation of such measures. Given these assumptions, we estimate that Japan's primary energy supply will generally level out until around FY2020, and thereafter show a slight decreasing trend.

When analyzing the changes in Japan's primary energy supply over the given period in terms of three factors, namely, energy consumption per GDP, GDP per capita and Japan's population, the following can be stated:

- Energy consumption per GDP, even though its improvement halted in the 1990s, will once again contribute to a decrease in energy consumption thanks to the combined effects of microscopic energy-saving measures through the employment of various technologies and a macro trend of energy-saving resulting from changes in the economic and social structure with an orientation toward higher-added values.
- As Japan comes out of stagnant economic growth and deflation that lasted over 10 years, both the total GDP and the GDP per capita will grow. This will contribute to a general increase in energy consumption.
- Japan's population peaked in FY2004 and is now decreasing. The population decrease will contribute to a gradual decrease in energy consumption, particularly from FY2010.

Table 13 Analysis of factors for primary energy supply in Japan

(Unit: Annual rate of change in percentage)

	1980–1990	1990–2004	2004–2010	2010–2020	2020–2030	2004–2030
Change in total	0.5	2.6	-0.2	0.2	0.0	0.1
Energy consumption per GDP	-3.4	1.4	-2.1	-1.2	-1.1	-1.4
GDP per capita	3.4	0.9	2.1	1.8	1.7	1.8
Population factor	0.5	0.2	-0.1	-0.3	-0.5	-0.3

Energy consumption per GDP is expected to improve by 33% from the FY2004 level. It is in excess of the Government's target ("further improvement of efficiency by 30% by 2030") in the "New National Energy Strategies" currently under development.

When looking at fossil fuels by type, the demand for oil is expected to decrease because energy-saving measures will be applied more extensively in the transport sector, and also because the proportion of oil in final energy consumption as well as the use of oil by the energy transformation sector will decrease. The dependency of oil in FY2030 will be 37%, fulfilling the target in the New National Energy Strategies, which is to reduce dependency to "a level below 40% by 2030." Regarding coal, the output of coal-fired power generation will increase but it will be offset by improved generation efficiency. As a result, the amount of coal consumed for this purpose will generally flatten out. With decreasing final demand and improved efficiency in coke production, the overall demand for coal will slowly decrease. There will be a significant increase in the demand for natural gas to produce city gas. Even though the output of LNG-fired power generation will boom, as in the case of coal-fired power generation, overall growth will be slightly alleviated by the leveling-off of LNG consumption for power generation, resulting from improved generation efficiency. However, LNG is still the only fossil fuel for which consumption is expected to grow.

3.2 Prospects for CO_2 Emissions

Historically, the CO_2 emissions from fuel combustion have increased with the growth of energy consumption. Total CO_2 emission in FY2004 amounted to 331 million carbon-equivalent tons (15% increase over the FY1990 level) due to such causes as prolonged shutdown of some nuclear power plants. Assuming the reference case, which only assumes the set of present-day technologies and the results from various programs already in effect, we expect that CO_2 emission will decrease to 311 million tons (8.5% increase over the FY1990 level) by FY2010, and that a decreasing trend will be maintained in subsequent years. The Kyoto Protocol Goals Achievement Plan, sanctioned by the Cabinet in April 2005, aims at controlling the emission of energy-derived CO_2 to a level 0.6% higher than the FY1990 level (and controlling the total emission of all greenhouse gases to a level 6% lower than the FY1990 level).

Table 14 Analysis of factors for energy-derived CO_2 emission

(Unit: Annual rate of change in percentage)

	1973–1990	1990–2004	2004–2010	2010–2020	2020–2030	2004–2030
Change in total	0.8	1.0	-1.0	-0.3	-0.6	-0.6
Decarbonization	-0.7	-0.1	-1.0	-0.4	-0.4	-0.5
Improved energy efficiency	-2.1	0.0	-2.0	-1.4	-1.4	-1.5
Economic growth	3.8	1.1	2.0	1.5	1.1	1.5

When analyzing the changes in CO_2 emission in terms of three factors, namely, decreased carbon factor (lower CO_2 emission per primary energy supply in Japan), improved energy efficiency (lower primary energy supply in Japan per GDP) and economic growth (GDP), the following can be stated:

- The scale of economy will continue to grow in future, and economic growth will contribute to increased CO_2 emission at an annual rate of 1.5%.
- The improvement of energy efficiency, even though it was halted in the 1990s, will be resumed, and will contribute to decreased CO_2 emission at an annual rate of 1.5%, offsetting the increase in emission by economic growth.
- A decrease in the carbon factor will contribute to decreased CO_2 emission at an annual rate of 0.5%. This will generally be the rate of CO_2 emission decrease in future.

3.3 Prospects for Final Energy Consumption

Final energy consumption has been growing constantly since the mid 1980s, when a range of energy-saving measures introduced after the Oil Crisis had been effectuated. Even in the period following the collapse of the bubble economy, public investment, intensified as simulative measures, sustained the basis of energy-intensive raw material production in spite of the stagnant economy. In subsequent years, final energy consumption continued growing due to such factors as the increased number of privately owned automobiles. From around the end of the 1990s, however, the growth of final energy consumption began slowing down due to such causes as the materialization of newly introduced energy-saving measures and a further shift to a service-oriented industrial structure.

According to estimates, final energy consumption will flatten out in the period up to around FY2020 due to tendency to heighten the added value in the economic and industrial structure, progress of the declining birth rate and aging society, smaller population, and effects of various energy-saving efforts. After leveling off, final energy consumption will show a slight decrease.

Table 15 Prospects for final energy consumption

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Total final energy consumption	**323**	100.0	**372**	100.0	**372**	100.0	**369**	100.0	**359**	100.0	1.0	0.0	-0.1	-0.3
(Breakdown by sector)														
Industrial sector	**170**	52.5	**178**	47.8	**179**	48.0	**177**	48.1	**175**	48.7	0.3	0.1	-0.1	-0.2
Resi. and com. sector	**79**	24.4	**102**	27.5	**105**	28.4	**110**	29.9	**111**	30.9	1.9	0.5	0.5	0.0
Residential	**43**	13.3	**54**	14.5	**54**	14.5	**56**	15.1	**55**	15.4	1.7	0.0	0.3	-0.1
Commercial	**36**	11.2	**48**	13.0	**51**	13.8	**54**	14.8	**56**	15.5	2.1	1.1	0.6	0.2
Transport sector	**74**	23.0	**92**	24.7	**88**	23.6	**81**	22.0	**73**	20.5	1.5	-0.7	-0.8	-1.0
Passenger transport	**44**	13.7	**60**	16.0	**58**	15.6	**55**	14.9	**49**	13.7	2.1	-0.5	-0.5	-1.1
Freight transport	**30**	9.3	**32**	8.7	**30**	8.1	**27**	7.2	**24**	6.7	0.5	-1.2	-1.2	-1.0
(Breakdown by energy source)														
Coal	**42**	13.0	**39**	10.5	**37**	10.1	**36**	9.7	**34**	9.5	-0.5	-0.7	-0.4	-0.5
Oil	**196**	60.6	**216**	58.0	**204**	54.9	**189**	51.1	**171**	47.8	0.7	-0.9	-0.8	-1.0
Gas	**16**	4.9	**26**	7.1	**30**	8.1	**34**	9.1	**37**	10.3	3.7	2.2	1.1	1.0
Electricity	**65**	20.2	**87**	23.4	**96**	25.7	**104**	28.2	**109**	30.3	2.1	1.6	0.9	0.4
New energy, etc.	**4**	1.4	**4**	0.9	**5**	1.2	**6**	1.8	**7**	2.1	-1.6	4.5	3.5	1.3

(*) Figures for the industrial sector include non-energy consumption (indirect energy consumption through material consumption).

When analyzing the changes in final energy consumption in terms of three factors, namely, energy consumption per GDP, GDP per capita and Japan's population, the contribution from the improvement of energy consumption per GDP appears to be large because, unlike the primary energy supply, which includes energy consumption for power generation. When looking at the overall trend, however, its contribution is generally the same as that from changes in the amount of primary energy supply.

Table 16 Analysis of factors for final energy consumption

(Unit: Annual rate of change in percentage)

	1980–1990	1990–2004	2004–2010	2010–2020	2020–2030	2004–2030
Change in total	2.0	1.0	0.0	-0.1	-0.3	-0.1
Energy consumption per GDP	-1.9	-0.1	-2.0	-1.5	-1.4	-1.6
GDP per capita	3.4	0.9	2.1	1.8	1.7	1.8
Population factor	0.5	0.2	-0.1	-0.3	-0.5	-0.3

3.3.1 Energy consumption by the industrial sector

Even though energy consumption by the industrial sector is expected to reach a small peak in the mid 2010s, growth will almost flatten out compared with past trends. Thanks to the environmental voluntary action plan of Nippon Keidanren and other initiatives, energy efficiency will improve within various industries, and moreover, the industrial structure and the line-up of industrial products will be oriented toward less consumption of energy and higher added value. In spite of a growth in industrial activities, these factors will prevent increased energy consumption.

The four energy-intensive raw material industries will gradually decrease their share in total energy consumption, while the machinery industries will increase their share nearly to 30%. Such changes in the industrial structure will produce energy-saving effects at the macro level, which will be a major factor inhibiting the growth of energy consumption by the industrial sector, along with the progress of energy-saving in individual industries.

Table 17 Prospects for energy consumption by the industrial sector

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Coal and coal-derived products	**41**	24.2	**38**	21.5	**36**	20.4	**35**	19.6	**33**	18.9	-0.5	-0.8	-0.5	-0.5
Oil	**88**	52.1	**91**	51.1	**86**	48.2	**81**	45.7	**76**	43.6	0.2	-0.9	-0.6	-0.6
Gas	**5**	2.7	**10**	5.6	**13**	7.1	**15**	8.4	**17**	9.9	5.7	3.9	1.7	1.4
Electricity	**33**	19.3	**36**	20.5	**40**	22.6	**43**	24.1	**43**	24.9	0.8	1.7	0.5	0.2
New energy, etc.	**3**	1.7	**2**	1.3	**3**	1.7	**4**	2.3	**5**	2.7	-1.8	5.2	2.8	1.8
Total of all industries	**170**	100.0	**178**	100.0	**179**	100.0	**177**	100.0	**175**	100.0	0.3	0.1	-0.1	-0.2
Production index (100 = Year 2000 level)	101.2		100.6		112.3		126.0		138.4		0.0	1.9	1.2	0.9

(*) Figures include non-energy consumption (indirect energy consumption through material consumption).

We shall now look at different energy sources one by one. The demand for electricity will continue to grow with changes in the industrial structure and product line-up toward higher functionality and more added value, and the trend of recycling and reuse. The demand for city gas will grow sharply due to such factors as switching from other fuels for easier management with less labor and in the context of alleviating global warming; switching from other fuels at the opportunity to install distributed generators; and expansion of service areas.

The demand for oil, on the other hand, is expected to decrease due to such factors as switching from oil (particularly the heavy oil) to other fuels and the decrease of its demand for raw material production with an expected decrease in ethylene production. The demand for oil in FY2030 is expected to be 76 million oil-equivalent tons (Mtoe), which approximately matches the demand level as of around 1987. The demand for coal will decrease due to lower production of crude steel and cement, and also due to extended use of energy produced by waste such as disused tires and plastics.

Table 18 Analysis of factors for energy consumption
by the industrial sector (IIP basis)

(Unit: One million oil-equivalent tons)

	1980–1990	1990–2004	2004–2010	2010–2020	2020–2030	2004–2030
Change in total	9.8	16.2	1.9	0.2	-1.6	0.5
Energy consumption per IIP in each industry	-31.3	16.7	-7.7	-12.0	-11.3	-31.0
Structural changes	-10.8	1.5	-8.1	-6.3	-5.3	-19.7
Changes in production	53.2	1.4	17.9	18.7	15.2	51.9

3.3.2 Energy consumption by the residential and commercial sector

The growth of energy consumption by the residential and commercial sector in the future will be slower than in the past. Energy consumption by the residential sector will peak around 2020. While energy consumption by the commercial sector will continue to grow, energy consumption by the residential and commercial sector as a whole is expected to start to decrease in the second half of the 2020s. Factors that contribute to the decrease and suppression of energy demand from the residential and commercial sector include the following: improved efficiency of electric and other appliances thanks to the Top Runner standards and other efforts; decrease in population and number of households; and decelerated increase in floor space for business operation.

When analyzing the changes in energy consumption by the residential sector in terms of three factors, namely, the number of households, the utility[3] and the energy efficiency of appliances, the following can be stated:

- Due to the increased number of air conditioners and other appliances in each household, the appearance in the market of new appliances, the pursuit of amenity and the progressive aging of society, the utility will continue to increase, contributing to increased energy consumption.
- The efficiency of appliances will continue to improve thanks to the effectiveness of the Top Runner standards and the extensive use of high-efficiency appliances, offsetting most of the increase in energy consumption resulting from a higher utility.
- Even though the number of households will gradually decrease after having peaked in 2017, this will contribute little to the decrease in energy demand, because the decrease in the number of households will be slow and will start later than the decrease in population.

Table 19 Prospects for energy consumption by the residential sector

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Oil	**17**	40.7	**20**	36.5	**18**	33.8	**17**	29.9	**14**	25.7	0.9	-1.3	-0.9	-1.6
City gas	**8**	18.1	**9**	17.5	**9**	17.0	**9**	15.8	**8**	15.2	1.4	-0.5	-0.4	-0.5
Electricity	**16**	38.1	**24**	44.9	**26**	48.4	**30**	53.7	**32**	58.4	2.8	1.3	1.4	0.7
New energy, etc.	**1**	3.1	**1**	1.1	**0**	0.8	**0**	0.6	**0**	0.6	-5.6	-4.8	-2.8	-0.4
Total of the residential sector	**43**	100.0	**54**	100.0	**54**	100.0	**56**	100.0	**55**	100.0	1.6	0.0	0.3	-0.1
Number of households (Unit: million)	41.16		49.84		51.41		51.70		50.45		1.4	0.5	0.1	-0.2

[3] The utility refers to the effect that consumers will obtain. The utility, when multiplied by the energy efficiency improvement achieved by the given appliance, gives the actual energy consumption.

Table 20 Prospects for energy consumption by the commercial sector

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/1990	2010/2004	2020/2010	2030/2020
		(%)		(%)		(%)		(%)		(%)				
Oil	**17**	47.5	**15**	31.4	**14**	27.5	**13**	23.7	**11**	20.5	-0.9	-1.2	-0.9	-1.2
City gas	**4**	10.0	**7**	14.5	**8**	16.0	**10**	17.6	**10**	18.7	4.8	2.8	1.6	0.8
Electricity	**14**	39.7	**24**	50.5	**27**	52.6	**30**	54.4	**31**	56.1	3.9	1.8	0.9	0.5
New energy, etc.	**1**	2.8	**2**	3.5	**2**	3.9	**2**	4.3	**3**	4.7	3.9	2.6	1.7	1.1
Total of the commercial sector	**36**	100.0	**48**	100.0	**51**	100.0	**54**	100.0	**56**	100.0	2.1	1.1	0.6	0.2
Floor space for business operations (Unit: million m^2)	1,285		1,742		1,830		1,932		1,964		2.2	0.8	0.5	0.2

Table 21 Analysis of factors for energy consumption by the residential sector

(Unit: Annual rate of change in percentage)

	1980–1990	1990–2004	2004–2010	2010–2020	2020–2030	2004–2030
Change in total	3.5	1.7	0.0	0.3	-0.1	0.1
Number of households	1.4	1.4	0.5	0.1	-0.2	0.0
Utility	2.6	1.0	1.5	1.7	1.1	1.4
Improvement of efficiency	-0.5	-0.7	-2.0	-1.4	-1.0	-1.3

By energy source, we see that the demand for electricity grows due to the following factors: the increased number of electric and other appliances in each household; the market appearance of new electric appliances such as next-generation DVD recorders; and the use of air conditioners over a longer period of the year and longer hours of the day. With the improved efficiency of air conditioners, electric water heaters and IH appliances attracting more consumers, there will be a shift in demand to electricity, which is more convenient and safe than other energy sources. Thus, electricity will be the only energy source for which the demand increases in the residential sector; electricity will acquire a share of nearly 60% by 2030.

Regarding kerosene, LPG and city gas, large increases in demand are unlikely because utilization of these fuels for water heating and cooking will decrease with the improved efficiency of appliances, and also because a shift to electricity is expected in each field of application including space heating. The demand for kerosene, in particular, will decline due to such factors as the effect of urbanization. The demand for kerosene in 2030 will be as low as two-thirds of the present level. The use of solar heating, a major form of new energy in homes, will decrease slightly due to a shift from conventional solar water heaters to passive solar systems.

