

An Overview of the New “Long-term Outlook for Energy Supply and Demand” and Its Challenges for the Future

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1. Introduction

While it has been the 14th time for the Advisory Committee for Natural Resources and Energy to release a “Long-term Energy Supply-Demand Forecast” since its creation, what characterizes the latest version is that it uses not only FY 2010 as a forecast year, which is the target year for Japan’s commitments under the Kyoto Protocol, but also FY 2030, which has never been used as a forecast year in the past, projecting for what is called an “ultra long-term” time span. The last several forecasts have used FY 2010 as a projection target because the accomplishment of the committed goals under the Kyoto Protocol has been a critical issue for the Japanese government ever since the COP3 (the 3rd Session of the Conference of the Parties to the UNFCCC), held in Kyoto in December 1997. However, FY 2010 viewed from 2004 is only several years away, leaving an extremely narrow range of choice in formulating policy measures. Furthermore, any plans projecting into only the next several years could hardly be considered as being of a long-term nature. The forecast released this time therefore purposely avoided the usual expression of “Long-term Energy Supply-Demand Forecast” and instead opted for using a phrase such as “Energy Supply-Demand Outlook for 2030”.

In the context of the subject in discussion, the term “forecast” has been misunderstood for many years, where it should be interpreted as a policy target, which is also an argument this author has repetitiously advocated. However, forecasting such a distant future as FY 2030 as a target year for policy measures will involve too many uncertainties, and the way macro indices, technological advances, or energy costs are viewed or assumed, i.e. how these external factors are postulated, could have a direct impact on the energy balance or carbon dioxide (CO₂) emissions.

Even though both forecasts equally concern the future, completely different patterns of thinking are required when forecasting for FY 2010 and FY 2030. For this reason, in dealing with FY 2030, the present forecast has employed an approach using a type of sensitivity analysis in which analyses are performed by applying variations to elements such as those mentioned above.

Behind the latest release of the forecast spanning up to FY 2030, the following background facts can be mentioned. In Europe, the EU Secretariat has proposed macro indices and energy supply-demand forecasts covering periods up to 2030 for the 25 EU member nations including the 10 Eastern and Central European countries that have recently joined, and in France

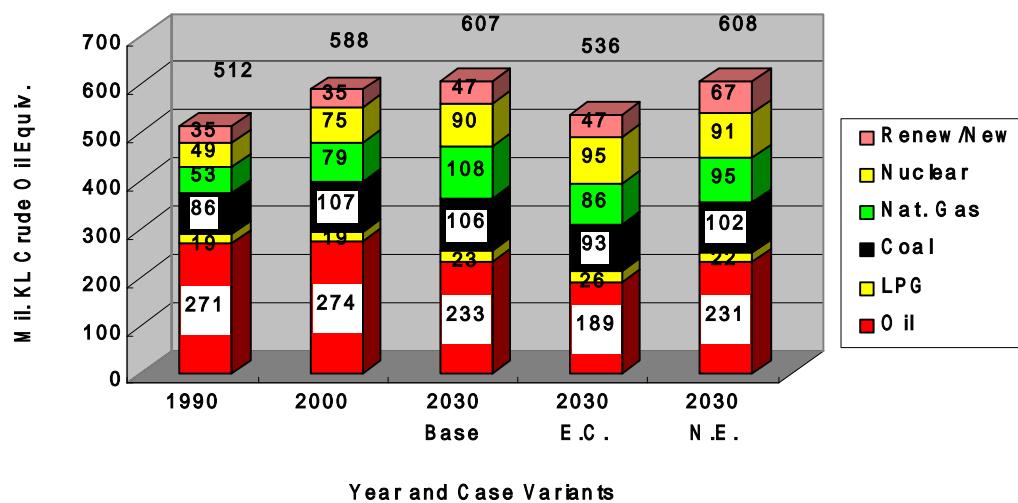
and UK, the governments have released outlook and case studies for periods up to 2020 (now revised to 2030) and 2050, respectively. Also in the USA, the Energy Information Administration (EIA) of the Department of Energy has published a forecast up to 2025 based on econometric models from a pure research point of view.

In October, 2004, the Advisory Committee for Natural Resources and Energy submitted the report to the Minister of Economy, Trade and Industry, in which a combination of energy supply and demand was proposed for FY 2010 so as to enable the targeted reduction of greenhouse gas emissions committed under the Kyoto Protocol. For FY 2030, the report has attempted to fortify the supply-demand structure also from an energy security standpoint, in addition to clearing environmental restrictions as an objective, for which several case studies have been proposed along with a reference case used as the benchmark. In this paper, the above reference case will be referred to as the Base Case.

2. Outlook on primary energy supply (Base Case)

The total primary energy supply in FY 2000 in terms of crude oil equivalent was 588 million kiloliters (KL), which represented a 14.8% increase over FY 1990. However, for the ten year period from FY 2000 - 2010, the Base Case only allowed an increase of 2.4%. The forecast points out that energy conservation should be promoted so as to limit the total primary energy supply at 607 million KL crude oil equivalent in FY 2030, with an increase of 3.2% over FY 2000 or an annual average growth rate at a near flat 0.1%, while maintaining the annual average economic growth rate at 1.4% (see FIG. 1).

