INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

JAPAN 1999 REVIEW

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TABLE OF CONTENTS

Tables and Figures

TABLES

FIGURES

1

SUMMARY AND RECOMMENDATIONS

SUMMARY

The principal goals of Japanese energy policy are summarised as the "3 Es": economic growth, energy security and environmental protection. These goals are a short-hand description of the *Shared Goals* of the IEA. The intention of Japan's energy policy is to achieve the three goals simultaneously, and the possibility of trade-offs between the goals is acknowledged by the Government. Because of the possibility of trade-offs, it will be important that the benefits and costs of the goals be quantified wherever possible and decisions based on a clear understanding of the extent to which the goals are achieved by pursuing any particular policy.

Since the last in-depth review in 1994, the two major developments in Japan's energy policy have been: reform of the regulatory framework and measures to respond to climate change. The strengthening of deregulation efforts was decided in May 1997, in the *Action Programme for Economic Structure Reform*. In line with this decision, increased efforts have been undertaken by the energy sector for restructuring the supply side, which does not yet meet international standards in terms of costs and services. Reform in the energy sector is an important component of overall policy on economic recovery and, increasingly, the market will be relied on to achieve a satisfactory outcome.

Electricity regulatory reform is the central issue in this review. Competition in electricity is closely related to developments in the gas market, to energy efficiency policies, and to Japan's commitment to reduce greenhouse gas emissions. These linkages are the key issues discussed in the chapters of the review on these areas.

Energy Efficiency

It is commendable that Japan has made energy efficiency one of the priorities for meeting greenhouse gas emission reduction targets in the short and long terms. However, in view of the rising trends in energy consumption in all sectors, the share of the targets to be achieved by energy efficiency measures would require drastic changes in lifestyle, energy infrastructure and the use of efficient technology. This review discusses the cost-effectiveness of energy efficiency measures currently in place. If the measures are not successful, then additional contributions would be required from fuel switching (from coal to nuclear, gas or renewables) or from international flexibility mechanisms. Government direct support for voluntary action and the possibility of improving the analytical basis for energy savings projections are also discussed.

Energy and the Environment

Approximately 90% of carbon dioxide produced in Japan is energy-related. Japan has agreed to reduce greenhouse gas emissions by 6% compared with 1990 during

the first commitment period between 2008 and 2012. For the energy sector, policy is focused on drastic energy efficiency measures in the industry, residential and commercial, and transportation sectors and, on the supply side, on the promotion of nuclear power and new energies.

The review concludes that Japan's nuclear energy production target is achievable. To achieve it, however, is likely to require attention be given to improving the capacity utilisation factor, which in turn requires that consideration be given to regulatory issues, such as the periodic inspection regime, while, of course, always giving primary consideration to safety as an essential element in public acceptance. Public acceptance of nuclear energy is essential if the planned growth in nuclear power generation is to be achieved.

Electricity

The Japanese electricity sector has been shaped by the Government's key energy policy goals of energy security, economic growth and environmental protection. The ten vertically integrated utilities that serve virtually all end-users of electricity in Japan have enhanced energy security through diversification away from oil. Investment in nuclear power has contributed to diversification and is expected to reinforce government efforts to limit carbon dioxide emissions from the energy sector.

Government concerns about high electricity prices (the highest in the OECD) have led to reforms of the sector of which the introduction of competition is seen as a key measure. Amendment of the Electric Utility Industries Law has required utilities to conduct tenders for independent power producers to supply short-term thermal power to the utilities. These tenders have been highly successful and demonstrate significant potential for other industrial companies to enter the power business. These tenders will be expanded beginning in 1999 (and overseen by a neutral agency) to allow competition in the supply of all future thermal power needs, unless a remarkable change in the situation occurs.

Further reforms, particularly the introduction of partial liberalisation of retail supply have been considered by an advisory committee to the MITI Minister. The proposed reforms, which will be embodied in a new law in 1999, are expected to liberalise the market for extra high voltage consumers (28% of all supply) and to introduce accounting measures to separate the activities of the incumbent utilities to ensure non-discrimination.

The decision to move forward with partial liberalisation of retail supply is an important, irreversible step for Japan. In particular, the recognition by Japan of the need for equal conditions in competition between the utilities and new entrants, the need for fair and transparent rules on the use of power transmission lines, and the commitment to set a timetable for liberalisation are essential points in any liberalisation effort.