Table 22 Analysis of factors for energy consumption by the commercial sector

(Unit: One million oil-equivalent tons)

	1980–1990	1990–2004	2004–2010	2010–2020	2020–2030	2004–2030
Change in total	10.0	12.2	3.2	3.0	1.3	7.5
Floor space factor	9.2	13.0	2.5	2.8	0.9	6.2
Intensity factor	0.8	-0.7	0.7	0.2	0.3	1.3
Space heating	-2.0	-4.6	-1.0	-1.1	-0.9	-3.0
Space cooling	1.0	0.5	0.3	0.8	0.9	2.0
Water heating	-1.8	-1.8	-0.0	-0.2	-0.1	-0.3
Cooking	0.3	0.8	0.2	0.3	-0.0	0.5
Power and lighting	3.3	4.3	1.1	0.4	0.4	2.0

When analyzing changes in energy consumption by the commercial sector in terms of gross commercial floor space, intensity and its breakdown by modality of energy utilization, the following are shown:

- The increase in gross commercial floor space will be slower in the future than in the past due to the population decrease and fewer children in each family. Still, most of the increase in energy consumption by the commercial sector in the future will be attributable to this factor. However, its contribution in the period up to 2030 is expected to be 6.2 Mtoe, which is merely half the contribution it has made in the last 14 years.
- Factors such as the following will create pressure to increase the intensity: the increased number of owned appliances (mainly electric and electronic appliances); the market appearance of new appliances; and the pursuit of amenity exemplified by the use of air conditioners over a longer period. However, the following factors will minimize changes to the intensity: the improved efficiency of appliances; the improved energy efficiency of buildings; and the penetration of energy management practices.

The demand for electricity will grow due to the increased number of owned appliances (mostly electric and electronic appliances) and market inroads in new appliances resulting in increased demand for power and lighting. In the mid- to long-term, the all-electric design will also penetrate the commercial sector, led by increases in high-rise buildings and improved efficiency of IH and other devices.

The demand for oil, particularly heavy oil, will decrease due to decreased consumption with space and water heating. The demand for city gas, even though it will also be affected by decreased consumption with water heating, will record the highest growth among all energy sources due to increased energy consumption in kitchens with the shift to a service-oriented society and the increased participation of women in social activities, and also due to the increased share of gas in the area of space cooling as it becomes more popular. The future growth of new energy utilization depends heavily on using heat from cogeneration and fuel cell systems. The contribution of new energy to the overall energy supply, however, will be limited.

3.3.3 Energy consumption by the transport sector

According to forecast, energy consumption by the transport sector will continue to decrease over the given period as fuel consumption and transport efficiency improves while transport demand (passenger-kilometers and ton-kilometers) grows very little.

Passenger transport demand (passenger-kilometers), as part of the gross transport demand, will hit a ceiling due to the population decrease. Freight transport demand (ton-kilometers) will generally level out due to the shift to a service-oriented economy and the downsizing of manufacturing industries. The automobile transport share will change little from the present level, with passenger transport almost leveling off at approximately 66% and freight transport showing a slight increase up to around 60%.

Table 23 Prospects for energy consumption by the transport sector

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Total of the transport sector	**74**	100.0	**92**	100.0	**88**	100.0	**81**	100.0	**73**	100.0	1.5	-0.7	-0.8	-1.0
Passenger transport	**44**	59.6	**60**	64.9	**58**	65.9	**55**	67.4	**49**	67.1	2.1	-0.5	-0.5	-1.1
Freight transport	**30**	40.4	**32**	35.1	**30**	34.1	**27**	32.6	**24**	32.9	0.5	-1.2	-1.2	-1.0
Automobile	**65**	87.8	**80**	87.2	**76**	87.0	**71**	86.8	**64**	86.7	1.5	-0.8	-0.8	-1.0
Air	**3**	4.4	**4**	4.7	**5**	5.3	**5**	6.1	**5**	6.6	2.0	1.3	0.6	-0.1
Marine	**4**	5.1	**5**	5.8	**5**	5.2	**4**	4.5	**3**	4.0	2.5	-2.4	-2.3	-2.2
Rail	**2**	2.7	**2**	2.3	**2**	2.5	**2**	2.7	**2**	2.7	0.3	0.6	0.0	-0.8
Passenger transport (Unit: billion passenger-kilometers)	1,298.4		1,418.4		1,466.1		1,492.8		1,450.9		0.6	0.6	0.2	-0.3
Freight transport (Unit: billion ton-kilometers)	546.8		570.0		577.3		581.4		570.2		0.3	0.2	0.1	-0.2
GDP (Unit: one trillion yen)	449		526		593		687		770		1.1	2.0	1.5	1.1

While the demand for automobile transport constitutes about two-thirds of the total transportation demand, automobiles consume nearly 90% of the total energy consumed by the transport sector. Reduction in total energy consumption by the transport sector, therefore, is mostly due to reduction of energy consumed by automobiles. Automobile energy consumption can be analyzed in terms of three factors, namely, the number of owned automobiles, the travel distance and the fuel consumption efficiency. Growth in the number of owned passenger vehicles will hit a ceiling due to such factors as market saturation and population decrease; it is expected to decrease after having reached a peak around 2024. The number of trucks already peaked in 1990 and then turned to decrease due to such factors as improved efficiency of freight transport; this trend will be maintained in the future. The mean travel distance of passenger vehicles shows a decreasing trend due to such factors as the growing number of aged and female drivers and the increase of second cars in households. In contrast, the mean travel distance of trucks shows an increasing trend as the utilization rate improves.

Improved fuel consumption efficiency of automobiles is currently promoted by the Top Runner standards. It is expected that the goals set for passenger vehicles and small-sized trucks will be met at an early stage. In 2006, standards for fuel consumption efficiency were established for large- and medium-sized trucks and buses. Even after achieving these goals, improvements in fuel consumption efficiency will continue over a long period with manufacturers' initiatives and market penetration of hybrid vehicles. Table 24 analyzes the changes in the total amount of gasoline consumed by passenger vehicles in terms of three contributing factors and shows how reduced gas consumption owes much to improved fuel consumption efficiency.

Table 24 Analysis of factors for gasoline consumption by passenger vehicles

(Unit: Annual rate of change in percentage)

		1980–1990	1990–2004	2004–2010	2010–2020	2020–2030	2004–2030
Gasoline consumption		3.2	3.1	0.2	-0.5	-1.2	-0.6
	Number of owned passenger vehicles	3.3	3.7	1.7	0.6	-0.1	0.6
	Travel distance	-0.1	-0.8	-0.2	-0.2	-0.0	-0.1
	Fuel consumption efficiency	0.0	0.2	-1.2	-0.9	-1.2	-1.1

In the future, the most important energy-saving and environmental protection measure in the automobile sector will continue to be improved fuel consumption efficiency of conventional vehicles, while clean energy vehicles running on alternative fuels (fuel cell vehicles, natural gas vehicles and LPG vehicles) are not expected to penetrate the market beyond a limited number of environment-oriented corporations and municipalities, because these vehicles will require the development of supporting infrastructures. On the other hand, hybrid vehicles, which are already available in the market, do not have infrastructure-imposed restrictions, and the difference between their price and that of conventional vehicles is getting smaller. Therefore, hybrid vehicles (passenger vehicles in particular) are expected to penetrate the market more deeply. We assume that the number of hybrid vehicles will exceed 10 million by 2030. Biofuels (bioethanol and biodiesel) are attracting attention throughout the world in the context of promoting carbon neutrality and lowering fossil fuel dependency. Since amendment of the Gasoline Quality Assurance Law has enabled the use of "E3" fuel (gasoline with 3% ethanol content), the use of biofuels will gradually become more popular.

3.4 Prospects for Electric Power Generation Mix

The demand for electricity is expected to increase in the future at the annual average rate of

0.9% as various micro- and macro-level factors prompt a shift in demand to electricity. Even though distributed generators, particularly cogeneration systems, are expected to increase, growth in the proportion of autoproducers will not be as fast in the future as in the past due to such factors as the preference for grid power with the fixation of fuel prices at a high level and the drop in electricity price; slowness in the growth of large-scale autoproducers of electricity in raw material manufacturing and other industries; and increase in the share of grid power resulting from increased electricity demand in the residential and commercial sector, which has only a small proportion of auto generation. With these contributing factors, the gross electric power sold and gross electric power generated by utilities are both expected to grow at the same annual average rate of 0.9% as the electricity demand.

Concerning nuclear power generation, against the backdrop of increasing electricity demand, we assumed the construction of 10 new reactors and smooth growth of the installed capacity. At the same time, considering that the nuclear power plant inspection scheme is currently under government review, we assumed an improved capacity factor up to 88%. Given these assumptions, nuclear power generation in 2030 will be a major source of electricity supply with a share of more than 40%. With a larger proportion of demand coming from the residential and commercial sector, and as small machinery industries rather than raw material industries increase their share in the industrial sector, the load factor is expected to decrease. The extent of this decrease, however, will remain below a level that can be dealt with by conventional supply-demand adjustment measures such as pumped-storage generation.

Concerning hydropower generation, we expect only very minor growth of installed capacity because Japan has already developed about 70% of the potential hydropower resources, and also because hydropower development (e.g., dam construction) is becoming difficult due to its large environmental impact. (Hydro power generation output is expected to decrease slightly from the FY2004 level when abundant water was available.)

Concerning thermal power generation, we expect increased output, but the share will gradually decrease to less than 50% by 2030 as nuclear power generation increases. Coal-fired power generation, even though it produces a high environmental impact in terms of global warming, offers a stable supply and is economical. With the advent of such generation efficiency technologies as the ultra-super critical Pressure Condition Power Generation and pressurized fluidized bed combustion plant, coal-fired generation plants will establish themselves as base-load and middle-class power plants. LNG-fired power generation plants, with smaller environmental impact than other thermal power plants, will continue to be used in future to serve various loads from base load to peak load, with such generation efficiency technologies as advanced combined cycle generation and more advanced combined cycle generation. Some oil-fired generation plants will continue to be used as peak load plants or will be preserved for the sake of generation mix diversity, but their availability will decrease as LNG-fired plants will also serve peak loads. Therefore, the output from oil-fired plants will continue to decrease.

Table 25 Prospects for electric power generated by utilities

(Unit: TWh)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Coal-fired	**71**	9.5	**216**	22.9	**210**	20.2	**240**	21.1	**242**	20.4	8.2	-0.4	1.3	0.1
LNG-fired	**163**	21.7	**269**	28.6	**266**	25.7	**282**	24.8	**303**	25.5	3.6	-0.1	0.6	0.7
Oil-fired, etc.	**224**	29.8	**72**	7.7	**69**	6.6	**50**	4.4	**38**	3.2	-7.8	-0.8	-3.2	-2.7
Total of thermal power generation	**459**	61.0	**557**	59.2	**545**	52.5	**572**	50.3	**583**	49.0	1.4	-0.3	0.5	0.2
Nuclear	**201**	26.8	**282**	30.0	**386**	37.2	**452**	39.8	**484**	40.7	2.4	5.4	1.6	0.7
Hydro	**90**	12.0	**96**	10.2	**92**	8.8	**91**	8.0	**94**	7.9	0.4	-0.7	-0.1	0.4
Geothermal, etc.	**2**	0.3	**6**	0.6	**15**	1.4	**21**	1.9	**27**	2.3	8.0	16.1	3.7	2.7
Total generated power	**752**	100.0	**941**	100.0	**1,038**	100.0	**1,136**	100.0	**1,189**	100.0	1.6	1.7	0.9	0.5

3.5 Prospects for Demand by Energy Sources

3.5.1 Electricity demand

Since there will be a shift toward electricity, electricity demand will continue to show stable growth in the future in spite of a general decrease in energy demand. Even though improved efficiency of electric appliances contributes to decreased electricity demand, electricity demand will still increase due to such contributing factors as the preference for convenience and safety, and the increase of highly functional electric appliances and industrial machinery.

Electricity demand from the industrial sector will grow with the increase of machinery products, the manufacturing of which consumes much energy. Within raw material and other non-machinery industries, electricity demand will increase as products become more highly functional and value-added.

Electricity demand from the residential sector will grow firmly with the increasing number of electric appliances in households. Even though the efficiency of electric appliances will be improved through the Top Runner standards and other efforts, electricity demand will still grow due to such factors as the replacement of oil and gas in space and water heating applications, and the increase of highly functional household electrical appliances that appeal to consumers because of convenience. The aging of society will contribute to the all-electric design because of the major convenience and safety advantages offered.

Electricity demand from the commercial sector is expected to increase as well due to such factors as the increased space cooling demand, a result of increased heat from office equipment, and the increased consumption of electricity for lighting as larger retail shops are built, particularly in the suburbs. The expansion of service industries, accelerated by the diversification of lifestyles, will also contribute to the demand growth. While much of the electricity demand came from the industrial sector in the past, the demand from the residential and commercial sector grew significantly in recent years, and it is expected to constitute nearly 60% of the total demand by 2030. Electricity demand from the residential and commercial sector, particularly from space cooling and heating needs, is largely affected by the ambient temperature, and changes considerably with the season and hours of the day.

Accordingly, the increase in the proportion of electricity demand from the residential and commercial sector will negatively affect the load factor. Even though electricity demand from the residential and commercial sector comes from a great number of small loads, for which systematic control could be difficult, additional capacity for supply-demand adjustments will be required in the future as the importance of, and dependency upon, the electric supply infrastructure grow.

Auto generation increased in recent years with the growing popularity of, for example, cogeneration systems. The growth of auto generation output, however, is expected to slow down significantly in the future. As competition with grid power is expected to intensify due to increased fuel prices and other factors, the proportion of electricity met by auto generation will generally level out. Regarding fuel cells for stationary application, the reference case assumes a limited number of installations judging from the state of technology development and costs. Given these assumptions, the volume of electricity sold is expected to grow in parallel with the growth of electricity demand. Lighting services mainly for household use will show firm growth, as stated above, thanks to increasing home electrical appliances and adoption of all-electrical lifestyles. Power services including the deregulated demand will expand mainly in the fields of machinery manufacturing and business operations.

Table 26 Prospects for electricity sales by utilities

(Unit: TWh)

	Actual			Forecast			Mean annual growth rate (%)				
	1980	1990	2004	2010	2020	2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total	464.3	678.1	892.1	982.8	1,071.4	1,116.4	3.9	2.0	1.6	0.9	0.4
Lighting services	105.3	177.4	272.6	295.5	339.6	362.2	5.4	3.1	1.4	1.4	0.6
Power services (including deregulated demand)	359.0	500.7	619.6	687.4	731.9	754.2	3.4	1.5	1.7	0.6	0.3

3.5.2 Oil demand

The demand for oil, which constitutes about 50% of the primary energy supply, currently shows a decreasing trend that is expected to continue in the future, and we expect that the dependency on oil will drop to below 40% by 2030. The major factors of the decrease in demand are the shift to electricity and city gas in both the industrial and residential and commercial sectors, and a decrease in the requirement for automobile fuels.

In the industrial sector, oil demand will drop with a significant decrease in the amount of oil consumed for producing chemical products, and a major replacement of oil fuels by electricity and city gas. Adding to the disuse of oil for environmental reasons and for convenience, changes in the industrial sector will also contribute largely to decreased oil demand. Oil demand will drop in the residential and commercial sector as well due to expanded use of gas and electricity for space and water heating. In the transport sector, oil demand will drop significantly due to a decrease in the number of owned automobiles and the improvement of fuel consumption efficiency.[4]

Looking at different types of oil fuels, the demand for automobile fuels, gasoline and diesel oil, will decrease. The number of owned passenger vehicles is expected to grow in the short-term future, but most of the increase will come from the purchase of second cars in households, particularly light cars, that will not cover much travel distance. Moreover, the Top Runner standards and the market penetration of hybrid vehicles will improve the fuel consumption efficiency. Given these factors, we expect that demand for gasoline will start to decrease within several years. The number of owned automobiles is expected to peak around 2020, and in subsequent years, demand for gasoline will show an even clearer decreasing trend. The sales volume of diesel oil peaked in 1996 and is already decreasing along with the number of diesel passenger and freight vehicles. The decrease in demand for diesel oil is expected to continue in the future with decreases in the number of owned diesel-powered vehicles.[5]

The production of naphtha, the raw material for ethylene from which various petrochemical products are made, peaked in 2004 and is expected to decrease in the future as ethylene production decreases, and moreover, because the share of LPG as the raw material for ethylene is showing signs of a slight increase with the diversification of raw materials for ethylene.

The demand for kerosene and fuel oil A, which are mainly used for space heating, is expected to show a decreasing trend toward 2030 due to decreased heating demand resulting from the population decrease and improvement of building insulation, as well as the growing proportion of gas-fueled and electric heating appliances. The demand for kerosene and fuel oil A from the agriculture, forestry and fishery sectors will decrease with diminished activities in these sectors.

Regarding fuel oil C, demand from electric utilities is expected to decrease, with the exception of demand from peak load plants, and the demand from autoproducers of electricity is also expected to decrease due to a shift from conventional monogeneration to gas-fired cogeneration. The demand from process heat applications will also decrease due to expanded use of gas-fired applications that are more convenient and environment-friendly. With these factors, and due to changes in the industrial structure, demand for fuel oil C will drop significantly. Even though the demand will decrease with most oil fuels, the drop in demand for fuel oil will be most significant, resulting in a larger share of more refined oil fuels.

Demand for LPG will decrease in the residential sector due to a shift in demand to city gas and electricity, but it will increase in the industrial and commercial sectors due to a shift in demand from fuel oil. While the LPG demand from taxis will decrease, the demand from trucks will increase with the additional number of LPG-fueled trucks. The LPG sales quantity,

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[4] We expect little progress in the use of non-oil fuels such as natural gas; most automobile fuels in the future will be oil-based fuels as they are now.