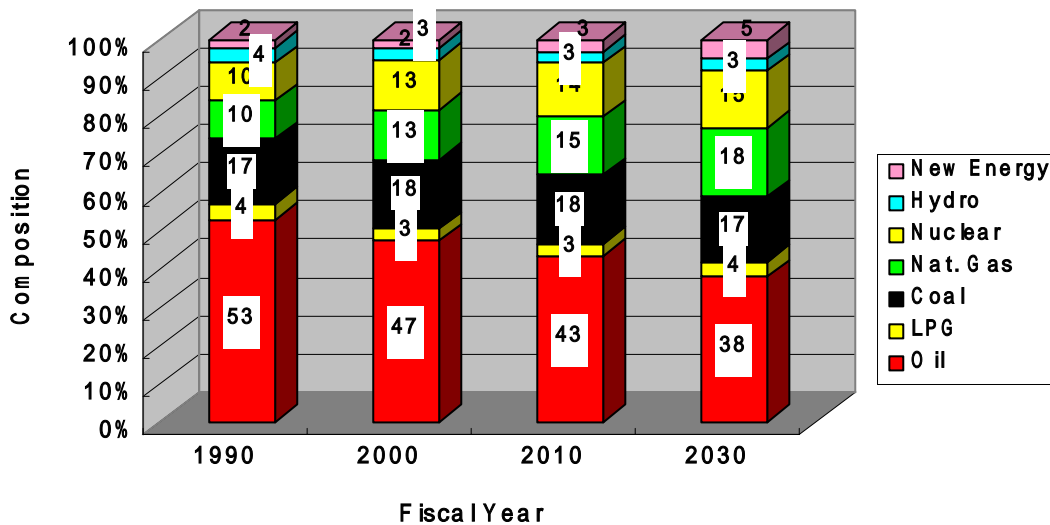
FIG. 1: Outlook on Japanese primary energy supply up to FY 2030 (Base Case)



(Note) E.C. = Energy Conserving Case, N.E = New Energy Case

The forecast proposes that the share of oil (including LPG) in the total primary energy supply be lowered from 57% in FY 1990 and 50% in FY 2000 to 46% in FY 2010 and 42% in FY 2030. The quantity of oil supplied is projected to drop by 15% (an annual average decrease of 0.5%) during the period of FY 2000 - 2030. The share of natural gas is forecast to consistently increase from 10% in FY 1990 and 13% in FY 2000 to 15% in FY 2010 and 18% in FY 2030. The natural gas supply is accordingly projected to grow by 37% (an annual average increase of 1.05%) over the FY 2000 - 2030 period. For nuclear power, it is forecast that 10 units of 1.36 million kW class nuclear power plants will be put into service by FY 2030 with an assumed utilization rate of 85%, and while the pace of growth will slow down, because of the sluggish growth of energy demand in general which will even shift to a declining trend after FY 2021, the share of nuclear power will gradually increase from 13% in FY 2000 to 14% in FY 2010 and 15% in FY 2030. For new energies and others, although their share is projected to steadily grow from 2% in FY 2000 to 3% in FY 2010 and 5% in FY 2030, it is not expected to grow to the extent that they can substitute principal energy sources such as oil, natural gas, nuclear, or coal (see FIG. 2).

FIG. 2: Outlook on Japanese primary energy supply composition up to FY 2030 (Base Case)



3. Outlook on electricity generation and the source composition for electric utilities (Base Case)

With respect to the electricity source composition, under a stagnant growth trend in the power generation output (by electric utilities), which is projected to grow by 20% (an annual average increase of 0.6%) during the period of FY 2000 – 2030 (the growth for the overall power generation output is estimated at 30% or at an annual average increase of 0.9% for the same period), nuclear power generation is expected to continue to steadily expand its share from 34.3% in FY 2000 to 36.8% in FY 2010 and 38.2% in FY 2030 on a kWh basis. However, the nuclear power generation output remains to show only a modest growth of 34% (an annual average

increase of 1%) during the period of FY 2000 – 2030. The supply share of natural gas based thermal electricity will increase from 26.4% in FY 2000 to 30.1% in FY 2030, with the main growth factor being the combined gas turbine power generation. The output by natural gas thermal is expected to grow by 37% (an annual average increase of 1.1%) during the period of FY 2000 – 2030, outperforming nuclear power generation albeit by a small margin. By contrast, the supply share for oil based thermal electricity will be cut back from 10.7% in FY 2000 to 6.5% in FY 2010 and 4.9% in FY 2030. The combined supply share for hydroelectricity and new energies will remain approximately the same at 10.2% in FY 2000 and 10.3% in FY 2030 (see FIG. 3, FIG. 4).