Oil

Oil remains a critically important energy source for Japan, accounting for nearly 55% of primary energy supply. Because of its share of primary energy supply, oil accounts for about 65% of energy-related carbon dioxide emissions. On both energy security and environmental grounds, reducing oil consumption or diversifying supply are logical goals of the Government, but the cost-effectiveness of policies to achieve these ends, such as promotion of Japanese investment in oil production worldwide through the Japan National Oil Corporation, needs to be considered in the context of the current low world oil price and plentiful supply.

Liberalisation of the market for petroleum products in Japan has lowered gasoline prices and promoted a major restructuring of the distribution of petroleum products. Further change is inevitable, because retail margins are too low to support the number of retail outlets. Liberalisation of the electricity sector, and the introduction of cost-reflective electricity tariffs, could contribute to lowering the need for oil to meet peak demand. Energy market liberalisation generally is likely to be an effective means of ensuring the compatible achievement of Japan's energy policy goals.

Japan wishes to maintain domestic refining capacity to ensure that, during emergency periods, stocks of oil can be readily converted to products. The structure of customs duty may offer protection to the refining industry in competition with imports. The different levels of taxation on crude and oil products, as well as the differences between oil products, could generally raise the issue of cross-subsidies leading to economic inefficiency.

Gas

Natural gas is one of Japan's most important energy sources in terms of energy security since dependency on the Middle East is smaller than that for oil, and on environmental grounds because of lower greenhouse gas emissions from gas-fired power than from coal-fired power. Consumption is largely for electricity generation. Electricity and gas issues are consequently closely related since natural gas is imported as liquefied natural gas (LNG) and the gas pipeline network is not highly developed.

Given the uncertainty of achieving the nuclear target, natural gas might be considered as an alternative means of meeting energy demand with an acceptable environmental outcome. To develop gas further would require overcoming two major barriers: developing the network and lowering the cost of supplying LNG. Only 5% of the land area (but 50% of the population) is covered by the gas grid. Some small LPG retailers have a high degree of market power. The review discusses measures, including third party access and better gas load management, which might improve the performance of the gas market, simultaneously enhancing security and environmental objectives.

The ability of individual companies to operate flexibly is limited by the present organisation of the gas market within Japan. Third party access to LNG terminals may be one way of introducing competition and lowering costs but would, of course, require consideration of the terms of access and/or compensation to the owners. The development of the gas market may also be impeded by the way in which gas prices are formed. The efficient functioning of the gas market would be improved substantially if market players could operate with more flexibility, for example by encouraging trade in gas between large consumers.

Coal

Japan is by far the world's largest importer of steam coal for power generation (64.1 Mt in 1997) and of coking coal for steel making (65.3 Mt in 1997). Japan accounts for about 28% of total world coal imports. In Japan, where steam coal is primarily used for baseload power generation, security of physical supplies of steam coal is essential. The question arises whether pressure to reduce fuel costs for electricity generation will conflict with Japan's energy security goal. Over time, the Asia-Pacific coal market may develop along lines seen in the European coal market, with the spot market becoming a more prominent point of reference for determining price, but distinguished from the European market by the demand for coal in baseload power generation. This latter feature of the market could lead to long-term contracts with prices related to the spot price, but with explicit premiums for security of supply, and thus limit the physical size of the spot market.

Japan maintains a small but heavily subsidised coal mining industry, justified in part on security grounds and as a means of supporting the development of coal technology. Production has declined under competitive pressure from imported coal from about 55 Mt in the early 1960s to its present level of 3.97 Mt (1997 financial year). Competition in the electricity market is also placing pressure on subsidies for Japanese coal production. The future of domestic production is currently under review. To date, policies have been very effective in reducing the level of domestic production. The real need of coal mining regions in Japan appears to be creation of employment opportunities for the remaining mining workforce, rather than energy security or supporting the development of coal technology.

Research, Development and Technology

Achieving the *3 Es* in the short and long terms will require continuation of recent trends in research, development and deployment, in the areas of energy efficiency and renewables, while continuing to give attention to nuclear, particularly waste management and research directed at raising the level of public acceptance of nuclear power. A balance of long-term and short-term research and development is likely to continue to be needed, particularly in light of increased private sector focus

on short-term research and development. Consideration could also be given to further research on the effectiveness of market-based mechanisms for achieving the *3 Es* of Japanese energy policy.