[5] As gasoline hybrid vehicles will become popular, we assume that diesel passenger cars will not have much marketability due to poor economic performance and public impression.

therefore, is expected to grow slightly in the future.

Table 27 Prospects for oil products sales

(Unit: GL)

	Actual			Forecast			Mean annual growth rate (%)				
	1980	1990	2004	2010	2020	2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total of all fuel oils	209.22	218.01	237.21	221.47	202.19	178.81	0.4	0.6	-1.1	-0.9	-1.2
Gasoline	34.54	44.78	61.47	62.16	59.88	53.36	2.6	2.3	0.2	-0.4	-1.1
Naphtha	26.30	31.42	48.99	43.99	39.41	35.24	1.8	3.2	-1.8	-1.1	-1.1
Jet fuel	2.97	3.74	4.91	5.32	5.62	5.54	2.3	2.0	1.3	0.6	-0.1
Kerosene	23.57	26.70	27.98	28.14	26.73	23.26	1.3	0.3	0.1	-0.5	-1.4
Diesel oil	21.56	37.68	38.20	33.23	29.06	26.48	5.7	0.1	-2.3	-1.3	-0.9
Fuel oil A	21.08	27.07	29.10	26.22	24.02	21.74	2.5	0.5	-1.7	-0.9	-1.0
Fuel oil B and C	79.20	46.62	26.56	22.42	17.47	13.20	-5.2	-3.9	-2.8	-2.5	-2.8
LPG (Unit: Mt)	13.95	18.78	17.89	18.73	18.93	19.08	3.0	-0.3	0.8	0.1	0.1

3.5.3 Natural gas demand

Among all the fossil fuels, natural gas is the only fuel for which the demand is expected to grow. The proportion of natural gas demand in the total primary energy supply is currently 14% and is expected to reach about 18% by 2030. The growth of natural gas demand will be due mostly to the increased requirement for natural gas for city gas production in terms of convenience and environmental factors. Natural gas demand from electric power utilities will grow only slightly.

The city gas sales volume will show stable growth mostly due to increased demand from the industrial and commercial sectors. However, demand from the residential sector will decrease. Growth of city gas consumption by water heating and cooking is inhibited by a decrease in the number of persons per household. Consumption of city gas per household has already turned to decrease. Gas sales in the residential sector will decrease in the future due to further decreases in city gas consumption per household, resulting from such factors as the growing popularity of all-electric design, as the expansion of the city gas service area will reach a limit and the number of households will stop growing.

In the industrial sector, against the backdrop of heightening environmental concerns and the sharp increase in the oil price in recent years, a rapid shift in demand from oil to gas is taking place, resulting in an increased demand of more than 10% from the previous year. The implementation of gas-fired cogeneration systems by the food and machinery industries, in particular, is contributing to increased demand. Even though growth will gradually slow down in the future as the number of new installations decreases and the LNG price reaches equilibrium with the oil price when compared based on thermal quantity, demand growth in the industrial sector will still be faster than in any other sector.

City gas demand from the commercial and other sectors, including demand from hospitals and public facilities, is growing not only with the installation of gas-fired cogeneration systems but also with the growing popularity of gas-fueled space cooling systems. Due also to the replacement of oil by gas as a fuel for space heating and the expansion of service industries, city gas sales will grow firmly in the commercial and other sectors. While demand from the residential sector constituted more than half the demand in the past, its proportion will drop to below 20% by 2030 as the proportion of industrial demand becomes dominant. As a result, the sales volume will be affected not only by changes in the ambient temperature as in the past, but also by changes in production activities.

Table 28 Prospects for city gas sales

(Unit: One million m^3, 1 m^3 = 10,000 kcal)

	Actual			Forecast			Mean annual growth rate (%)				
	1980	1990	2004	2010	2020	2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total demand	9,302	15,367	30,138	36,059	41,482	45,482	5.1	4.9	3.0	1.4	0.9
Residential sector	5,649	7,764	9,463	9,182	8,818	8,422	3.2	1.4	-0.5	-0.4	-0.5
Commercial sector	1,616	2,562	4,712	5,638	6,725	7,452	4.7	4.4	3.0	1.8	1.0
Industrial sector	1,469	4,019	13,285	17,858	21,731	24,848	10.6	8.9	5.1	2.0	1.3
Other sectors	568	1,021	2,678	3,381	4,208	4,760	6.1	7.1	4.0	2.2	1.2

LNG demand from electric power utilities is expected to be stable in the future. As the proportion of nuclear power in the utilities' generation mix will increase, growth in the output from LNG-fired plants will be less than the growth of the total generation output. Since generation efficiency at LNG-fired plants will gradually improve, demand for LNG as generation fuel will not grow as fast as the output from LNG-fired plants. LNG demand from electric power generation plants, therefore, will increase only slightly.

3.5.4 Coal demand

Coal demand will gradually decrease due to such factors as declining production of crude steel and cement. Consumption of raw material coal in crude steel manufacturing, in particular, will decrease with less steel produced by blast furnaces, and with the introduction of energy efficiency technologies such as pulverized coal blowing, high-efficiency burners and next-generation coke furnaces. Demand for steam coal, mostly used for electric power generation, boomed in the past as coal-fired power generation increased sharply under the fuel diversification policy adopted after the Oil Crisis, but major growth in the future is unlikely due to environmental concerns. Nevertheless, we may expect stable demand for coal in the future because of such advantages as supply stability and economy.

4. TECHNOLOGY DEVELOPMENT CASE

4.1 Basic Concept

It is extremely difficult to make accurate predictions concerning the degree of technology development in the future in terms of the timing of technology development, progress, and practical application, and also in terms of how fast new technologies will penetrate the market. New technologies in the field of energy enable significant improvements in energy use efficiency, and thus can potentially make very large contributions to energy security and global environmental protection through increased energy self-sufficiency and decreased CO_2 emissions.

Therefore, with the technology development case, we made assumptions concerning various energy-saving technologies and new energy technologies currently under development or in the initial stage of implementation, that their market penetration will be more extensive than assumed in the reference case and thus manifest their full potential, thanks to breakthroughs in technology development, etc.

4.2 Assumptions and Views on Different Technologies

4.2.1 New technologies implemented mostly by the industrial and commercial sectors

The technology development case assumes that various new technologies currently in the development or demonstration stage will be materialized for practical use and released to the market. The choice of technologies and energy-saving effects in assumptions are based on the "2030 Energy Supply and Demand Forecast" made in March 2005 by the Advisory Committee for Natural Resource and Energy. Major new technologies assumed in technology development include:

- Ultra-micro LSI technologies (extreme-ultraviolet exposure system, leading-edge system LSI engineering, etc.)
  Smaller semiconductor chips with a higher level of integration will achieve higher functionality with less energy consumption. If optical lithography can reduce the wiring pitch from 130 nm (present level) to 45–65 nm, the integration level will multiply by a factor of about 4 to 9.
- Energy-saving technologies for personal computers and servers
  While many energy-saving technologies are studied and developed for these applications, we made the following assumptions concerning major technologies. Organic EL device technology will enable the production of highly energy-efficient and highly luminous display panels. Optical mass storage technology, which uses optical technologies for data storage, will enable larger storage capacity and faster record/replay operation with less electric power consumption. Non-volatile memory will also allow faster record/replay operation with less electric power consumption.
- Optical communication technologies (photonic network technology, intense pulsed light optical electronics technologies, etc.)
  These technologies for fully optical networking will enable faster communication and larger capacity with less consumption of electric power. Even though communication

through optical signals is a technique already in use, optical signals currently must be converted to electric signals for line switching, constituting a bottleneck in communication capacity.

- Nano-composite structure control technologies
  These technologies will be used to directly control material structures at atomic and molecular levels and produce materials having desired features. The availability of materials with superb thermal insulation performance, durability and other features will facilitate the development of high-efficiency appliances and installations with energy-saving effects.

The use of new technologies such as those listed above is expected to produce an energy-saving effect of about 6.3 Mtoe by 2030.

4.2.2 Top Runner standards

Among those appliances used in the residential and commercial sector and covered by the Top Runner standards, there are some types for which the target year has already passed. Even though the target value remains effective after the target year, there are some appliances for which the establishment of a new target value is either planned or considered. In the past, only CRT-type television sets were covered by the Top Runner standards. In 2005, however, television sets with thin display panels were included in the scope of the standards in consideration of the rapid change in the type of television sets sold (sales of LCD and plasma display television sets surpassed the sales of CRT television sets).

Table 29 Next-phase Top Runner standards for major appliances in the residential and commercial sector

	Control target	Target year	Energy-saving effect
Refrigerators	kWh/year	To be decided	To be decided
CRT TV sets	kWh/year	-	The present target level must be maintained
LCD, PDP TV sets	kWh/year	FY2008	About 15.3% improvement from the FY2004 level
Air conditioners for both space cooling and heating	COP	FY2010 for refrigeration and A/C industries	About 23% improvement from the FY2005 level

In the technology development case, we made assumptions concerning the expected introduction of Top Runner standards in the future. For some household electric appliances that are currently not covered by the standards, we assumed that their efficiency will also improve thanks to the development of peripheral technologies.

4.2.3 Clean energy vehicles

In the technology development case, we assume that market penetration of hybrid vehicles will be accelerated at an early stage and that they become common as passenger vehicles by around 2030, numbering more than 25 million (over 60% of the passenger vehicle sales). As for fuel cell vehicles, we assume that their prices will drop to a competitive level, and as hydrogen stations are built, they will begin to penetrate the market in a substantial manner, particularly in large cities, starting around 2020. We assume that the number of fuel cell vehicles will be slightly more than 5 million by 2030 (1/3 of 15 million, which is supposed to be the Government's target). Even though natural gas vehicles and LPG trucks will be used particularly by environment-oriented corporations and municipalities, their economic and environmental advantages are expected to show a relative decline as fuel cell vehicles become more popular. Therefore, even in the technology development case, we kept the low forecast made in the reference case.

Concerning fuel cell vehicles, we assume the use of direct hydrogen feeding (off-board reforming) because onboard reforming is expected to be difficult. Concerning the hydrogen supply, we assume that large, central stations (offsite stations) will conduct by-product gas recovering, LNG reforming and oil product reforming, while smaller, distributed stations (onsite stations) will mostly conduct city gas reforming. Considering reforming efficiency, raw material cost and transportation cost, we assume that onsite reformation of city gas will be the major form of supply. Electrolysis requires a higher cost, and therefore, its use will be limited. Vehicles running on hydrogen produced by electrolysis with renewable electric power are unlikely to appear in the period up to 2030, even though they are deemed as ideal non-polluting vehicles.

4.2.4 Other demand-side energy-saving measures

The number of installations of high-efficiency water heaters has been growing gradually with incentives from subsidies. At this time, however, conventionally designed water heaters still dominate the market. As the market penetration and energy efficiency of high-efficiency water heaters may improve in the future with the lowering of production costs and further technology development, and also that the efficiency of conventional-type water heaters may show gradual improvement even after the target year set by the Top Runner standards, we assume that the mean efficiency of water heaters sold in 2030 will be of the level achieved by today's high-efficiency water heaters.

Concerning high-efficiency light technologies, we assume that their use in common commercial applications will start from the mid 2010s, and that the number of installations will grow gradually. Regarding their use in common household applications, we assume that installations will be limited unless the consumer mindset changes significantly, because of the cold, hard impression associated with LED(Light Emitting Diode) lamps and the low color rendering performance. Regarding the use of LEDs in traffic signals, we assume that the speed of growth in the installation rate achieved by the Tokyo Metropolis, currently the top installer of LED traffic signals, will be achieved in other parts of Japan.

Regarding energy management systems, we assume that the high-efficiency BEMS(Building Energy Management System) will improve energy efficiency by 10% as it is operated properly in the commercial sector with heightened awareness about energy-saving. Concerning HEMS(Home Energy Management System) for households, there is a possibility that it will be spread. Their contribution to energy-saving, however, will be limited. Because it will be difficult to use them in a way that would produce high energy-saving effects without a major change in the level of consumer awareness, as with high-efficiency lighting appliances.

4.2.5 New energy

Concerning the use of photovoltaic and wind power in the electric power generation sector, the technology development case assumes that their share will increase significantly with further improvement in generation efficiency and accelerated reduction in production costs, resulting in part from mass production. As for waste-burning and biomass power generation, we postulated little difference between the reference case and the technology development case because of expected restrictions concerning fuel supply.

Concerning solar heat utilization, the technology development case assumes a stronger shift from solar water heaters to solar systems with both space heating and water heating features. However, we increased the total number of expected installations only moderately from the reference case. Regarding utilization of heat from waste burners, it is assumed that the amount of heat utilized will increase as more of the waste that is currently used for landfill begins to be used for this purpose. As for automotive biofuels, it is assumed that “E10” fuels will be introduced in view of the export capacity of Brazil and other producers of ethanol for biofuels.

4.2.6 Distributed generation

As for fuel cells for stationary application, the technology development case assumes that further technology development will meet such challenges as lower price and longer life of installations, and that the generation capacity from fuel cells will reach about 5 million kilowatts by 2030, as fuel cells are used in 6% of households. Concerning cogeneration systems, even though we expect improved economic performance with higher generation and thermal efficiency, we do not expect major growth in installed capacity due to such factors as lower electricity demand, resulting from further progress in energy-saving, and competition with stationary fuel cells that will become more popular.

4.2.7 Energy-saving by electric power utilities

The technology development case assumes improved efficiency at LNG-fired thermal power plants with, for example, extensive implementation of more advanced combined cycle generation technology (MACC). On the other hand, decreases in electricity demand from the utilities, resulting from the use of stationary fuel cells and from progress in energy-saving, will inhibit speedy construction of new generation plants, slowing down the general improvement of power plant efficiency inclusive of older plants.

4.2.8 Energy-saving in the crude steel and coke manufacturing sectors

Major energy-saving efforts at blast furnaces include utilization of waste energy and reduction of coke consumption by using the pulverized coal blowing technique. Reduced consumption of coke will lead to reduced consumption of energy and coal by the coke manufacturing industry. In FY2004, manufacturing a single ton of steel in a blast furnace consumed 383 kg of coke and 126 kg of pulverized coal. Ongoing technology development efforts aim at reducing the amount of pulverized coal blow-fed in normal operation to about 200 kg per single ton of steel yield. Considering that it was proven in one of the blast furnaces in 1998 that the amount of blow-fed pulverized coal consumed per ton of steel yield could be as low as 266 kg, the technology development case assumes that this will be the mean consumption level by 2030, averaged over all blast furnaces in Japan.

The following summarizes assumptions described above concerning the technology development case:

Table 30 Assumptions concerning the technology development case

	Reference case	Technology development case
Introduction of new technologies	-	Energy-saving of 6.3 Mtoe by 2030: About 4.0 Mtoe saved in the industrial sector and about 2.3 Mtoe saved in the commercial sector.
Effects of the Top Runner standards and other efforts	Assumes the achievement of goals set by the existing Top Runner standards.	Includes the effects of Top Runner standards currently under planning. Assumes the improvement of appliances not covered by Top Runner standards.
High-efficiency appliances	Assumes growth in the scale of implementation at the present speed.	Assumes accelerated growth in the scale of implementation.
Energy management	Assumes 3% energy-saving by BEMS. No introduction of HEMS	Assumes 10% energy-saving by BEMS. No introduction of HEMS
Clean energy vehicles	About 11 million clean energy vehicles in 2030 (mostly hybrid vehicles).	About 32 million clean energy vehicles in 2030: About 26 million hybrid vehicles and about 6 million fuel cell vehicles.
New energy sources (excluding black liquor, etc.)	About 12 million kL in 2030 Photovoltaic: about 15 GW Wind power: about 6 GW	About 21 million kL in 2030 Photovoltaic: about 33 GW Wind power: about 10 GW
Stationary fuel cells	About 0.15 GW in 2030	About 5 GW in 2030
Electric power generation by the utilities	Assumes general improvement of generation efficiency.	Assumes higher improvement of generation efficiency at LNG-fired plants.

4.3 Calculation Results

The supply of primary energy in Japan will start to decrease shortly after FY2010, thanks to various energy-saving measures in final energy consumption. With the technology development case, the amount of energy-saving achieved in 2030 will be 46 Mtoe more than the amount estimated with the reference case. The decrease in Japan's primary energy supply will be larger than the 23-Mtoe reduction in final energy consumption because of the additional contributions from energy-saving in the energy transformation sector and from decreased consumption of fuel by the power generation sector, resulting from decreased final consumption of electricity. Comparing final energy consumption by sector, the transport sector will achieve the largest amount of energy-saving (8 Mtoe) with a major contribution from the extensive use of clean energy vehicles.