FIG. 3: Outlook on Japan’s electricity generation output (for electric utilities, basis kWh) by source up to FY 2030 (Base Case)

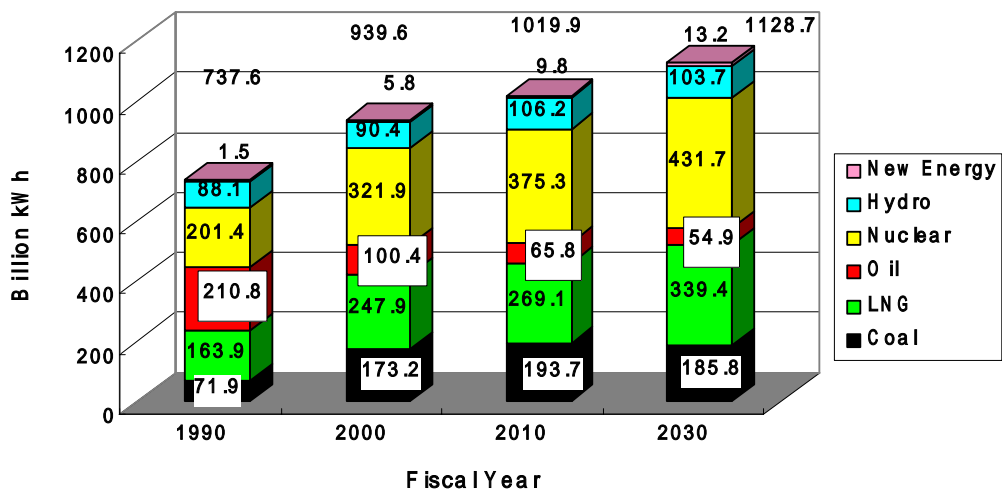
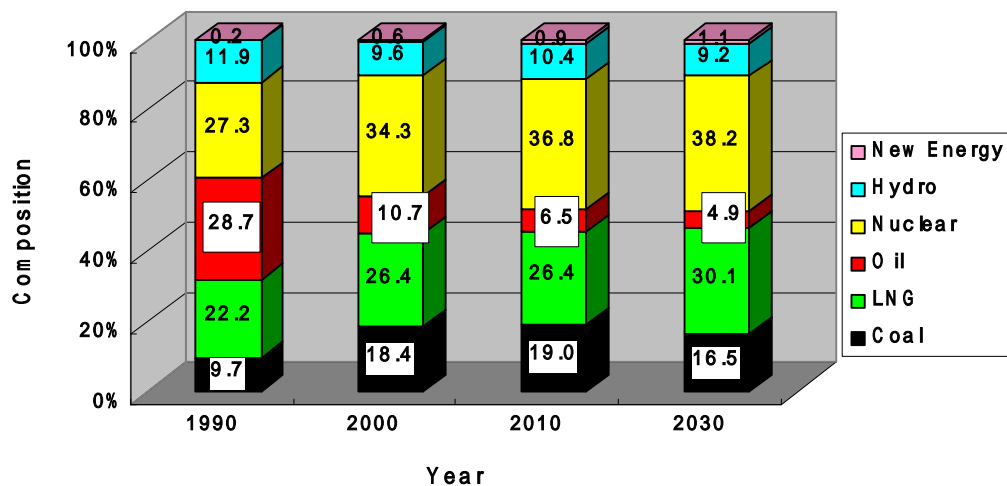


FIG. 4: Outlook on Japan’s electricity source composition (for electric utilities, basis kWh) up to FY 2030 (Base Case)



4. Outlook on final energy consumption (Base Case)

The amount of final energy consumption in terms of crude oil equivalent grew by approximately 20%, from 343 million KL in FY 1990 to 414 million KL in FY 2000. It is forecast to increase by a little less than 2% until FY 2010 and then almost level off, growing only up to 425 million KL crude oil equivalent by FY 2030. For the period of FY 2000 – 2030, the final energy consumption will basically display a flat trend with an overall growth rate of 3% (an annual average increase of 0.1%). The final energy consumption for industry use is forecast to decline by 4% over the period of FY 2000 – 2030 (an annual average decrease of 0.1%), and its share in the total consumption to decrease from 50.1% in FY 1990 and 47.1% in FY 2000 to 44.7% in FY 2010 and 44.2% in FY 2030. On the other hand, the consumption for household use will continue to grow from 12.5% in FY 1990 and 13.3% in FY 2000 to 14.3% in FY 2010 and 15.1% in FY 2030. While the consumption for business use will increase from 13.4% in FY 1990 to 16.9% in FY 2030, as will the use for passenger transport from 12.5% in FY 1990 to 15.5% in FY 2030, the use for cargo transport will decline from 11.4% in FY 1990 to 8.2% in FY 2030, reflecting the advancement in industry structure (see FIG. 5, FIG. 6).