RECOMMENDATIONS

The Government of Japan should:

General Energy Policy

☐ Give consideration to redefining the role and scope of the Long Term Energy Supply and Demand Outlook, with a view to enhancing its value as an objective analysis of the energy outlook in Japan, with a range of possible outcomes for the future based on plausible, published assumptions.

Efficiency

☐ Through electricity and gas market liberalisation policies, encourage the widespread use of cost-reflective energy pricing, including time-differentiated electricity pricing to encourage energy conservation in summer and also to assist in levelling electricity loads.

☐ Review policies to achieve improved energy efficiency, taking care to distinguish between improvements attributable to government policies and improvements that would have happened otherwise, and utilise the results of reviews undertaken to adjust the package of policies intended to meet Japan's Third Conference of the Parties (COP 3) target, in particular the possible need to adjust the balance between energy demand and energy supply policies.

☐ Evaluate the applicability to Japan of policies used in other IEA Member countries to monitor and enforce voluntary agreements with industry.

☐ Consider strengthening energy conservation standards for buildings, adopting energy conservation information systems for residential buildings and developing a process of energy audits/certification for buildings as part of the documentation prepared when buildings are sold.

Nuclear

☐ Give consideration to means by which the Government could improve the overall capacity utilisation factor of nuclear plants, consistent with good safety

and reliability by, for example, allowing utilities to increase the length of the power cycle in nuclear plants between two refuelling operations, from 13 to 18 months or more as is the present trend in other OECD countries.

☐ Continue efforts to ensure full transparency and accountability for regulating safety of nuclear power reactors.

Electricity

☐ See Chapter 7, page 100.

Oil

☐ In the course of the planned review of the role of the Japan National Oil Corporation (JNOC), seek to quantify the tangible energy security benefits arising from JNOC's activities to date, and evaluate the cost-effectiveness of their achievement.

☐ Consistent with its policy of self-responsibility, permit further rationalisation of gasoline retailing, notwithstanding the drastic reduction in the number of service stations that appears likely in the immediate future.

☐ Review the structure of customs duty applying to petroleum products, to remove anomalies which may exist between products, and particularly with the higher tariff on heavy oil.

Gas

☐ Give consideration to the means by which competition might be introduced into LNG procurement as a means of reducing the cost of gas and enhancing security of supply.

☐ Review the basis on which prices are set in the gas market, to determine the extent to which monopolistic price-setting may be impeding the growth of gas consumption and the introduction of new technologies such as trigeneration of electricity, heat and cold.

☐ Ensure that large gas consumers are able to exchange gas freely and that the tariff on transport is set at a threshold low enough to encourage small-scale cogeneration and trigeneration; ensure that a protective tariff applies to gas transport for all captive users.

☐ Further encourage the introduction of competition in the gas market wherever the gas grid has already been developed, by expanding the range of consumers able to directly negotiate price and conditions of supply, by monitoring price and

conditions of supply, and by monitoring prices and trade practices of LPG retailers with a view to preventing any anti-competitive activities.

☐ Encourage gas grid expansion wherever economical to do so.

Coal

☐ In reviewing the future of the domestic coal industry, and the role of coal generally, acknowledge the operation of the international coal market as a cost-effective means of contributing to Japan's energy security and encourage the development of pricing formulae in long-term contracts to provide the same level of security as the former benchmark pricing system.

☐ Clarify the objectives of assistance to the coal industry, particularly those objectives which could be achieved by measures other than continuing coal production.

☐ Continue efforts to achieve structural adjustment in the coal mining industry, and the abolition by FY 2001 of existing subsidies for domestic coal production.

Research, Development and Technology

☐ Review the share of research and development funding given to developing wind power, in the light of its economic and technical performance in other IEA countries, and with a view to responding to the difficulties encountered in its application in Japan.

☐ Review the share of research and development funding for energy conservation, in view of the importance of energy conservation to achieving Japan's greenhouse targets; and give consideration to socio-economic research on consumer motivation and the effectiveness of pricing as an instrument of energy policy.

☐ Ensure that industry views are considered in reaching decisions on funding for particular projects, within the Government's overall research and development strategy, so that long-term commercial potential is a criterion for project selection for projects expected to be implemented by 2010, in particular.

☐ Continue to pursue a mix of shorter-term and long-term research and development and to encourage industry to do the same; and consider sharing the results of the Electricity Research and Development Review Committee's deliberations on this subject with other IEA Member countries.