Table 31 Prospects for primary energy supply
(Technology development case)

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Coal	**80**	17.3	**118**	21.7	**103**	19.2	**96**	18.3	**88**	18.0	2.8	-2.2	-0.8	-0.8
Oil	**264**	56.6	**256**	47.1	**240**	44.6	**210**	40.2	**174**	35.7	-0.2	-1.1	-1.3	-1.8
Natural gas	**49**	10.6	**78**	14.4	**80**	14.9	**81**	15.6	**76**	15.6	3.4	0.4	0.1	-0.6
Nuclear	**46**	9.8	**61**	11.2	**83**	15.4	**97**	18.7	**104**	21.4	2.1	5.4	1.6	0.7
Hydro and geothermal	**21**	4.5	**22**	4.0	**21**	3.8	**21**	4.0	**21**	4.3	0.3	-1.1	0.3	0.0
New energy	**6**	1.3	**9**	1.6	**11**	2.0	**17**	3.2	**24**	5.0	2.4	3.9	4.4	3.7
Total primary energy supply	**466**	100.0	**544**	100.0	**538**	100.0	**522**	100.0	**487**	100.0	1.1	-0.2	-0.3	-0.7
Substantial GDP (trillion yen)	449		526		593		687		770		1.1	2.0	1.5	1.1
Energy consumption per GDP (100 = FY1990 level)	100		99		87		73		61		0.0	-2.2	-1.8	-1.8
CO_2 emission (one million carbon-equivalent tons)	287		331		308		280		244		1.0	-1.2	-0.9	-1.4
(100 = FY1990 level)	100		115		107		98		85					

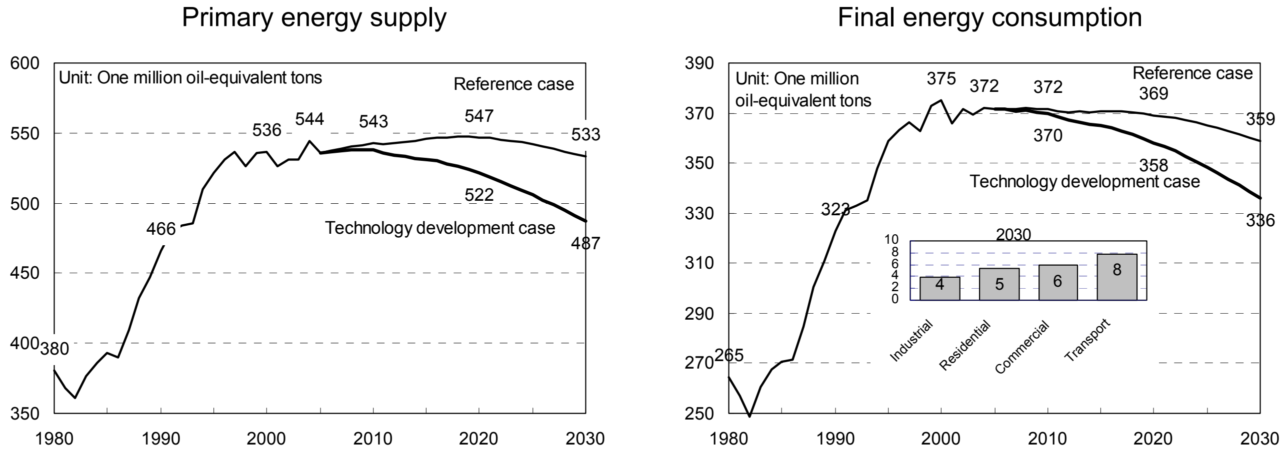
Table 32 Prospects for final energy consumption
(Technology development case)

(Unit: 10^{13} kcal)

	Actual				Forecast						Mean annual growth rate (%)			
	FY1990		FY2004		FY2010		FY2020		FY2030		2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
		(%)		(%)		(%)		(%)		(%)				
Total final energy consumption	**323**	100.0	**372**	100.0	**370**	100.0	**358**	100.0	**336**	100.0	1.0	-0.1	-0.3	-0.6
(Breakdown by sector)														
Industrial sector	**170**	52.5	**178**	47.8	**179**	48.2	**175**	49.0	**171**	50.8	0.3	0.1	-0.2	-0.3
Resi. and com. sector	**79**	24.4	**102**	27.5	**104**	28.1	**103**	28.8	**100**	29.7	1.9	0.3	-0.1	-0.4
Residential	**43**	13.3	**54**	14.5	**53**	14.4	**52**	14.6	**50**	14.8	1.7	-0.2	-0.2	-0.5
Commercial	**36**	11.2	**48**	13.0	**50**	13.6	**51**	14.2	**50**	14.8	2.1	0.8	0.1	-0.2
Transport sector	**74**	23.0	**92**	24.7	**88**	23.7	**79**	22.2	**66**	19.5	1.5	-0.8	-1.0	-1.9
Passenger transport	**44**	13.7	**60**	16.0	**58**	15.6	**53**	14.8	**44**	13.1	2.1	-0.5	-0.8	-1.9
Freight transport	**30**	9.3	**32**	8.7	**30**	8.1	**26**	7.3	**22**	6.5	0.5	-1.2	-1.3	-1.9
(Breakdown by energy source)														
Coal	**42**	13.0	**39**	10.5	**37**	10.1	**37**	10.2	**34**	10.1	-0.5	-0.8	-0.2	-0.8
Oil	**196**	60.6	**216**	58.0	**203**	55.0	**184**	51.4	**157**	46.7	0.7	-1.0	-1.0	-1.6
Gas	**16**	4.9	**26**	7.1	**30**	8.1	**31**	8.8	**35**	10.3	3.7	2.1	0.5	1.0
Electricity	**65**	20.2	**87**	23.4	**94**	25.5	**98**	27.3	**98**	29.1	2.1	1.4	0.3	0.0
New energy, etc.	**4**	1.4	**4**	0.9	**5**	1.3	**8**	2.2	**10**	2.9	-1.6	5.4	4.9	2.3

Looking at final energy consumption through the use of different energy sources, oil consumption will decrease by 15 Mtoe with major contributions from higher fuel consumption efficiency and the introduction of biofuels in the transport sector. Electricity consumption will decrease by 11 Mtoe with major contributions from energy saved in the residential, commercial and industrial sectors, thanks to the Top Runner standards concerning electricity demand from households, and the effects of new technologies and energy management concerning electricity demand from the commercial sector.

Fig. 3 Prospects for primary energy supply and final energy consumption (Technology development case)



CO_2 emissions from fuel combustion will be reduced by 40 million carbon-equivalent tons by 2030. Looking at contributions from different sectors, the industrial sector will contribute the most to reduction even though the sector is expected to achieve the least energy-saving in terms of final energy consumption. This is attributable to the following factors: a significant reduction in electricity demand; decreased consumption of fuel for electric power generation with increased efficiency of cogeneration systems, combined with decreased final consumption of fuels; and reduced consumption of coke that has a high carbon emission factor. In contrast, the reduction of CO_2 emission by the transport sector will be small compared with the major reduction in final energy consumption that the sector will achieve because the latter reduction is entirely attributable to energy-saving from consuming less fuel.

Fig. 4 Prospects for emission of energy-derived CO_2
(Technology development case)

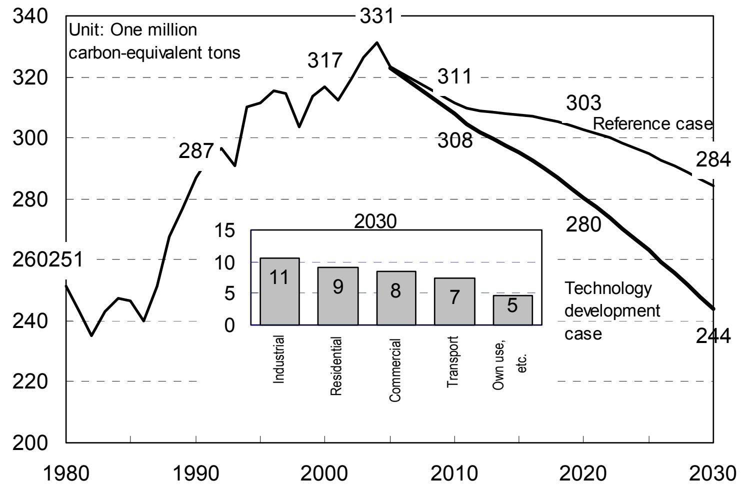


Table 33 Analysis of factors contributing to CO_2 emission
(Technology development case)

(Unit: Annual rate of change in percentage)

	1973–1990	1990–2004	2004–2030	
			Reference case	Technology development case
Total change in CO_2 emission:	0.8	1.0	-0.6	-1.2
Contribution from decreased carbon factor	-0.7	-0.1	-0.5	-0.8
Contribution from improved energy efficiency	-2.1	0.0	-1.5	-1.9
Contribution from economic growth	3.8	1.1	1.5	1.5

5. SENSITIVITY ANALYSIS

While a number of different factors influence energy supply and demand, we refer to two factors, namely, economic growth rate and international energy price, due to the importance of their impact on the supply and demand structure and the significance of their future uncertainty. We analyze how changes in these two factors affect energy supply and demand.

5.1 High Economic Growth Case

The direction of macro economy may change substantially in a long term depending on policies and international economic trends. The high economic growth case assumes that the global economy will develop more favorably and Japan's economy will grow at an annual average rate 0.5% higher than the reference case, thanks to the positive feedback cycle represented by export growth → production growth → investment growth → income growth → consumption growth → production growth.[6]

Table 34 Real GDP growth rate (%) assumed in the high economic growth case and reference case

	2010 / 2004	2020 / 2010	2030 / 2020	2030/ 2004
High economic growth case	2.5	2.0	1.6	2.0
Reference case	2.0	1.5	1.1	1.5

Faster economic growth by an annual average rate of 0.5% will result in increased final energy consumption by 0.2% compared with the reference case. Generally speaking, business entities are more sensitive than households to economic trends and the industrial, commercial and freight transport sectors are a little more affected by a difference in the economic growth rate. Still, the elasticity coefficient as a measure of the relationship between energy consumption and GDP is around 0.4, which is not very large. The higher energy consumption predicted with the high economic growth case will result in CO_2 emission 0.3% higher than predicted with the reference case. The expected increase in CO_2 emission is sharper than the expected increase in energy consumption because a high proportion of the latter increase is attributable to increased electricity demand. In meeting the additional electricity demand, an amount of energy 2.5 times as large as the output must be consumed. Since assumption concerning rapid economic growth driven by export implies higher growth in machinery production, and electric demand from the commercial sector is expected to grow faster, the amount of electricity sales is expected to increase by 0.3% compared with the reference case. With an accelerated shift in demand to city gas in the industrial and commercial sectors (inclusive of fuel demand for auto generation), the amount of city gas sales will increase by 0.4% compared with the reference case.

[6] We use the high economic growth case for conducting sensitivity analyses that address the impact of economic growth. We do not consider such scenarios as the higher growth of global economy leading to stringent supply-demand balance in the international energy market, resulting in a higher energy price.

Table 35 Mean growth rate (%) of energy demand (2004–2030)

	Real GDP	Final energy consumption	CO_2 emission	Fuel oil sales	City gas sales	Electricity sales
High economic growth case	2.0	0.1	-0.3	-0.9	2.0	1.2
Reference case	1.5	-0.1	-0.6	-1.1	1.6	0.9
Difference in the growth rate	0.5	0.2	0.3	0.2	0.4	0.3

5.2 High Energy Price Case

It is very difficult to precisely predict changes of international energy prices such as for oil because they are heavily influenced by international political and economic affairs. The high energy price case assumes that the supply and demand balance of crude oil will become more stringent than assumed in the reference case due to insufficient investment in oil development. The oil price in 2030 is assumed to be $60 per barrel, which is $15 higher than assumed in the reference case. It is assumed that the LNG price will rise with the oil price. On the other hand, it is assumed that the coal price will be influenced only slightly by the sharp increase in oil and LNG prices.

Table 36 Assumptions concerning international energy prices
in the high energy price case and reference case

		Real prices (Actual 2004 prices)				Nominal prices			
		2004	2010	2020	2030	2004	2010	2020	2030
Crude oil	$/bbl (High energy price case)	39	45	50	60	39	51	69	100
	(Reference case)		40	42	45		45	58	75
LNG	$/t (High energy price case)	277	322	380	484	277	363	522	810
	(Reference case)		286	317	364		322	435	609
Steam coal	$/t (High energy price case)	56	49	50	51	56	55	69	85
	(Reference case)		49	50	51		55	69	85

In the high energy price case, we assumed that an increase in international energy prices will slow down economic growth by a mean annual rate of 0.2%. It should be noted, therefore, that the estimated energy demand reflects both slower economic growth and high energy prices.

The assumption of mean annual oil/LNG prices being 1.1% higher results in a 0.2% decrease in final energy consumption compared with the reference case. If we simply take the 0.4 elasticity coefficient gained in the high economic growth case as a measure of the relationship between energy consumption and GDP, approximately 0.1% of the given 0.2% is attributable to slower economic growth and the remaining 0.1% to high energy prices. While the amount of various energy carrier sales will decrease equally by 0.2% compared with the reference case, a drop in the amount of fuel oil sales is slightly more significant than a drop in the amount of other energy carrier sales when we discount the influence from slower economic growth.

Table 37 Mean growth rate (%) of energy demand (2004–2030)

	Oil/LNG prices	Real GDP	Final energy consumption	CO_2 emission	Fuel oil sales	City gas sales	Electricity sales
High energy price case	1.7	1.3	-0.3	-0.8	-1.3	1.4	0.7
Reference case	0.6	1.5	-0.1	-0.6	-1.1	1.6	0.9
Difference in the growth rate	1.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2

6. SUMMARY AND IMPLICATIONS

Summary:

Assumptions made prior to estimations

We assume high energy prices and environmental restrictions with the following background:

- ✓ We account for population decrease and aging society. We assume that the annual average economic growth rate up to 2030, would be 1.5%.
- ✓ Concerning the oil price, we assume that today's overly high price level would be corrected, but that the oil price would start rising again after 2010 and reach the real price of $45/bbl in 2030.
- ✓ We assume a shift to higher value-added products in industries.
- ✓ We assume progress in the development and implementation of energy-saving technologies, and more expanded use of renewable energy.
- ✓ We assume a shift to lower carbon factor energy and stable progress in the utilization of nuclear power.

Summary of the outlook

- Due to the maturing of the economy, population decrease and progress in energy-saving, we expect, even with the reference case, that final energy consumption will decrease, and that final energy consumption in 2030 will be 4% less than the 2004 level. (In this case, we can say that final energy consumption peaked in FY2000). Compared with the reference case, final energy consumption in 2030 will be 6% less with the technology development case, 6% more with the high economic growth case, and 4% less with the high energy price case.
- In this situation, electricity demand will grow due to such factors as the pursuit of

amenity and convenience in the residential and commercial sector and a shift to higher processing products in the industrial sector, but growth will gradually slow down. With the technology development case, it is expected that electricity demand will level out in 2020 and subsequent years, thanks to further improvement in efficiency of household electric appliances.

- Gas demand, particularly in the industrial and commercial sectors, will grow due to such advantages as environmental friendliness and convenience. The amount of city gas sales is expected to grow in all of the postulated cases. The amount of city gas sales will be 45.5 billion m^3 with the reference case and 50 billion m^3 with the high economic growth case, which are increases of 50 to 66% from the 2004 level. We will be faced with the challenge of stable supply of LNG as an important resource.
- Oil demand will continue to decrease due to sluggish growth of transport demand and improvement of fuel consumption efficiency achieved by automobiles. With the technology development case, an even larger decrease in oil demand is expected, based on the assumption of even higher fuel consumption efficiency achieved by automobiles. The amount of fuel oil sales will decrease in all of the postulated cases. Compared with the reference case, the amount of fuel oil sales in 2030 will be 10 million kL more with the high economic growth case and 19 million kL less with the technology development case. The difference among cases, therefore, is quite large.
- Dependency on oil will drop from the present level of 47% to 37%. Oil, however, will continue to be dominant as a primary energy source. With the technology development case, we assume that dependency will drop to 36%.
- Nuclear power, which can contribute much to improvement of energy self-sufficiency and reduction of global warming gas emissions, will continue to serve as a major energy source for electric power generation. The proportion of nuclear power in generated electricity will reach 41% in 2030 with the reference case (47% with the technology development case, 38% with the high economic growth case and 43% with the high energy price case).
- Regarding new energy, in spite of high expectations concerning solar and wind power, the amount of energy available in 2030 from new energy sources (excluding black liquor, scrap wood and similar sources) is expected to be equivalent to 12.39 million kL of oil, which amounts to only 2% of the total primary energy supply, even though it is three times as much as the energy available today from new energy sources. With the technology development case, we expect that the energy available from new energy sources will be equivalent to 26.21 million kL of oil, which means a share of about 5%. More substantial market penetration of new energy is expected to take place after 2030.
- After reaching the current peak, the CO_2 emission is expected to decrease in line with the falling energy demand and expanding share of non-fossil energy sources. The level in 2030 will be 14% less than that in 2004. With the reference case, which only

assumes the set of present-day technologies and the results from various programs already in effect, the CO2 emission in 2010 is expected to be 8.5% greater than in 1990, exceeding the reduction goal for this year (0.6% increase from the 1990 level). To achieve the reduction goal, it is important that various additional measures, currently being prepared by the Government, are implemented steadily.