FIG. 5: Outlook on Japan's final energy consumption by use up to FY 2030 (Base Case)

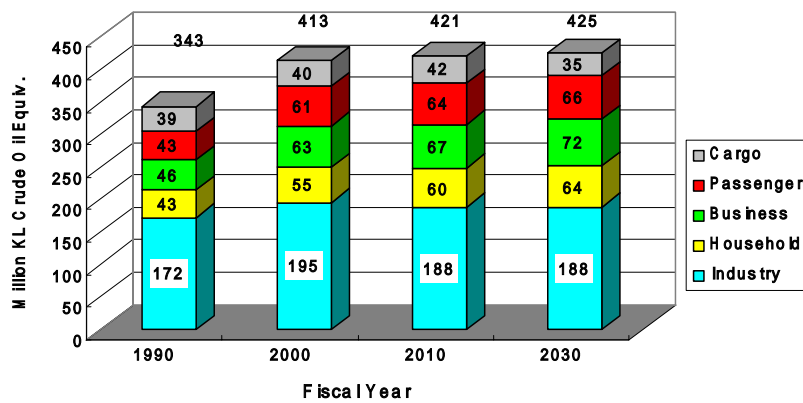
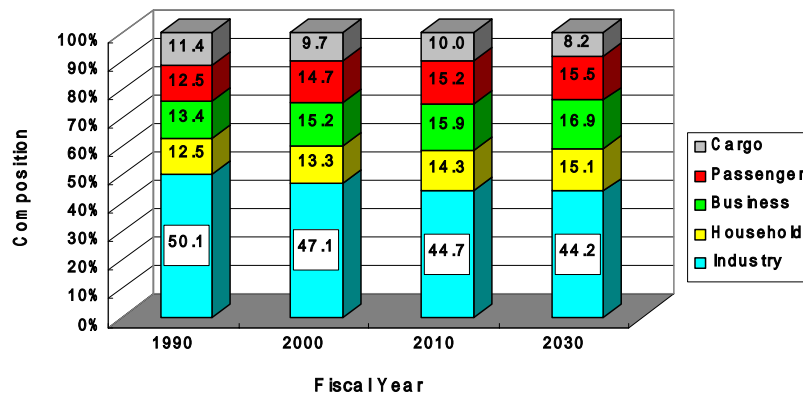


FIG. 6: Outlook on Japan's final energy consumption structure up to FY 2030 (Base Case)



5. Case studies concerning the forecast for nuclear power

With respect to the forecast for nuclear power, it is projected as a near-certainty that the power output in FY 2010 will be approximately 50 million kW after putting one plant back into service in addition to the FY 2000 capacity of approximately 45 million kW, with four additional plants being added later on. For this projection, a utilization rate of 85% is assumed. Concerning the outlook for FY 2030 in the Base Case, the assumption is that another six 1.36 million kW class plants will be put into service during the period of FY 2000 – 2030 to expand the output to approximately 58 million kW at the utilization rate of 85%.

One of the two variants that have been set out against the Base Case as described in the above is a high nuclear scenario (hereafter coded as Nuclear-H) which assumes the number of newly added nuclear power plants at 13 to raise the output to approximately 68 million kW, together with a possibility to improve the utilization rate up to 90%. Conversely, a low nuclear scenario (hereafter coded as Nuclear-L) limits the number of new plants to four with the FY 2030 output of approximately 56 million kW at the utilization rate of 85% (see Table-1).

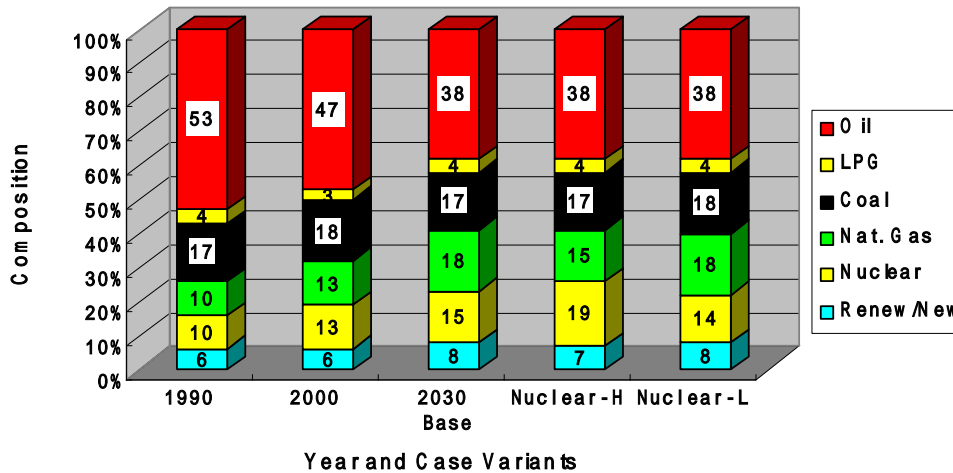
Table 1: Three cases in forecasting for nuclear power generation

| | FY2000 Actual | FY2010 Forecast | FY2030 Outlook |
|--|---|--|---|
| High Nuclear Case (Additional 17 units) | | | 67.95 Mil. kW (+13 units) Utilization rate 90% |
| Base Case (Additional 10 units) | 44.92 Mil. kW Utilization rate 82% | 50.14 Mil. kW (+4 units) Utilization rate 85% | 57.98 Mil. kW (+6 units) Utilization rate 85% |
| Low Nuclear Case (Additional 8 units) | | | 55.97 Mil. kW (+4 units) Utilization rate 85% |

5.1. Nuclear power case studies and changes in primary energy supply composition

Nuclear power’s share in the primary energy supply composition, which is projected to be 15% in the Base Case, will go up to 19% in the case of Nuclear-H and drop to 14% in Nuclear-L. Among the various primary energies, natural gas will be affected the most, where its 18% share in the Base Case will drop to 15% in the case of Nuclear-H. These changes are a reflection of changes in the electricity source composition (see FIG. 7).

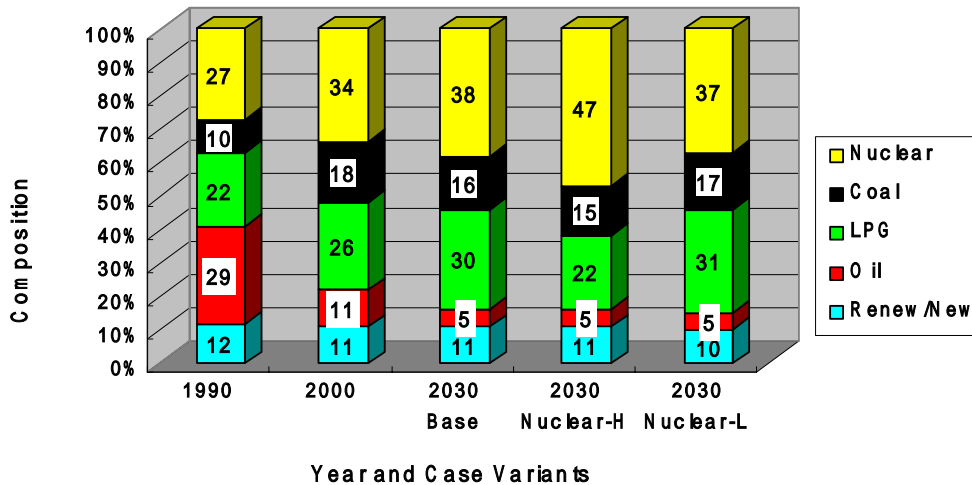
FIG. 7: Nuclear power case studies and changes in primary energy supply composition



5.2. Nuclear power case studies and changes in electricity source composition

Nuclear power’s share of the electricity source, which is projected to be 38% in the Base Case, will go up to 47% in the case of Nuclear-H, whereas the share of natural gas thermal will drop from 30% to 22%. In the case of Nuclear-L, nuclear power’s share will drop from 38% to 37% while the share of natural gas will increase from 30% to 31%. At the same time, coal thermal’s share will also increase from 17% to 18% (see FIG. 8).

FIG. 8: Nuclear power case studies and outlook for electricity source composition



5.3 Nuclear power case studies and influence on energy self-sufficiency

Japan’s energy self-sufficiency in FY 2030, which is projected to be 22.6% in the Base Case, will rise to 26.3% in the case of Nuclear-H and drop to 22.1% in Nuclear-L. In the accompanying Table-2, the “net self-sufficiency” considers energy supplied only by renewable and new energies, whereas the “quasi-domestic ratio” refers to the share of nuclear power in the primary energy supply and the “gross self-sufficiency” is the sum of the “net self-sufficiency”

and the “quasi-domestic ratio” (see Table-2).

Table-2: Nuclear power case studies and changes in energy self-sufficiency (%)

| Fiscal Year | 1990 | 2000 | 2030 | 2030 | 2030 |
|------------------------|------|------|-----------|-----------|-----------|
| Case Variants | | | Base Case | Nuclear-H | Nuclear-L |
| Net self-sufficiency | 6.7 | 6.0 | 7.7 | 7.7 | 7.7 |
| Quasi domestic ratio | 9.6 | 12.7 | 14.9 | 18.6 | 14.4 |
| Gross self-sufficiency | 16.3 | 18.7 | 22.6 | 26.3 | 22.1 |

5.4 Nuclear power case studies and influence on CO2 emissions

With respect to the amount of CO2 emissions, which is projected for the FY 2030 Base Case to be 8.7% over the figure for FY 1990, while it could be reduced to a level of 4.9% over that of FY 1990 in the case of Nuclear-H, it goes up to 9.8% over FY 1990 in Nuclear-L (see Table-3).

Table-3: Changes in CO2 emissions (for FY 2030 increments [in million tons carbon equivalent] and incremental percentages [%] over FY 1990)

| Fiscal Year | 1990 | 2000 | 2030 | 2030 | 2030 |
|-------------------------|------|------|-----------|-----------|-----------|
| Case Variants | | | Base Case | Nuclear-H | Nuclear-L |
| CO2 Emissions | 287 | 287 | 287 | 287 | 287 |
| Increment, Mil. Tons-C. | 0 | 31 | 25 | 14 | 28 |
| Increment, % | 0 | 10.8 | 8.7 | 4.9 | 9.8 |

6. Case studies for promotion of energy technologies (energy conservation, new energy)

In the long-term outlook released this time, significant expectations are placed on technological advancement as supported by policy measures, with a particular emphasis on promotion of technological advancement in the areas of energy conservation and new energies. This is because the extent of improvements in the energy self-sufficiency and the reduction in CO2 emissions does not appear to be sufficient even if the expected expansions in nuclear energy are to be realized. For this reason, several case studies have been established as additional action cases for the promotion of technological development concerning energy conservation and new energies so that the energy self-sufficiency improvement and the CO2 emissions reduction can be dealt with as policy targets.