- Even with the high economic growth case, CO_2 emission is expected to start to decrease after peaking out in 2004. However, CO_2 emission will be 10% higher in 2010 and 6% higher in 2030, compared with the 1990 level. Thus, CO_2 emission will never decrease to the 1990 level within the given period.
- With the high energy price case that assumes a higher oil price, CO_2 emission in 2010 will be 8% higher than in 1990, but CO_2 emission in 2030 will be 7% lower than in 1990.
- With the technology development case, CO_2 emission in 2010 will be only 1% less compared with the reference case, but CO_2 emission in 2030 will be 14% less, which is a big difference. Less consumption of electricity (which significantly reduces primary energy consumption) and higher efficiency achieved by the electric power generation sector contribute much to this reduction in CO_2 emission. The major difference in the level of achievement between 2010 and 2030 is attributable to the substantial penetration of new technologies assumed in the technology development case can only start from 2010.

<u>Implications</u>:

[Best mix of fossil fuels]

1. Oil

With the reference case, Japan's oil demand will drop from 277 million kL (4.78 million B/D) as of 2004 to 214 million kL (3.69 million B/D) as of 2030. The share of oil among the primary energy sources will drop from 47.1% to 37.2%. Still, oil will be the largest source of energy.

Considering that more than 90% of imported oil currently comes from the Middle East, and that we cannot expect future increases in supply from non-OPEC countries, it is feared that Japan's dependency on the Middle East may continue at a high level in the future. Japan will be required to prepare self-developed oil resources and strengthen cooperative relationships with oil-producing countries in the Middle East, while actively trying to diversify supply sources by giving attention to non-conventional oil resources, such as oil sand in Canada, that have become comparable to conventional oil resources in terms of cost competitiveness.

Concerning ethanol-mixed gasoline that Japan is currently preparing to introduce into the market, Japan, in the meantime, is considering using supplies from Brazil, which will also contribute to the diversification of supply sources. While there are arguments concerning the choice to depend solely on Brazil, and concerning stable supply in case the ethanol content in fuels is increased (e.g. “E10”), one possible measure for stable supply would be to encourage Japanese corporations to become involved in the production of fuels, starting from the cultivation of sugar cane and other raw material crops in Brazil and other countries.

2. Coal

Since the availability of coal is not limited to a particular region of the world and it can be imported from advanced countries such as Australia and Canada, its use as an energy resource has the major advantages of stable supply and economy. Therefore, rather than discarding this option on the grounds of its high environmental impact, we should look for beneficial ways to use coal. Particularly for Asian countries where the energy demand is increasing sharply, it will be extremely important to be able to use abundant coal resources efficiently in accord with the environment. In the context of this challenge, Japan, with its accumulated know-how, will be able to play a major role.

3. Natural gas

Natural gas is cleaner than coal and oil, and is available in abundant supply from Asian and Pacific countries, as well as from Russian regions including Sakhalin. Among all types of fossil fuels, natural gas will show the most expanded use in the future. However, since the natural gas price has risen recently with sharp increases in the oil price, a major challenge will be to achieve economical use. We should produce strong bargaining power through coordination between the electric and gas sectors in Japan, as well as with South Korea and other LNG-importing countries, to achieve a lower LNG price and flexible supply arrangements. At the same time, the sales price in Japan must be reduced by improving the efficiency of the supply chain.

Besides natural gas, Japan should have a wide range of options at hand concerning the supply of all kinds of fossil fuels. This will not only increase Japan’s bargaining power but also contribute to stable supply.

[Market deregulation, stable supply and environmental protection]

Against the backdrop of further globalization of the economy and progress in structural reforms, the deregulation of energy markets is an essential challenge today that must be met. The process of deregulating the oil industry is almost complete, and discussions are almost finalized for most of the issues concerning deregulation of the gas industry. Discussions concerning deregulation of the electric power industry are currently at the final stage. It cannot be denied, however, that activities based on market principle tend to focus on short-term economic efficiency, which may not be quite adequate for the energy sector that requires various endeavors based on long-term perspectives.

Concerning the tradeoff between stable supply and economic efficiency, and concerning the way to reconcile economic efficiency with environmental restrictions, we will be required to establish a policy unique to Japan as a country that has little energy resources within its territory. The treatment of nuclear power in the context of deregulation is a particularly important issue requiring extensive discussion. Nuclear power plays a very important role in our efforts to reduce dependency on oil, improve energy security and make progress in environmental efforts. In future, the importance of nuclear power in these contexts will be even greater. Impartial judgment and clarification will have to be made, with emphasis on fairness, concerning the market arrangements that will be required to address the social costs that are often outside the market concerns, such as the costs required to address such issues as environmental protection and stable supply, and how such costs should be shared by the Government, energy suppliers and public.

[Environmental and stable supply strategies from a global perspective]

In view of the scale of environmental efforts required at the global level, Japan's efforts within its territory can only have limited effectiveness. Environmental strategies that address the entire Asian region, where energy demand is expected to grow, will be far more effective when looked at from a holistic point of view. The environmental support that Japan can offer through technology transfer and other programs is important not only in the context of fulfilling the obligations of developed countries, but also in view of major business opportunities that will arise as a byproduct. Japan leads the world with its state-of-the-art energy-saving and environmental technologies. It is important that Japan continues to support its economy with its technology resources.

However, new technologies tend to require huge investments and long-term efforts before they penetrate the market, which often cannot be covered by the private sector alone. Active support from the Government is called for.

[The Kyoto Protocol]

To meet Kyoto Protocol agreements, combine maximum domestic efforts with active implementation of international programs based on Kyoto mechanisms such as CDM and JI is required. Countries in the world have already started discussions over longer-term efforts concerning the Second Commitment Period (from 2013). Since the abatement of global warming will require major reduction in greenhouse gas emissions, the following issues are currently in focus: participation of all countries in the world, including developing countries, in a global effort to reduce emissions; coordination with energy security issues; and the role of technology in energy-saving and fuel-switching strategies as measures to achieve these goals. Thus, we should prepare and implement measures from an early stage against global warming abatement strategies from a long-term perspective.

Positioning on the forecasts given in this report:

This report presents estimates based on a set of assumptions with a logically and quantitatively integrated prediction method. Considering various uncertainty factors, there can be considerable deviation from these estimates. Therefore, we performed sensitivity analyses using the technology development case, and also with the supplemental postulation of the high economic growth case and the high energy price case, the results of which are included in this report. We hope that these forecasts serve as a reference and basis for studies and discussions concerning energy supply and demand in the future.

Staff members:

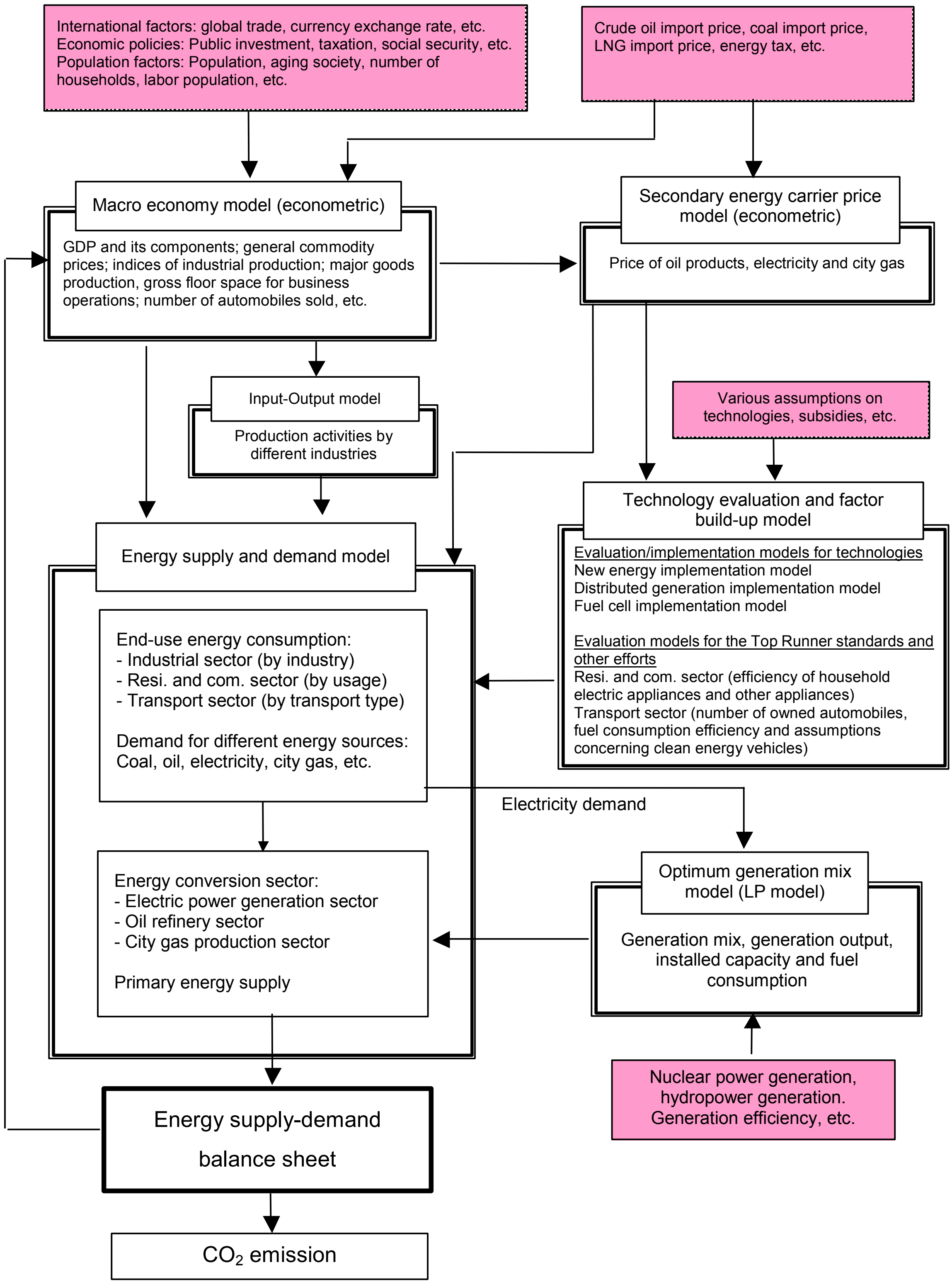
Managing Director	Kokichi Ito
Director, The Energy Data and Modelling Center	Yuji Morita
Senior Economist, The Energy Data and Modelling Center	Akira Yanagisawa
Senior Economist, The Energy Data and Modelling Center	Shigeru Suehiro
Economist, The Energy Data and Modelling Center	Ryoichi Komiyama
Senior Economist, The Energy Data and Modelling Center	Zhongyuan Shen

Support from:

Director, The Energy Data and Modelling Center	Hiromi Kato
Strategy and Industry Research Unit	
Global Environment and Sustainable Development Unit	

<Inquiries are received at: ieej-info@tky.ieej.or.jp>

EDMC/IEEJ Long-Term Energy Supply and Demand Model Configuration



The items in boxes are exogenous or given by other models.

Contact: report@tky.ieej.or.jp

Table 1 Macroeconomic and Social Indicators [Reference Case]

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Gross Domestic Product	Real GDP	Trillions of 2000 Yen	303.8	448.7	526.4	593.1	687.4	769.6	4.0	1.1	2.0	1.5	1.1
	Private Consumption		168.9	243.6	297.9	327.1	376.9	419.8	3.7	1.4	1.6	1.4	1.1
	Government Consumption		44.9	63.4	93.8	101.9	114.9	124.3	3.5	2.8	1.4	1.2	0.8
	Residential Investment		18.5	26.1	18.7	19.9	20.5	20.6	3.5	-2.4	1.0	0.3	0.0
	Private Investment		38.1	82.5	78.1	104.7	135.2	163.9	8.0	-0.4	5.0	2.6	1.9
	Public Investment		27.2	28.7	24.6	20.8	18.3	17.0	0.5	-1.1	-2.7	-1.3	-0.7
	Exports		23.3	36.5	69.6	93.1	119.7	150.4	4.6	4.7	5.0	2.5	2.3
	Imports		17.8	33.8	55.8	73.3	97.0	125.2	6.6	3.7	4.7	2.8	2.6
	Nominal GDP	Trillion Yen	244.1	446.5	496.2	590.8	836.3	1,110.3	6.2	0.8	3.0	3.5	2.9
	GDP per Capita	Thousand Yen	2,595	3,630	4,120	4,659	5,558	6,572	3.4	0.9	2.1	1.8	1.7
Growth Accounting	Labour Input	%							0.7	-0.5	-0.5	-0.6	-0.5
	Capital Input	%							1.8	0.5	0.9	0.8	0.6
	TFP	%							1.5	1.2	1.6	1.2	1.0

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Population, Households	Population	Million	117.06	123.61	127.78	127.29	123.67	117.10	0.5	0.2	-0.1	-0.3	-0.5
	Aged 0-14		27.51	22.49	17.73	16.92	14.92	13.16	-2.0	-1.7	-0.8	-1.2	-1.3
	Aged 15-64		78.84	85.90	85.08	81.67	74.24	69.22	0.9	-0.1	-0.7	-1.0	-0.7
	Aged 65 and over		10.65	14.90	24.88	28.69	34.51	34.72	3.4	3.7	2.4	1.9	0.1
	Share of Aged 65+	%	9.1	12.0	19.5	22.5	27.9	29.6					
	Number of Household	Million	35.83	41.16	49.84	51.41	51.70	50.45	1.4	1.4	0.5	0.1	-0.2

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Labour, Prices	Rate of Unemployed	%	2.1	2.1	4.6	4.1	4.0	3.9	0.0	5.8	-1.7	-0.3	-0.4
	Labour Force	Million	56.71	64.14	66.39	64.43	60.22	55.69	1.2	0.2	-0.5	-0.7	-0.8
	Employed	Million	55.52	62.80	63.32	61.76	57.81	53.55	1.2	0.1	-0.4	-0.7	-0.8
	GDP Deflator	CY2000=100	80.4	99.5	94.3	99.6	121.7	144.3	2.2	-0.4	0.9	2.0	1.7
	CGPI	CY2000=100	115.0	108.7	96.4	106.4	124.0	140.7	-0.6	-0.9	1.7	1.5	1.3
	CPI	CY2000=100	76.4	92.9	98.0	105.1	128.6	154.3	2.0	0.4	1.2	2.0	1.8

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Overseas	Current Account	Trillion Yen	-1.5	4.8	18.2	21.8	25.9	21.8	-	9.9	3.1	1.7	-1.7
	Exchange Rate	JPY/USD	217.3	141.5	107.5	110.0	110.0	110.0	-4.2	-1.9	0.4	0.0	0.0
	Nominal Crude Oil Price	USD/bbl	35	23	39	45	58	75	-3.9	3.7	2.6	2.5	2.7

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Public Finance	Public Debt	Trillion Yen	-	0.0	-36.6	-24.5	-11.7	5.8	-	-	-6.5	-7.1	-
	Primary Balance	Trillion Yen	-	12.5	-24.0	-2.1	17.6	30.8	-	-	-33.2	-	5.8
	Long Term Debt Outstanding	Trillion Yen	118.2	265.8	721.3	833.2	876.0	780.9	8.4	7.4	2.4	0.5	-1.1
	Per Nominal GDP	%	48.4	59.5	145.4	141.0	104.7	70.3					

Table 1 Macroeconomic and Social Indicators [Reference Case] (continued)

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Indices of Production	IIP	CY2000=100	67.5	101.2	100.6	112.3	126.0	138.4	4.1	0.0	1.9	1.2	0.9
	Foods and Tobacco		91.1	100.1	96.0	93.4	93.1	89.6	0.9	-0.3	-0.5	0.0	-0.4
	Textile		208.8	184.9	68.4	58.2	53.9	51.1	-1.2	-6.9	-2.7	-0.8	-0.5
	Iron and Steel		98.2	113.2	108.2	107.1	102.2	98.9	1.4	-0.3	-0.2	-0.5	-0.3
	Chemicals		52.1	86.9	102.4	110.4	127.3	142.7	5.3	1.2	1.3	1.4	1.2
	Ceramics and Cement		109.7	127.0	83.3	81.6	80.7	77.2	1.5	-3.0	-0.3	-0.1	-0.4
	Paper and Pulp		59.6	91.9	97.9	103.7	112.0	117.5	4.4	0.5	1.0	0.8	0.5
	Non-ferrous Metals		68.3	92.6	97.6	108.0	123.7	137.9	3.1	0.4	1.7	1.4	1.1
	Metals and Machinery, etc.		56.0	97.8	103.2	120.8	139.2	156.3	5.7	0.4	2.7	1.4	1.2
	Fabricated Metals		95.8	117.5	84.2	85.5	86.9	85.0	2.1	-2.4	0.2	0.2	-0.2
	Transport Equipment		83.5	109.8	118.7	126.1	134.8	141.2	2.8	0.6	1.0	0.7	0.5
	Electrical & Electronic		4.1	62.4	104.3	136.7	177.0	218.5	31.4	3.7	4.6	2.6	2.1
	General Machinery, etc.		73.5	118.4	103.6	127.9	143.3	158.4	4.9	-1.0	3.6	1.1	1.0
	Other Manufacturing		98.7	120.8	90.7	86.1	78.7	65.9	2.0	-2.0	-0.9	-0.9	-1.8
	Agriculture, Forestry and Fisheries		110.7	114.9	93.3	89.9	85.9	79.5	0.4	-1.5	-0.6	-0.5	-0.8
Raw Materials	Crude Steel	Mt	107.39	111.71	112.90	107.85	97.67	90.34	0.4	0.1	-0.8	-1.0	-0.8
	Ethylene	Mt	3.87	5.97	7.56	6.94	6.27	5.71	4.4	1.7	-1.4	-1.0	-0.9
	Cement	Mt	85.88	86.85	71.68	69.39	65.77	61.25	0.1	-1.4	-0.5	-0.5	-0.7
	Paper and Paperboard	Mt	17.53	28.54	30.87	32.61	34.99	36.39	5.0	0.6	0.9	0.7	0.4