6.1 The case for promotion of energy conservation technology and its impact

For the case of energy conservation technology promotion, the following four categories have been considered:

- a) Promulgation and promotion of conventional energy conservation technologies
- b) Promulgation and promotion of novel energy conservation technologies
- c) Promulgation and promotion of energy conservation technologies based on heat pumps
- d) Promulgation and promotion of fuel cells and distributed energies (cogeneration, etc.)

In the estimates based on the case for energy conservation technology promotion, it is assumed that, due to the expected energy saving effect, the final energy consumption in FY 2030 will decline by 50 million KL in crude oil equivalent or approximately 9% in comparison with the Base Case, allowing the annual average increase rate for the period of FY 2000 – 2030 to drop from +0.1% in the Base Case to – 0.3%. This also enables a reduction of the annual average increase rate for overall electricity demands (including those not supplied by electric utilities) from +0.9% to +0.3% during the same period. As a result of the popularization of fuel cells and others, distributed type electricity sources will increase their share in the overall power generation output from 11.2% in FY 2000 (Base Case) to 21.0% in FY 2030.

Since the output and other conditions for nuclear power in this case study are fixed constant in accordance with the assumptions used in the Base Case, and the consumption of fossil fuels will decline as energy conservation measures are further promoted, non-fossil fuel energies such as nuclear energy will expand their supply share as a consequence. Nuclear power's share of the primary energy supply in FY 2030, which is projected to be 14.8% in the Base Case, will expand to 17.6%. Further, nuclear power's share of the power generation output by electric utilities in FY 2030 will grow from 38.2% in the Base Case to 47.4%. As is the case with nuclear energy, renewable and new energies will also expand their share from 10.4% to 13.5%. For natural gas, although natural gas based thermal electricity will be drastically cut down because of reductions in demand for power grids (the FY 2030 share of the electricity source composition goes down from 30.1% in the Base Case to 18.2%), popularization of distributed type electricity sources will increase the demand to limit the decline of natural gas's share of 17.8% of the primary energy supply as a whole at 16.0%.

The final energy consumption in FY 2030 in the case of energy conservation technology promotion is estimated to decline by a little over 11% from that of the Base Case, where contributions are expected particularly from reductions in household use and passenger transport, at 19% and 16%, respectively in comparison with the Base Case. In terms of the share of the total consumption, household use will shrink from 15.5% to 13.0%, as will passenger transport from 15.1% to 13.8%, whereas industrial use will increase its share from 44.2% to 49.1% despite the progress in energy conserving measures (see FIG. 9, FIG. 10, FIG. 11, Table-4, Table-5, and

Table-6).

6.2 The case for promotion of new energy technology and its impact

In the estimates based on the case for new energy technology promotion, it is assumed that the combined share of renewable and new energies in the primary energy supply reaches approximately 10% by FY 2030 (actual calculation result was 11%, with an estimated supply of 67 million KL crude oil equivalent or approximately 1.4 times that of the Base Case). Of the above figures, new energies represent a 7.6% supply share, with an estimated supply of 46 million KL crude oil equivalent which is approximately 1.7 times that of the Base Case (see FIG. 9, FIG. 10).

FIG. 9: Energy conservation and new energy case studies and changes in primary energy supply

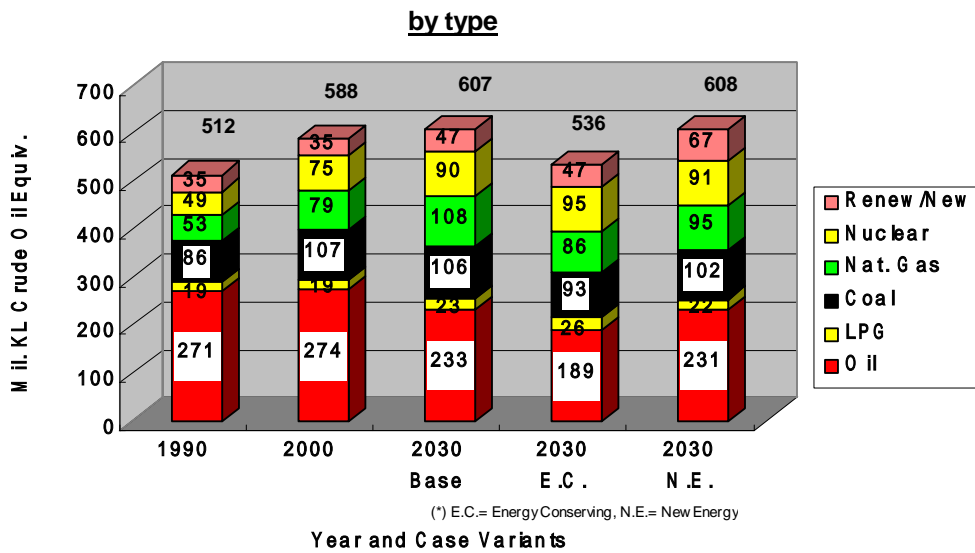


FIG. 10: Energy conservation and new energy case studies and changes in primary energy supply

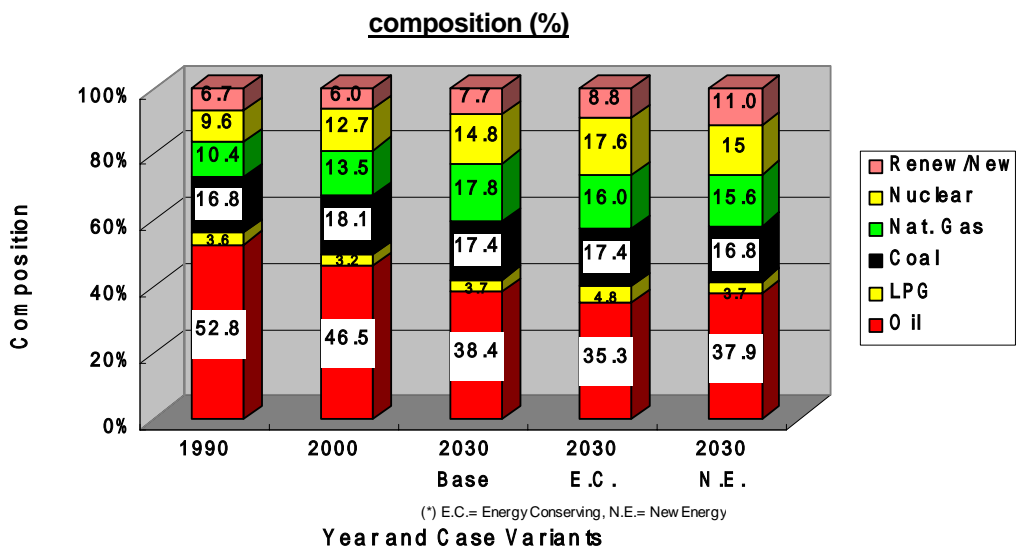
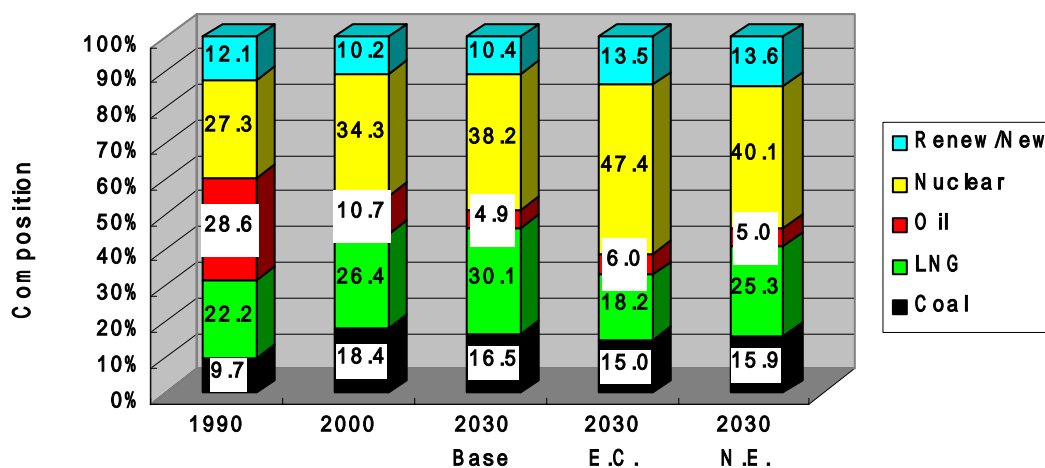


Table-4: Energy conservation and new energy case studies and changes in power output (in Billion kWh) by electricity source

| Fiscal Year/Case | 1990 | 2000 | 2030 Base | 2030 EC* | 2030 NE* |
|------------------|--------------|--------------|---------------|--------------|---------------|
| Coal | 719 | 1,732 | 1,858 | 1,362 | 1,707 |
| LNG | 1,639 | 2,479 | 3,394 | 1,655 | 2,723 |
| Oil | 2,108 | 1,004 | 549 | 544 | 540 |
| Nuclear | 2,014 | 3,219 | 4,317 | 4,317 | 4,317 |
| Renewable/New | 896 | 962 | 1,169 | 1,223 | 1,471 |
| Total | 7,376 | 9,396 | 11,287 | 9,101 | 10,758 |

* EC = Energy conservation, NE = New energy

FIG. 11: Energy conservation and new energy case studies and changes in electricity source composition (% basis kWh)



(*) E.C.= Energy Conserving, N.E.= New Energy

Year and Case Variants

Table-5: Energy conservation technology promotion case study and changes in final energy consumption (in Million KL crude oil equivalent)

| Fiscal Year/Case | 1990 | 2000 | 2030 Base | 2030 EC* |
|------------------|------------|------------|------------|------------|
| Industry | 172 | 195 | 188 | 185 |
| Household | 43 | 55 | 64 | 52 |
| Business | 47 | 62 | 72 | 62 |
| Passenger | 43 | 61 | 66 | 49 |
| Cargo | 39 | 40 | 35 | 29 |
| Total | 344 | 413 | 425 | 377 |