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Floor Space for Commercial Use	Total	Million m^2	936.2	1,285.2	1,741.8	1,830.5	1,931.8	1,964.2	3.2	2.2	0.8	0.5	0.2
	Office and Buildings		204.2	313.4	453.8	479.0	499.8	506.8	4.4	2.7	0.9	0.4	0.1
	Wholesales and Retails		222.7	299.9	429.1	442.6	468.9	491.3	3.0	2.6	0.5	0.6	0.5
	Restaurants		33.5	50.4	64.5	67.5	68.9	65.9	4.2	1.8	0.8	0.2	-0.4
	Schools		254.3	311.3	353.7	364.0	373.0	375.3	2.0	0.9	0.5	0.2	0.1
	Hotels and Inns		55.3	76.6	93.9	96.0	96.9	91.9	3.3	1.5	0.4	0.1	-0.5
	Hospitals		45.4	64.6	100.3	114.9	138.0	142.0	3.6	3.2	2.3	1.8	0.3
	Theatres and Amusement Places		21.2	24.1	35.1	37.5	39.1	38.4	1.3	2.7	1.1	0.4	-0.2
	Others		99.5	144.8	211.3	229.1	247.3	252.6	3.8	2.7	1.4	0.8	0.2

			Actual			Forecast			Average Annual Growth Rate (%)				
			FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Passenger Traffic	Total	Billion pkm	891.1	1,298.4	1,418.4	1,466.1	1,492.8	1,450.9	3.8	0.6	0.6	0.2	-0.3
	Aviation		29.7	51.6	81.8	95.9	115.7	129.6	5.7	3.3	2.7	1.9	1.1
	Ship		6.1	6.3	3.9	3.9	3.6	3.1	0.2	-3.4	0.0	-0.7	-1.5
	Railway		314.5	387.5	385.2	398.6	397.0	360.2	2.1	0.0	0.6	0.0	-1.0
	Automobile		540.7	853.1	947.5	967.6	976.5	957.9	4.7	0.8	0.4	0.1	-0.2
	Passenger Cars Owned	Million	23.65	35.15	56.29	60.29	63.70	63.48	4.0	3.4	1.2	0.6	0.0
	Per Capita	Vehicle/Person	0.20	0.28	0.44	0.47	0.52	0.54	3.5	3.2	1.2	0.8	0.5
Freight Traffic	Total	Billion tkm	439.8	546.8	570.0	577.3	581.4	570.2	2.2	0.3	0.2	0.1	-0.2
	Aviation		0.3	0.8	1.1	1.3	1.6	1.8	10.7	2.0	3.2	2.2	1.6
	Ship		222.2	244.5	218.8	212.1	204.0	198.8	1.0	-0.8	-0.5	-0.4	-0.3
	Railway		37.3	27.2	22.4	23.6	25.9	27.9	-3.1	-1.4	0.8	0.9	0.7
	Automobile		180.0	274.2	327.6	340.3	349.9	341.6	4.3	1.3	0.6	0.3	-0.2
	Trucks Owned	Million	13.30	21.15	16.86	15.32	14.20	13.27	4.7	-1.6	-1.6	-0.8	-0.7

Table 2 Total Primary Energy Supply [Reference Case]

(Unit: 10^{10}kcal)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total	380,298	466,268	543,999	542,508	546,960	533,106	2.1	1.1	0.0	0.1	-0.3
Coal	66,911	80,464	117,922	104,080	103,899	98,448	1.9	2.8	-2.1	0.0	-0.5
Oil	245,951	263,813	256,333	240,660	220,337	198,171	0.7	-0.2	-1.0	-0.9	-1.1
Natural Gas	24,165	49,276	78,425	83,997	91,514	95,157	7.4	3.4	1.2	0.9	0.4
Hydro, Geothermal	20,771	20,977	21,934	20,507	20,441	20,643	0.1	0.3	-1.1	0.0	0.1
Nuclear	18,583	45,511	60,725	83,050	97,274	104,129	9.4	2.1	5.4	1.6	0.7
New Energies, etc.	3,918	6,226	8,660	10,216	13,494	16,559	4.7	2.4	2.8	2.8	2.1
	Share (%)										
Coal	17.6	17.3	21.7	19.2	19.0	18.5					
Oil	64.7	56.6	47.1	44.4	40.3	37.2					
Natural Gas	6.4	10.6	14.4	15.5	16.7	17.8					
Hydro, Geothermal	5.5	4.5	4.0	3.8	3.7	3.9					
Nuclear	4.9	9.8	11.2	15.3	17.8	19.5					
New Energies, etc.	1.0	1.3	1.6	1.9	2.5	3.1					

(1) Conversion factors for primary electricity in forecast period are 2,150 kcal per 1 kWh (efficiency 39.98%).

(2)10^{10} kcal = 1,000 tonne of oil equivalent (ktoe), 10^{13} kcal = 1,000,000 tonne of oil equivalent (Mtoe).

CO_2 Emissions from Fuel Combustion

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
(Mt-C)	251.3	287.1	331.4	311.5	302.6	284.2	1.3	1.0	-1.0	-0.3	-0.6
(FY1990=100)	(87.6)	(100.0)	(115.5)	(108.5)	(105.4)	(99.0)					

GDP, GDP Intensity

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
GDP (Trillions of Chained (2000) Yen)	303.8	448.7	526.4	593.1	687.4	769.6	4.0	1.1	2.0	1.5	1.1
TPES per GDP (FY1990=100)	120.5	100.0	99.5	88.0	76.6	66.7	-1.8	0.0	-2.0	-1.4	-1.4

Table 3 Total Final Energy Consumption [Reference Case]

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total		264,541	322,870	371,809	371,723	369,040	358,752	2.0	1.0	0.0	-0.1	-0.3
By Sectors	Industry	146,102	160,787	172,011	173,278	172,549	169,905	1.0	0.5	0.1	0.0	-0.2
	Residential and Commercial	56,520	78,924	102,192	105,441	110,298	110,808	3.4	1.9	0.5	0.5	0.0
	Residential	30,486	42,913	53,964	54,022	55,833	55,085	3.5	1.7	0.0	0.3	-0.1
	Commercial	26,034	36,011	48,228	51,419	54,466	55,724	3.3	2.1	1.1	0.6	0.2
	Transport	55,002	74,386	91,778	87,767	81,353	73,405	3.1	1.5	-0.7	-0.8	-1.0
	Passenger	29,737	44,303	59,588	57,826	54,803	49,288	4.1	2.1	-0.5	-0.5	-1.1
	Freight	25,265	30,083	32,190	29,941	26,549	24,118	1.8	0.5	-1.2	-1.2	-1.0
	Non-energy	6,918	8,772	5,828	5,238	4,841	4,634	2.4	-2.9	-1.8	-0.8	-0.4
By Energies	Coal	39,947	41907	39,208	37,491	35,908	34,114	0.5	-0.5	-0.7	-0.4	-0.5
	Oil	167,208	195,525	215,673	203,921	188,652	171,389	1.6	0.7	-0.9	-0.8	-1.0
	City and Natural Gas	10,253	15,959	26,489	30,157	33,743	37,101	4.5	3.7	2.2	1.1	1.0
	Electricity	44,024	65,076	86,924	95,571	104,247	108,701	4.0	2.1	1.6	0.9	0.4
	New Energies, etc.	2,967	4,122	2,699	2,847	3,320	3,054	3.3	-3.0	0.9	1.5	-0.8
	Geothermal, Heat and Hydrogen	143	280	816	1,735	3,170	4,393	7.0	7.9	13.4	6.2	3.3

		Share (%)					
By Sectors	Industry	55.2	49.8	46.3	46.6	46.8	47.4
	Residential and Commercial	21.4	24.4	27.5	28.4	29.9	30.9
	Residential	11.5	13.3	14.5	14.5	15.1	15.4
	Commercial	9.8	11.2	13.0	13.8	14.8	15.5
	Transport	20.8	23.0	24.7	23.6	22.0	20.5
	Passenger	11.2	13.7	16.0	15.6	14.9	13.7
	Freight	9.6	9.3	8.7	8.1	7.2	6.7
	Non-energy	2.6	2.7	1.6	1.4	1.3	1.3
By Energies	Coal	15.1	13.0	10.5	10.1	9.7	9.5
	Oil	63.2	60.6	58.0	54.9	51.1	47.8
	City and Natural Gas	3.9	4.9	7.1	8.1	9.1	10.3
	Electricity	16.6	20.2	23.4	25.7	28.2	30.3
	New Energies, etc.	1.1	1.3	0.7	0.8	0.9	0.9
	Geothermal, Heat and Hydrogen	0.1	0.1	0.2	0.5	0.9	1.2

Table 4 Final Energy Consumption in Industry Sector [Reference Case]

(Unit: 10^{10}kcal)

		Actual FY1980	Actual FY1990	Actual FY2004	Forecast FY2010	Forecast FY2020	Forecast FY2030	Average Annual Growth Rate (%) 1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total		146,102	160,787	172,011	173,278	172,549	169,905	1.0	0.5	0.1	0.0	-0.2
By Industries	Agriculture, etc.	8,600	11,917	9,264	8,950	8,574	7,945	3.3	-1.8	-0.6	-0.4	-0.8
By Industries	Construction and Mining	4,524	6,109	3,771	3,481	2,955	2,505	3.0	-3.4	-1.3	-1.6	-1.6
By Industries	Manufacturing	132,978	142,762	158,976	160,847	161,020	159,454	0.7	0.8	0.2	0.0	-0.1
By Industries	Food	4,561	4,878	5,487	5,578	5,701	5,525	0.7	0.8	0.3	0.2	-0.3
By Industries	Textile	4,891	3,448	2,474	2,105	1,951	1,847	-3.4	-2.3	-2.7	-0.8	-0.5
By Industries	Paper and Pulp	8,472	9,880	9,273	9,386	9,457	9,378	1.5	-0.5	0.2	0.1	-0.1
By Industries	Chemicals	32,645	39,048	53,106	49,864	47,055	44,598	1.8	2.2	-1.0	-0.6	-0.5
By Industries	Ceramics and Cement	13,357	11,946	9,818	9,773	9,565	9,039	-1.1	-1.4	-0.1	-0.2	-0.6
By Industries	Iron and Steel	44,766	42,118	41,063	38,991	37,240	35,900	-0.6	-0.2	-0.9	-0.5	-0.4
By Industries	Non-ferrous Metals	4,411	3,965	3,222	3,369	3,468	3,511	-1.1	-1.5	0.7	0.3	0.1
By Industries	Machinery, etc.	19,875	27,479	34,533	41,781	46,583	49,656	3.3	1.6	3.2	1.1	0.6
By Energies	Coal	38,902	41,078	38,182	36,417	34,778	32,967	0.5	-0.5	-0.8	-0.5	-0.5
By Energies	Oil	77,041	79,528	85,098	80,827	76,163	71,431	0.3	0.5	-0.9	-0.6	-0.6
By Energies	City and Natural Gas	2,422	4,592	10,042	12,617	14,942	17,252	6.6	5.7	3.9	1.7	1.4
By Energies	Electricity	25,320	32,707	36,459	40,394	42,671	43,484	2.6	0.8	1.7	0.5	0.2
By Energies	New Energies, etc.	2,398	2,848	2,135	2,161	1,981	1,805	1.7	-2.0	0.2	-0.9	-0.9
By Energies	Geothermal and Heat	17	34	95	862	2,014	2,966	7.2	7.6	44.4	8.9	3.9

		Share (%) FY1980	FY1990	FY2004	FY2010	FY2020	FY2030
By Industries	Agriculture, etc.	5.9	7.4	5.4	5.2	5.0	4.7
By Industries	Construction and Mining	3.1	3.8	2.2	2.0	1.7	1.5
By Industries	Manufacturing	91.0	88.8	92.4	92.8	93.3	93.8
By Industries	Food	3.1	3.0	3.2	3.2	3.3	3.3
By Industries	Textile	3.3	2.1	1.4	1.2	1.1	1.1
By Industries	Paper and Pulp	5.8	6.1	5.4	5.4	5.5	5.5
By Industries	Chemicals	22.3	24.3	30.9	28.8	27.3	26.2
By Industries	Ceramics and Cement	9.1	7.4	5.7	5.6	5.5	5.3
By Industries	Iron and Steel	30.6	26.2	23.9	22.5	21.6	21.1
By Industries	Non-ferrous Metals	3.0	2.5	1.9	1.9	2.0	2.1
By Industries	Machinery, etc.	13.6	17.1	20.1	24.1	27.0	29.2
By Energies	Coal	26.6	25.5	22.2	21.0	20.2	19.4
By Energies	Oil	52.7	49.5	49.5	46.6	44.1	42.0
By Energies	City and Natural Gas	1.7	2.9	5.8	7.3	8.7	10.2
By Energies	Electricity	17.3	20.3	21.2	23.3	24.7	25.6
By Energies	New Energies, etc.	1.6	1.8	1.2	1.2	1.1	1.1
By Energies	Geothermal and Heat	0.0	0.0	0.1	0.5	1.2	1.7

Table 5 Final Energy Consumption in Residential Sector [Reference Case]

(Unit: 10^{10}kcal)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	30,486	42,913	53,964	54,022	55,833	55,085	3.5	1.7	0.0	0.3	-0.1
Coal	308	85	20	18	16	14	-12.1	-9.8	-1.7	-1.2	-1.6
Oil	13,630	17,451	19,690	18,248	16,684	14,180	2.5	0.9	-1.3	-0.9	-1.6
LPG	5,065	6,526	6,580	6,162	5,861	5,321	2.6	0.1	-1.1	-0.5	-1.0
City Gas	5,649	7,764	9,463	9,178	8,808	8,399	3.2	1.4	-0.5	-0.4	-0.5
Electricity	10,313	16,353	24,211	26,150	30,005	32,184	4.7	2.8	1.3	1.4	0.7
New Energies, Heat, etc.	587	1,261	580	428	319	309	7.9	-5.4	-5.0	-2.9	-0.3
	Share (%)										
Coal	1.0	0.2	0.0	0.0	0.0	0.0					
Oil	44.7	40.7	36.5	33.8	29.9	25.7					
LPG	16.6	15.2	12.2	11.4	10.5	9.7					
City Gas	18.5	18.1	17.5	17.0	15.8	15.2					
Electricity	33.8	38.1	44.9	48.4	53.7	58.4					
New Energies, Heat, etc.	1.9	2.9	1.1	0.8	0.6	0.6					

Intensity by End Use

(Unit: Mcal/Household)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	8,508	10,427	10,828	10,508	10,799	10,919	2.1	0.3	-0.5	0.3	0.1
(Effective Demand)			(10,828)	(11,836)	(13,943)	(15,520)			(1.5)	(1.7)	(1.1)
Space Heating	2,414	2,787	2,933	2,930	2,961	2,919	1.4	0.4	0.0	0.1	-0.1
Cooling	83	252	261	214	219	236	11.7	0.2	-3.2	0.2	0.7
Water Heating	2,810	3,356	3,014	2,688	2,499	2,334	1.8	-0.8	-1.9	-0.7	-0.7
Cooking	1,004	965	675	607	530	459	-0.4	-2.5	-1.8	-1.4	-1.4
Power and Lighting	2,196	3,068	3,945	4,070	4,590	4,972	3.4	1.8	0.5	1.2	0.8
	Share (%)										
Space Heating	28.4	26.7	27.1	27.9	27.4	26.7					
Cooling	1.0	2.4	2.4	2.0	2.0	2.2					
Water Heating	33.0	32.2	27.8	25.6	23.1	21.4					
Cooking	11.8	9.3	6.2	5.8	4.9	4.2					
Power and Lighting	25.8	29.4	36.4	38.7	42.5	45.5					

Table 6 Final Energy Consumption in Commercial Sector [Reference Case]

(Unit: 10^{10}kcal)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total	26,034	36,011	48,228	51,419	54,466	55,724	3.3	2.1	1.1	0.6	0.2
Coal	736	745	1,006	1,056	1,115	1,133	0.1	2.2	0.8	0.5	0.2
Oil	15,927	17,102	15,164	14,124	12,895	11,421	0.7	-0.9	-1.2	-0.9	-1.2
City Gas	2,181	3,603	6,984	8,230	9,605	10,430	5.1	4.8	2.8	1.6	0.8
Electricity	7,082	14,301	24,369	27,066	29,605	31,240	7.3	3.9	1.8	0.9	0.5
New Energies, Heat, etc.	107	260	705	943	1,247	1,499	39.3	9.2	42.0	6.9	3.9
	Share (%)										
Coal	2.8	2.1	2.1	2.1	2.0	2.0					
Oil	61.2	47.5	31.4	27.5	23.7	20.5					
City Gas	8.4	10.0	14.5	16.0	17.6	18.7					
Electricity	27.2	39.7	50.5	52.6	54.4	56.1					
New Energies, Heat, etc.	0.4	0.7	1.5	1.8	2.3	2.7					