* EC = Energy conservation

Table-6: Energy conservation technology promotion case study and changes in final energy consumption composition (%)

| Fiscal Year/Case | 1990 | 2000 | 2030 Base | 2030 EC* |
|------------------|------|------|-----------|----------|
| Industry | 50.0 | 47.2 | 44.2 | 49.1 |
| Household | 12.5 | 13.3 | 15.1 | 13.8 |
| Business | 13.7 | 15.0 | 17.0 | 16.4 |
| Passenger | 12.5 | 14.8 | 15.5 | 13.0 |
| Cargo | 11.3 | 9.7 | 8.2 | 7.7 |

* EC = Energy conservation

6.3 Energy conservation and new energy case studies and changes in energy self-sufficiency

In the case for energy conservation technology promotion, thanks to the expansion in the nuclear power ratio (i.e. the quasi-domestic ratio) resulting mainly from the energy saving effect, the gross self-sufficiency improves by more than 10% from 16.3% in FY 1990 to 26.5% in FY 2030, with a margin of improvement from the Base Case figure of 22.6% being almost 4%.

In the case for new energy technology promotion, due to the increase in the supply of renewable and new energies, the net self-sufficiency improves by more than 3% in comparison with the Base Case, improving the gross self-sufficiency up to 26.0% which is comparable to the result of the case for energy conservation technology promotion (see Table-7).

Table-7: Energy conservation/new energy case studies and changes in energy self-sufficiency (%)

| Fiscal Year/Case | 1990 | 2000 | 2030 Base | 2030 EC* | 2030 NE* |
|---------------------------|------|------|-----------|----------|----------|
| Net Self-sufficiency, % | 6.7 | 6.0 | 7.7 | 8.8 | 11.0 |
| Quasi Domestic Ratio % | 9.6 | 12.7 | 14.9 | 17.7 | 15.0 |
| Gross Self-sufficiency, % | 16.3 | 18.7 | 22.6 | 26.5 | 26.0 |

* EC = Energy conservation, NE = New energy

6.4 Energy conservation and new energy case studies and changes in CO2 emissions

In the case for energy conservation technology promotion, while the final energy consumption in FY 2030 will decline by 11% in comparison with the Base Case, which represents an increase of 10% over the FY 1990 record, the amount of CO2 emissions will drop from that of FY 1990 by 9.4% due to the expansion in nuclear as well as natural gas energies. In the case for new energy technology promotion, the amount of CO2 emissions in FY 2030 will be held at a level 4.5% higher than that of FY 1990 (see Table-8).

Table-8: Energy conservation/new energy case studies and changes in CO2 emissions in FY 2030
(amount and rate of change, against FY 1990)

| Fiscal Year/Case | 1990 | 2000 | 2030 Base | 2030 EC* | 2030 NE* |
|-------------------------|------|-------|-----------|----------|----------|
| CO2 Emissions in FY1990 | 287 | 287 | 287 | 287 | 287 |
| Increment, Mil. T, C. | - | 31 | 25 | -27 | 13 |
| Increment, % | - | 10.8% | 8.7% | -9.4% | 4.5% |

* EC = Energy conservation, NE = New energy

7. Discussion and the challenges for the future

(1) While the main objectives of Japan's energy policy could be represented by three "E"s, i.e. Energy security, Environmental protection, and Economic efficiency, improvement in the energy self-sufficiency and curtailment or reduction of CO2 emissions are clearly and explicitly laid out as specific policy objectives in the latest version of the Long-term Energy Supply-Demand Forecast.

(2) Expansion of nuclear power generation, promotion of renewable or new energy technologies, and facilitation of revolutionary innovations in energy conserving technology constitute the three largest pillars of policy measures, in which conversion to natural gas is also positioned as one of the major objectives.

(3) Expectations for increased capacity utilization of nuclear power plants: Although the expansion in terms of generated power output is modestly projected, the proposed increase in capacity utilization rate to the level of 85 – 90% would face considerable difficulties and, while such an improvement would be desirable from the energy policy point of view, it would not be easily achieved due to resistance from local residents at plant sites as well as from others.

(4) A revolutionary breakthrough in energy conserving technology is indispensable to dissociate the energy/electricity consumption from the real rate of GDP growth. While the income elasticity seems to have been underestimated in the report (in the Base Case for the period of FY 2000-2030, income elasticity of energy is projected to be 0.07, whereas income elasticity of electricity consumption is 0.64), a revolutionary innovation in energy conserving technology is still crucial for achieving the required dissociation between GDP and energy consumption

For future action, it appears necessary to provide more practicality to promotion of energy conservation measures as well as improvement in the utilization rate of nuclear power plants, and to investigate the means for achieving the targets for prevention of global warming while adequately integrating the Kyoto Mechanisms into the planning. (End)

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