Intensity by End Use

(Unit: Mcal/m^2)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total	278.1	280.2	276.9	280.9	281.9	283.7	0.1	-0.1	0.2	0.0	0.1
Space Heating	101.3	80.7	51.8	46.5	40.5	35.9	-2.3	-3.1	-1.8	-1.4	-1.2
Cooling	13.5	22.2	25.0	26.9	31.0	35.6	5.1	0.8	1.2	1.4	1.4
Water Heating	84.7	67.0	55.9	55.9	55.1	54.6	-2.3	-1.3	0.0	-0.1	-0.1
Cooking	15.6	17.9	23.3	24.5	25.9	25.9	1.4	1.9	0.8	0.6	0.0
Power and Lighting	63.0	92.4	120.8	127.2	129.4	131.7	3.9	1.9	0.9	0.2	0.2
	Share (%)										
Space Heating	36.4	28.8	18.7	16.5	14.4	12.6					
Cooling	4.9	7.9	9.0	9.6	11.0	12.6					
Water Heating	30.5	23.9	20.2	19.9	19.5	19.2					
Cooking	5.6	6.4	8.4	8.7	9.2	9.1					
Power and Lighting	22.6	33.0	43.6	45.3	45.9	46.4					

Table 7 Final Energy Consumption in Transport Sector [Reference Case]

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total		55,002	74,386	91,778	87,767	81,353	73,405	3.1	1.5	-0.7	-0.8	-1.0
By Sectors	Passenger	29,737	44,303	59,588	57,826	54,803	49,288	4.1	2.1	-0.5	-0.5	-1.1
	Freight	25,265	30,083	32,190	29,941	26,549	24,118	1.8	0.5	-1.2	-1.2	-1.0
By Energies	Oil	53,693	72,672	89,893	85,484	78,070	69,724	3.1	1.5	-0.8	-0.9	-1.1
	Electricity	1,309	1,714	1,885	1,960	1,967	1,793	2.7	0.7	0.7	0.0	-0.9
	Natural Gas	0	0	0	133	388	1,020				11.3	10.2
	New Energies	0	0	0	188	907	808				17.0	-1.1
	Hydrogen	0	0	0	1	22	61				37.1	10.5
		Share (%)										
By Sectors	Passenger	54.1	59.6	64.9	65.9	67.4	67.1					
	Freight	45.9	40.4	35.1	34.1	32.6	32.9					
By Energies	Oil	97.6	97.7	97.9	97.4	96.0	95.0					
	Electricity	2.4	2.3	2.1	2.2	2.4	2.4					
	Natural Gas	0.0	0.0	0.0	0.2	0.5	1.4					
	New Energies	0.0	0.0	0.0	0.2	1.1	1.1					
	Hydrogen	0.0	0.0	0.0	0.0	0.0	0.1					

Passenger, Freight

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Passenger		29,737	44,303	59,588	57,826	54,803	49,288	4.1	2.1	-0.5	-0.5	-1.1
	Automobile	25,724	40,067	53,734	51,643	48,490	43,335	4.5	2.1	-0.7	-0.6	-1.1
	Railway	1,513	1,847	1,948	2,016	2,008	1,822	2.0	0.4	0.6	0.0	-1.0
	Ship	130	167	159	153	142	122	2.5	-0.4	-0.6	-0.7	-1.5
	Aviation	2,360	2,840	3,748	4,013	4,163	4,009	1.9	2.0	1.1	0.4	-0.4

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Freight		25,265	30,083	32,190	29,941	26,549	24,118	1.8	0.5	-1.2	-1.2	-1.0
	Automobile	18,901	25,278	26,319	24,700	22,131	20,315	2.9	0.3	-1.1	-1.1	-0.9
	Railway	320	160	141	148	163	175	-6.7	-0.9	0.8	0.9	0.7
	Ship	5,833	3,613	5,177	4,446	3,493	2,781	-4.7	2.6	-2.5	-2.4	-2.3
	Aviation	221	414	553	647	762	846	6.5	2.1	2.7	1.7	1.0

Table 8 Power Generation Mix by Public Utilities [Reference Case]

(Unit: TWh)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total	512.7	752.3	940.6	1,038.1	1,135.9	1,188.6	3.9	1.6	1.7	0.9	0.5
Thermal	343.4	458.8	556.7	545.4	571.8	582.7	2.9	1.4	-0.3	0.5	0.2
Coal	22.5	71.5	215.7	210.2	239.9	242.0	12.2	8.2	-0.4	1.3	0.1
Oil, etc.	244.1	224.2	72.4	68.9	49.8	38.0	-0.8	-7.8	-0.8	-3.2	-2.7
LNG	76.7	163.1	268.5	266.3	282.1	302.8	7.8	3.6	-0.1	0.6	0.7
Hydro and Geothermal	87.2	91.5	98.7	95.1	93.9	97.4	0.5	0.5	-0.6	-0.1	0.4
Nuclear	82.0	201.4	282.4	386.3	452.4	484.3	9.4	2.4	5.4	1.6	0.7
New Energies	0.1	0.6	2.7	11.3	17.8	24.1	15.4	11.7	26.8	4.6	3.1
Thermal Efficiency	38.1%	38.8%	40.9%	41.2%	42.7%	45.8%	0.2	0.4	0.1	0.4	0.7
	Share (%)										
Thermal	67.0	61.0	59.2	52.5	50.3	49.0					
Coal	4.4	9.5	22.9	20.2	21.1	20.4					
Oil, etc.	47.6	29.8	7.7	6.6	4.4	3.2					
LNG	15.0	21.7	28.6	25.7	24.8	25.5					
Hydro and Geothermal	17.0	12.2	10.5	9.2	8.3	8.2					
Nuclear	16.0	26.8	30.0	37.2	39.8	40.7					
New Energies	0.0	0.1	0.3	1.1	1.6	2.0					

Table 9 Cogeneration (CHP) [Reference Case]

(Unit: GW)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total		0.12	1.95	6.94	8.42	10.73	12.64	31.8	9.5	3.3	2.4	1.7
By Sectors	Industry	0.11	1.67	5.48	6.60	8.27	9.65	31.2	8.8	3.1	2.3	1.6
	Commercial	0.01	0.28	1.46	1.82	2.46	2.99	36.2	12.5	3.8	3.0	2.0
By Energies	Oil	0.12	1.20	3.52	4.01	5.05	5.80	26.1	8.0	2.2	2.3	1.4
	City Gas	0.00	0.32	2.61	3.61	4.87	6.03		16.2	5.5	3.0	2.2
	Others	0.01	0.44	0.80	0.80	0.80	0.80	56.1	4.5	0.0	0.0	0.0

Table 10 New Energies [Reference Case]

(Unit: 10^{10}kcal)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	477	6,067	8,688	10,207	13,489	16,557	29.0	2.6	2.7	2.8	2.1
Photovoltaic	0	0	255	761	1,922	3,353			20.0	9.7	5.7
Wind Power	0	0	349	562	1,128	2,112			8.3	7.2	6.5
Waste Power	107	407	1,482	1,916	2,404	2,803	14.3	9.7	4.4	2.3	1.5
Biomass Power	0	0	216	255	350	438			2.8	3.2	2.3
Solar Heat	370	1,167	528	378	270	253	12.2	-5.5	-5.4	-3.3	-0.6
Unused Energy	0	0	37	79	116	152			13.5	3.8	2.8
Waste Heat	0	0	1,533	1,542	1,553	1,546			0.1	0.1	0.0
Biomass Heat	0	0	0	188	907	808				17.0	-1.1
Black Liquor, Waste, etc.	0	4,493	4,287	4,525	4,841	5,093		-0.3	0.9	0.7	0.5

Power Generation Capacity (GW)

	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	0.00	0.00	3.80	7.04	14.27	23.73			10.8	7.3	5.2
Photovoltaic	0.00	0.00	1.13	3.37	8.50	14.84			19.9	9.7	5.7
Wind Power	0.00	0.00	0.93	1.49	2.99	5.61			8.3	7.2	6.5
Waste Power	0.00	0.00	1.63	1.92	2.41	2.81			2.7	2.3	1.5
Biomass Power	0.00	0.00	0.11	0.26	0.37	0.48			16.4	3.3	2.7

Table 11 Electricity Sales [Reference Case]

(Unit: TWh)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	464.3	678.1	892.1	982.8	1,071.4	1,116.4	3.9	2.0	1.6	0.9	0.4
Lighting Services	105.3	177.4	272.6	295.5	339.6	362.2	5.4	3.1	1.4	1.4	0.6
Power Services	359.0	500.7	619.6	687.4	731.9	754.2	3.4	1.5	1.7	0.6	0.3

(*) Power services include deregulated demand.

Table 12 City Gas Sales [Reference Case]

(Unit: Mm^3, $1m^3$=10,000kcal)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	9,302	15,367	30,138	36,059	41,482	45,482	5.1	4.9	3.0	1.4	0.9
Residential	5,649	7,764	9,463	9,182	8,818	8,422	3.2	1.4	-0.5	-0.4	-0.5
Commercial	1,616	2,562	4,712	5,638	6,725	7,452	4.7	4.4	3.0	1.8	1.0
Industrial	1,469	4,019	13,285	17,858	21,731	24,848	10.6	8.9	5.1	2.0	1.3
Others	568	1,021	2,678	3,381	4,208	4,760	6.1	7.1	4.0	2.2	1.2

Table 13 Fuel Oil Sales [Reference Case]

(Unit: GL)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Fuel Oil Total	209.22	218.01	237.21	221.47	202.19	178.81	0.4	0.6	-1.1	-0.9	-1.2
Gasoline	34.54	44.78	61.47	62.16	59.88	53.36	2.6	2.3	0.2	-0.4	-1.1
Naphtha	26.30	31.42	48.99	43.99	39.41	35.24	1.8	3.2	-1.8	-1.1	-1.1
Jet Fuel	2.97	3.74	4.91	5.32	5.62	5.54	2.3	2.0	1.3	0.6	-0.1
Kerosene	23.57	26.70	27.98	28.14	26.73	23.26	1.3	0.3	0.1	-0.5	-1.4
Gas Oil	21.56	37.68	38.20	33.23	29.06	26.48	5.7	0.1	-2.3	-1.3	-0.9
Fuel Oil A	21.08	27.07	29.10	26.22	24.02	21.74	2.5	0.5	-1.7	-0.9	-1.0
Fuel Oil B, C	79.20	46.62	26.56	22.42	17.47	13.20	-5.2	-3.9	-2.8	-2.5	-2.8
LPG (Mt)	13.95	18.78	17.89	18.73	18.93	19.08	3.0	-0.3	0.8	0.1	0.1

Table 14 Total Primary Energy Supply [Technology Development Case]

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total		380,298	466,268	543,999	537,856	521,519	487,462	2.1	1.1	-0.2	-0.3	-0.7
	Coal	66,911	80,464	117,922	103,161	95,618	87,796	1.9	2.8	-2.2	-0.8	-0.8
	Oil	245,951	263,813	256,333	239,804	209,607	174,045	0.7	-0.2	-1.1	-1.3	-1.8
	Natural Gas	24,165	49,276	78,425	80,393	81,115	76,111	7.4	3.4	0.4	0.1	-0.6
	Hydro, Geothermal	20,771	20,977	21,934	20,535	21,117	21,135	0.1	0.3	-1.1	0.3	0.0
	Nuclear	18,583	45,511	60,725	83,050	97,274	104,129	9.4	2.1	5.4	1.6	0.7
	New Energies, etc.	3,918	6,226	8,660	10,912	16,789	24,245	4.7	2.4	3.9	4.4	3.7
		Share (%)										
	Coal	17.6	17.3	21.7	19.2	18.3	18.0					
	Oil	64.7	56.6	47.1	44.6	40.2	35.7					
	Natural Gas	6.4	10.6	14.4	14.9	15.6	15.6					
	Hydro, Geothermal	5.5	4.5	4.0	3.8	4.0	4.3					
	Nuclear	4.9	9.8	11.2	15.4	18.7	21.4					
	New Energies, etc.	1.0	1.3	1.6	2.0	3.2	5.0					

(*) Conversion factors for primary electricity in forecast period are 2,150 kcal per 1 kWh (efficiency 39.98%).

CO_2 Emissions from Fuel Combustion

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
(Mt-C)	251.3	287.1	331.4	308.0	280.1	244.0	1.3	1.0	-1.2	-0.9	-1.4
(FY1990=100)	(87.6)	(100.0)	(115.5)	(107.3)	(97.6)	(85.0)					

GDP, GDP Intensity

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
GDP (Trillions of Chained (2000) Yen)	303.8	448.7	526.4	593.1	687.4	769.6	4.0	1.1	2.0	1.5	1.1
TPES per GDP (FY1990=100)	120.5	100.0	99.5	87.3	73.0	61.0	-1.8	0.0	-2.2	-1.8	-1.8

Table 15 Total Final Energy Consumption [Technology Development Case]

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total		264,541	322,870	371,809	369,972	358,091	335,905	2.0	1.0	-0.1	-0.3	-0.6
By Sectors	Industry	146,102	160,787	172,011	173,269	170,619	166,034	1.0	0.5	0.1	-0.2	-0.3
	Residential and Commercial	56,520	78,924	102,192	103,796	103,277	99,646	3.4	1.9	0.3	-0.1	-0.4
	Residential	30,486	42,913	53,964	53,297	52,370	49,779	3.5	1.7	-0.2	-0.2	-0.5
	Commercial	26,034	36,011	48,228	50,499	50,907	49,868	3.3	2.1	0.8	0.1	-0.2
	Transport	55,002	74,386	91,778	87,669	79,354	65,591	3.1	1.5	-0.8	-1.0	-1.9
	Passenger	29,737	44,303	59,588	57,743	53,107	43,900	4.1	2.1	-0.5	-0.8	-1.9
	Freight	25,265	30,083	32,190	29,926	26,247	21,691	1.8	0.5	-1.2	-1.3	-1.9
	Non-energy	6,918	8,772	5,828	5,238	4,841	4,634	2.4	-2.9	-1.8	-0.8	-0.4
By Energies	Coal	39,947	41907	39,208	37,284	36,629	33,900	0.5	-0.5	-0.8	-0.2	-0.8
	Oil	167,208	195,525	215,673	203,389	184,186	156,879	1.6	0.7	-1.0	-1.0	-1.6
	City and Natural Gas	10,253	15,959	26,489	30,018	31,493	34,722	4.5	3.7	2.1	0.5	1.0
	Electricity	44,024	65,076	86,924	94,473	97,790	97,785	4.0	2.1	1.4	0.3	0.0
	New Energies, etc.	2,967	4,122	2,699	2,968	4,097	4,774	3.3	-3.0	1.6	3.3	1.5
	Geothermal, Heat and Hydrogen	143	280	816	1,840	3,895	7,845	7.0	7.9	14.5	7.8	7.3

		Share (%)					
By Sectors	Industry	55.2	49.8	46.3	46.8	47.6	49.4
	Residential and Commercial	21.4	24.4	27.5	28.1	28.8	29.7
	Residential	11.5	13.3	14.5	14.4	14.6	14.8
	Commercial	9.8	11.2	13.0	13.6	14.2	14.8
	Transport	20.8	23.0	24.7	23.7	22.2	19.5
	Passenger	11.2	13.7	16.0	15.6	14.8	13.1
	Freight	9.6	9.3	8.7	8.1	7.3	6.5
	Non-energy	2.6	2.7	1.6	1.4	1.4	1.4
By Energies	Coal	15.1	13.0	10.5	10.1	10.2	10.1
	Oil	63.2	60.6	58.0	55.0	51.4	46.7
	City and Natural Gas	3.9	4.9	7.1	8.1	8.8	10.3
	Electricity	16.6	20.2	23.4	25.5	27.3	29.1
	New Energies, etc.	1.1	1.3	0.7	0.8	1.1	1.4
	Geothermal, Heat and Hydrogen	0.1	0.1	0.2	0.5	1.1	2.3

Table 16 Sales [Technology Development Case]

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Electricity Sales (TWh)	464.3	678.1	892.1	967.7	987.6	975.0	3.9	2.0	1.4	0.2	-0.1
Fuel Oil Sales (ML)	209.22	218.01	237.21	220.82	194.59	160.07	0.4	0.6	-1.2	-1.3	-1.9
City Gas Sales (Mm^3)	9,302	15,367	30,138	35,806	38,867	42,925	5.1	4.9	2.9	0.8	1.0

Table 17 Total Primary Energy Supply [High Economic Growth Case]

(Unit: 10^{10}kcal)

	Actual FY1980	Actual FY1990	Actual FY2004	Forecast FY2010	Forecast FY2020	Forecast FY2030	Average Annual Growth Rate (%) 1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
Total	380,298	466,268	543,999	550,558	566,169	565,851	2.1	1.1	0.2	0.3	0.0
Coal	66,911	80,464	117,922	104,619	107,020	98,818	1.9	2.8	-2.0	0.2	-0.8
Oil	245,951	263,813	256,333	243,912	227,865	209,829	0.7	-0.2	-0.8	-0.7	-0.8
Natural Gas	24,165	49,276	78,425	88,190	99,933	115,991	7.4	3.4	2.0	1.3	1.5
Hydro, Geothermal	20,771	20,977	21,934	20,507	20,441	20,382	0.1	0.3	-1.1	0.0	0.0
Nuclear	18,583	45,511	60,725	83,050	97,274	104,129	9.4	2.1	5.4	1.6	0.7
New Energies, etc.	3,918	6,226	8,660	10,280	13,636	16,703	4.7	2.4	2.9	2.9	2.0
	Share (%)										
Coal	17.6	17.3	21.7	19.0	18.9	17.5					
Oil	64.7	56.6	47.1	44.3	40.2	37.1					
Natural Gas	6.4	10.6	14.4	16.0	17.7	20.5					
Hydro, Geothermal	5.5	4.5	4.0	3.7	3.6	3.6					
Nuclear	4.9	9.8	11.2	15.1	17.2	18.4					
New Energies, etc.	1.0	1.3	1.6	1.9	2.4	3.0					

(*) Conversion factors for primary electricity in forecast period are 2,150 kcal per 1 kWh (efficiency 39.98%).

CO_2 Emissions from Fuel Combustion

	Actual FY1980	Actual FY1990	Actual FY2004	Forecast FY2010	Forecast FY2020	Forecast FY2030	Average Annual Growth Rate (%) 1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
(Mt-C)	251.3	287.1	331.4	316.6	315.8	304.8	1.3	1.0	-0.8	0.0	-0.4
(FY1990=100)	(87.6)	(100.0)	(115.5)	(110.3)	(110.0)	(106.2)					

GDP, GDP Intensity

	Actual FY1980	Actual FY1990	Actual FY2004	Forecast FY2010	Forecast FY2020	Forecast FY2030	Average Annual Growth Rate (%) 1990/1980	2004/1990	2010/2004	2020/2010	2030/2020
GDP (Trillions of Chained (2000) Yen)	303.8	448.7	526.4	608.9	744.4	876.7	4.0	1.1	2.5	2.0	1.6
TPES per GDP (FY1990=100)	120.5	100.0	99.5	87.0	73.2	62.1	-1.8	0.0	-2.2	-1.7	-1.6

Table 18 Total Final Energy Consumption [High Economic Growth Case]

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total		264,541	322,870	371,809	376,913	382,405	380,192	2.0	1.0	0.2	0.1	-0.1
By Sectors	Industry	146,102	160,787	172,011	176,038	178,259	178,316	1.0	0.5	0.4	0.1	0.0
	Residential and Commercial	56,520	78,924	102,192	107,011	115,851	120,397	3.4	1.9	0.8	0.8	0.4
	Residential	30,486	42,913	53,964	54,749	58,238	58,567	3.5	1.7	0.2	0.6	0.1
	Commercial	26,034	36,011	48,228	52,262	57,613	61,830	3.3	2.1	1.3	1.0	0.7
	Transport	55,002	74,386	91,778	88,633	83,483	76,886	3.1	1.5	-0.6	-0.6	-0.8
	Passenger	29,737	44,303	59,588	58,278	56,339	51,489	4.1	2.1	-0.4	-0.3	-0.9
	Freight	25,265	30,083	32,190	30,355	27,145	25,398	1.8	0.5	-1.0	-1.1	-0.7
	Non-energy	6,918	8,772	5,828	5,232	4,812	4,593	2.4	-2.9	-1.8	-0.8	-0.5
By Energies	Coal	39,947	41907	39,208	37,957	36,463	34,473	0.5	-0.5	-0.5	-0.4	-0.6
	Oil	167,208	195,525	215,673	206,510	194,532	179,667	1.6	0.7	-0.7	-0.6	-0.8
	City and Natural Gas	10,253	15,959	26,489	30,553	35,108	39,769	4.5	3.7	2.4	1.4	1.3
	Electricity	44,024	65,076	86,924	97,185	109,411	118,052	4.0	2.1	1.9	1.2	0.8
	New Energies, etc.	2,967	4,122	2,699	2,877	3,387	3,119	3.3	-3.0	1.1	1.6	-0.8
	Geothermal, Heat and Hydrogen	143	280	816	1,833	3,504	5,111	7.0	7.9	14.4	6.7	3.8
		Share (%)										
By Sectors	Industry	55.2	49.8	46.3	46.7	46.6	46.9					
	Residential and Commercial	21.4	24.4	27.5	28.4	30.3	31.7					
	Residential	11.5	13.3	14.5	14.5	15.2	15.4					
	Commercial	9.8	11.2	13.0	13.9	15.1	16.3					
	Transport	20.8	23.0	24.7	23.5	21.8	20.2					
	Passenger	11.2	13.7	16.0	15.5	14.7	13.5					
	Freight	9.6	9.3	8.7	8.1	7.1	6.7					
	Non-energy	2.6	2.7	1.6	1.4	1.3	1.2					
By Energies	Coal	15.1	13.0	10.5	10.1	9.5	9.1					
	Oil	63.2	60.6	58.0	54.8	50.9	47.3					
	City and Natural Gas	3.9	4.9	7.1	8.1	9.2	10.5					
	Electricity	16.6	20.2	23.4	25.8	28.6	31.1					
	New Energies, etc.	1.1	1.3	0.7	0.8	0.9	0.8					
	Geothermal, Heat and Hydrogen	0.1	0.1	0.2	0.5	0.9	1.3					

Table 19 Sales [High Economic Growth Case]

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Electricity Sales (TWh)	464.3	678.1	892.1	998.5	1,123.4	1,210.3	3.9	2.0	1.9	1.2	0.7
Fuel Oil Sales (ML)	209.22	218.01	237.21	224.45	209.11	188.92	0.4	0.6	-0.9	-0.7	-1.0
City Gas Sales (Mm^3)	9,302	15,367	30,138	36,746	43,666	49,967	5.1	4.9	3.4	1.7	1.4

Table 20 Total Primary Energy Supply [High Price Case]

(Unit: 10^{10}kcal)

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total	380,298	466,268	543,999	539,457	535,532	511,222	2.1	1.1	-0.1	-0.1	-0.5
Coal	66,911	80,464	117,922	103,878	97,818	94,363	1.9	2.8	-2.1	-0.6	-0.4
Oil	245,951	263,813	256,333	239,011	215,336	188,249	0.7	-0.2	-1.2	-1.0	-1.3
Natural Gas	24,165	49,276	78,425	82,755	90,936	86,697	7.4	3.4	0.9	0.9	-0.5
Hydro, Geothermal	20,771	20,977	21,934	20,535	20,476	20,643	0.1	0.3	-1.1	0.0	0.1
Nuclear	18,583	45,511	60,725	83,050	97,274	104,129	9.4	2.1	5.4	1.6	0.7
New Energies, etc.	3,918	6,226	8,660	10,228	13,692	17,142	4.7	2.4	2.8	3.0	2.3
	Share (%)										
Coal	17.6	17.3	21.7	19.3	18.3	18.5					
Oil	64.7	56.6	47.1	44.3	40.2	36.8					
Natural Gas	6.4	10.6	14.4	15.3	17.0	17.0					
Hydro, Geothermal	5.5	4.5	4.0	3.8	3.8	4.0					
Nuclear	4.9	9.8	11.2	15.4	18.2	20.4					
New Energies, etc.	1.0	1.3	1.6	1.9	2.6	3.4					

(*) Conversion factors for primary electricity in forecast period are 2,150 kcal per 1 kWh (efficiency 39.98%).

CO_2 Emissions from Fuel Combustion

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
(Mt-C)	251.3	287.1	331.4	309.4	292.3	268.0	1.3	1.0	-1.1	-0.6	-0.9
(FY1990=100)	(87.6)	(100.0)	(115.5)	(107.8)	(101.8)	(93.4)					

GDP, GDP Intensity

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
GDP (Trillions of Chained (2000) Yen)	303.8	448.7	526.4	589.9	673.0	738.6	4.0	1.1	1.9	1.3	0.9
TPES per GDP (FY1990=100)	120.5	100.0	99.5	88.0	76.6	66.6	-1.8	0.0	-2.0	-1.4	-1.4

Table 21 Total Final Energy Consumption [High Price Case]

(Unit: 10^{10}kcal)

		Actual			Forecast			Average Annual Growth Rate (%)				
		FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Total		264,541	322,870	371,809	369,784	361,762	344,167	2.0	1.0	-0.1	-0.2	-0.5
By Sectors	Industry	146,102	160,787	172,011	172,398	169,373	162,915	1.0	0.5	0.0	-0.2	-0.4
	Residential and Commercial	56,520	78,924	102,192	104,677	107,352	105,485	3.4	1.9	0.4	0.3	-0.2
	Residential	30,486	42,913	53,964	53,690	54,689	53,215	3.5	1.7	-0.1	0.2	-0.3
	Commercial	26,034	36,011	48,228	50,987	52,663	52,270	3.3	2.1	0.9	0.3	-0.1
	Transport	55,002	74,386	91,778	87,478	80,230	71,192	3.1	1.5	-0.8	-0.9	-1.2
	Passenger	29,737	44,303	59,588	57,707	54,357	48,339	4.1	2.1	-0.5	-0.6	-1.2
	Freight	25,265	30,083	32,190	29,771	25,873	22,853	1.8	0.5	-1.3	-1.4	-1.2
	Non-energy	6,918	8,772	5,828	5,230	4,808	4,575	2.4	-2.9	-1.8	-0.8	-0.5
By Energies	Coal	39,947	41907	39,208	37,450	35,686	33,519	0.5	-0.5	-0.8	-0.5	-0.6
	Oil	167,208	195,525	215,673	202,839	185,558	165,419	1.6	0.7	-1.0	-0.9	-1.1
	City and Natural Gas	10,253	15,959	26,489	30,020	33,147	35,870	4.5	3.7	2.1	1.0	0.8
	Electricity	44,024	65,076	86,924	94,963	101,281	102,759	4.0	2.1	1.5	0.6	0.1
	New Energies, etc.	2,967	4,122	2,699	2,854	3,317	3,032	3.3	-3.0	0.9	1.5	-0.9
	Geothermal, Heat and Hydrogen	143	280	816	1,657	2,774	3,567	7.0	7.9	12.5	5.3	2.5
		Share (%)										
By Sectors	Industry	55.2	49.8	46.3	46.6	46.8	47.3					
	Residential and Commercial	21.4	24.4	27.5	28.3	29.7	30.6					
	Residential	11.5	13.3	14.5	14.5	15.1	15.5					
	Commercial	9.8	11.2	13.0	13.8	14.6	15.2					
	Transport	20.8	23.0	24.7	23.7	22.2	20.7					
	Passenger	11.2	13.7	16.0	15.6	15.0	14.0					
	Freight	9.6	9.3	8.7	8.1	7.2	6.6					
	Non-energy	2.6	2.7	1.6	1.4	1.3	1.3					
By Energies	Coal	15.1	13.0	10.5	10.1	9.9	9.7					
	Oil	63.2	60.6	58.0	54.9	51.3	48.1					
	City and Natural Gas	3.9	4.9	7.1	8.1	9.2	10.4					
	Electricity	16.6	20.2	23.4	25.7	28.0	29.9					
	New Energies, etc.	1.1	1.3	0.7	0.8	0.9	0.9					
	Geothermal, Heat and Hydrogen	0.1	0.1	0.2	0.4	0.8	1.0					

Table 22 Sales [High Price Case]

	Actual			Forecast			Average Annual Growth Rate (%)				
	FY1980	FY1990	FY2004	FY2010	FY2020	FY2030	1990/ 1980	2004/ 1990	2010/ 2004	2020/ 2010	2030/ 2020
Electricity Sales (TWh)	464.3	678.1	892.1	977.2	1,043.7	1,060.6	3.9	2.0	1.5	0.7	0.2
Fuel Oil Sales (ML)	209.22	218.01	237.21	219.91	197.51	169.64	0.4	0.6	-1.3	-1.1	-1.5
City Gas Sales (Mm^3)	9,302	15,367	30,138	35,866	40,461	43,055	5.1	4.9	2.9	1.2	0.6

Table 23 Comparisons between the Cases

		Actual		Forecast			Divergence Rate from Reference (%)			Average Annual Growth Rate (%)				
		FY1990	FY2004	FY2010	FY2020	FY2030	FY2010	FY2020	FY2030	2004/1990	2010/2004	2020/2010	2030/2020	2030/2004
TPES (10^{13}kcal)	Reference	466	544	543	547	533				1.1	0.0	0.1	-0.3	-0.1
	Technology			538	522	487	-0.9	-4.7	-8.6		-0.2	-0.3	-0.7	-0.4
	High Growth			551	566	566	1.5	3.5	6.1		0.2	0.3	0.0	0.2
	High Price			539	536	511	-0.6	-2.1	-4.1		-0.1	-0.1	-0.5	-0.2
CO_2 Emissions (Mt-C)	Reference	287	331	311	303	284				1.0	-1.0	-0.3	-0.6	-0.6
	Technology			308	280	244	-1.1	-7.4	-14.1		-1.2	-0.9	-1.4	-1.2
	High Growth			317	316	305	1.6	4.4	7.3		-0.8	0.0	-0.4	-0.3
	High Price			309	292	268	-0.7	-3.4	-5.7		-1.1	-0.6	-0.9	-0.8
TFEC (10^{13}kcal)	Reference	323	372	372	369	359				1.0	0.0	-0.1	-0.3	-0.1
	Technology			370	358	336	-0.5	-3.0	-6.4		-0.1	-0.3	-0.6	-0.4
	High Growth			377	382	380	1.4	3.6	6.0		0.2	0.1	-0.1	0.1
	High Price			370	362	344	-0.5	-2.0	-4.1		-0.1	-0.2	-0.5	-0.3
Industry (10^{13}kcal)	Reference	170	178	179	177	175				0.3	0.1	-0.1	-0.2	-0.1
	Technology			179	175	171	0.0	-1.1	-2.2		0.1	-0.2	-0.3	-0.2
	High Growth			181	183	183	1.5	3.2	4.8		0.3	0.1	0.0	0.1
	High Price			178	174	167	-0.5	-1.8	-4.0		0.0	-0.2	-0.4	-0.2
Residential (10^{13}kcal)	Reference	43	54	54	56	55				1.7	0.0	0.3	-0.1	0.1
	Technology			53	52	50	-1.3	-6.2	-9.6		-0.2	-0.2	-0.5	-0.3
	High Growth			55	58	59	1.3	4.3	6.3		0.2	0.6	0.1	0.3
	High Price			54	55	53	-0.6	-2.0	-3.4		-0.1	0.2	-0.3	-0.1
Commercial (10^{13}kcal)	Reference	36	48	51	54	56				2.1	1.1	0.6	0.2	0.6
	Technology			50	51	50	-1.8	-6.5	-10.5		0.8	0.1	-0.2	0.1
	High Growth			52	58	62	1.6	5.8	11.0		1.3	1.0	0.7	1.0
	High Price			51	53	52	-0.8	-3.3	-6.2		0.9	0.3	-0.1	0.3
Passenger (10^{13}kcal)	Reference	44	60	58	55	49				2.1	-0.5	-0.5	-1.1	-0.7
	Technology			58	53	44	-0.1	-3.1	-10.9		-0.5	-0.8	-1.9	-1.2
	High Growth			58	56	51	0.8	2.8	4.5		-0.4	-0.3	-0.9	-0.6
	High Price			58	54	48	-0.2	-0.8	-1.9		-0.5	-0.6	-1.2	-0.8
Freight (10^{13}kcal)	Reference	30	32	30	27	24				0.5	-1.2	-1.2	-1.0	-1.1
	Technology			30	26	22	-0.1	-1.1	-10.1		-1.2	-1.3	-1.9	-1.5
	High Growth			30	27	25	1.4	2.2	5.3		-1.0	-1.1	-0.7	-0.9
	High Price			30	26	23	-0.6	-2.5	-5.2		-1.3	-1.4	-1.2	-1.3
Fuel Oil Sales Million kL	Reference	218	237	221	202	179				0.6	-1.1	-0.9	-1.2	-1.1
	Technology			221	195	160	-0.3	-3.8	-10.5		-1.2	-1.3	-1.9	-1.5
	High Growth			224	209	189	1.3	3.4	5.7		-0.9	-0.7	-1.0	-0.9
	High Price			220	198	170	-0.7	-2.3	-5.1		-1.3	-1.1	-1.5	-1.3
City Gas Sales Billion m^3	Reference	15.4	30.1	36.1	41.5	45.5				4.9	3.0	1.4	0.9	1.6
	Technology			35.8	38.9	42.9	-0.7	-6.3	-5.6		2.9	0.8	1.0	1.4
	High Growth			36.7	43.7	50.0	1.9	5.3	9.9		3.4	1.7	1.4	2.0
	High Price			35.9	40.5	43.1	-0.5	-2.5	-5.3		2.9	1.2	0.6	1.4
Electricity Sales TWh	Reference	678	892	983	1,071	1,116				2.0	1.6	0.9	0.4	0.9
	Technology			968	988	975	-1.5	-7.8	-12.7		1.4	0.2	-0.1	0.3
	High Growth			998	1,123	1,210	1.6	4.8	8.4		1.9	1.2	0.7	1.2
	High Price			977	1,044	1,061	-0.6	-2.6	-5.0		1.5	0.7	0.2	0.7

Contact: report@tky.ieej.or.jp