2

CONDUCT OF THE REVIEW

REVIEW TEAM

The 1999 International Energy Agency's (IEA) in-depth review of the energy policies of Japan, and the electricity chapter of the review of regulatory reform in Japan by the Organisation for Economic Co-operation and Development (OECD)[1], were prepared by a team of energy policy specialists drawn from the Member countries of the IEA. The team visited Japan from 31 August to 4 September 1998 for discussions with government officials and representatives of the energy supply and distribution industries. Information provided during the course of the visit to Japan has been supplemented by published sources and IEA statistical analysis of data provided by the Ministry of International Trade and Industry (MITI).

Members of the team were:

David Jhirad (team leader)
Department of Energy, United States

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Wolfgang Stinglwagner
Bundesministerium für Wirtschaft, Germany

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Sally van Siclen
Competition Law and Policy Division, OECD

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Office of Long-Term Co-operation, International Energy Agency

Peter Fraser
Energy Diversification Division, International Energy Agency

Madeline Woodruff
Energy Technology Policy Division, International Energy Agency

John Cameron
Country Studies Division, International Energy Agency

1. The chapter on electricity (Chapter 7) in this report has been drafted for use in both reports and its structure is different in some respects from other chapters in this report.

Peter Fraser was responsible for drafting Chapter 7 (electricity), in consultation with the team. John Cameron was responsible for drafting all other chapters, in consultation with the team.

The team held discussions with the following organisations:

Ministry of International Trade and Industry, Agency of Natural Resources and Energy
- Director-General
- International Affairs Division
- Energy Policy Planning Division
- General Coordination Division
- Nuclear Energy Industry Division
- Nuclear Power Division, Public Utilities Department
- Planning Division, Public Utilities Department
- Electric Power Administration Division, Public Utilities Department
- Electric Power Development Division, Public Utilities Department
- Electric Power Technology Division, Public Utilities Department
- Gas Utility Industry Division, Public Utilities Department
- Planning Division, Petroleum Department
- Exploration and Production Division, Petroleum Department
- Refining Division, Petroleum Department
- Distribution Division, Petroleum Department
- Planning Division, Coal and New Energy Department
- International Affairs Office, Coal and New Energy Department
- Coal Industry Division, Coal and New Energy Department
- Energy Efficiency Policy Division, Coal and New Energy Department
- New Energy Policy Division, Coal and New Energy Department

Ministry of International Trade and Industry, Agency of Industrial Science and Technology
Ministry of International Trade and Industry, Environmental Protection and Industrial Location Bureau
Environmental Agency
Ministry of Transportation
Ministry of Construction
Tokyo Electric Power Company
Japan Gas Association
Keidanren (Japan Federation of Economic Organisations)
Petroleum Association of Japan
Institute of Energy Economics, Japan
Federation of Electric Power Companies
Nippon Steel Corporation

Additional discussions (7 - 8 September) were conducted by Mr Cameron, Mr Fraser and Ms van Siclen with Nomura Securities, members of the Utility Industry Council and the Study Group on Government Regulations and Competition Policy of the Fair Trade Commission, Electric Power Development Company, and the Fair Trade Commission.

The assistance and co-operation of all participants in the review are gratefully acknowledged.

REVIEW CRITERIA

The *Shared Goals* of the IEA, which were adopted by IEA Ministers at their 4 June 1993 meeting, held in Paris, provide the evaluation criteria for in-depth reviews conducted by the Agency. The *Shared Goals* are set out in Annex C.

3

GENERAL ENERGY POLICY AND OUTLOOK

GENERAL ENERGY POLICY

Responsibility for energy policy rests with the central Government, with the Ministry of International Trade and Industry (MITI) taking the lead role. Within MITI, the Agency of Natural Resources and Energy (ANRE) is responsible for the rational development of mineral resources, the securing of a stable supply of energy, promotion of efficient energy use, and regulation of the electric power and other energy industries. Responsibility for energy research and development is shared between ANRE and MITI's Agency of Industrial Science and Technology. Figure 1 illustrates the organisation of MITI. Other government departments involved in the energy sector include the Science and Technology Agency, with responsibilities including nuclear research and development, and the Ministry of Foreign Affairs.

The bulk of Japan's energy industry is in the private sector. The energy industries are heavily regulated by the Government. Significant deregulation has occurred, particularly in oil. First steps in deregulation of the gas and electricity sectors came into effect in 1995.

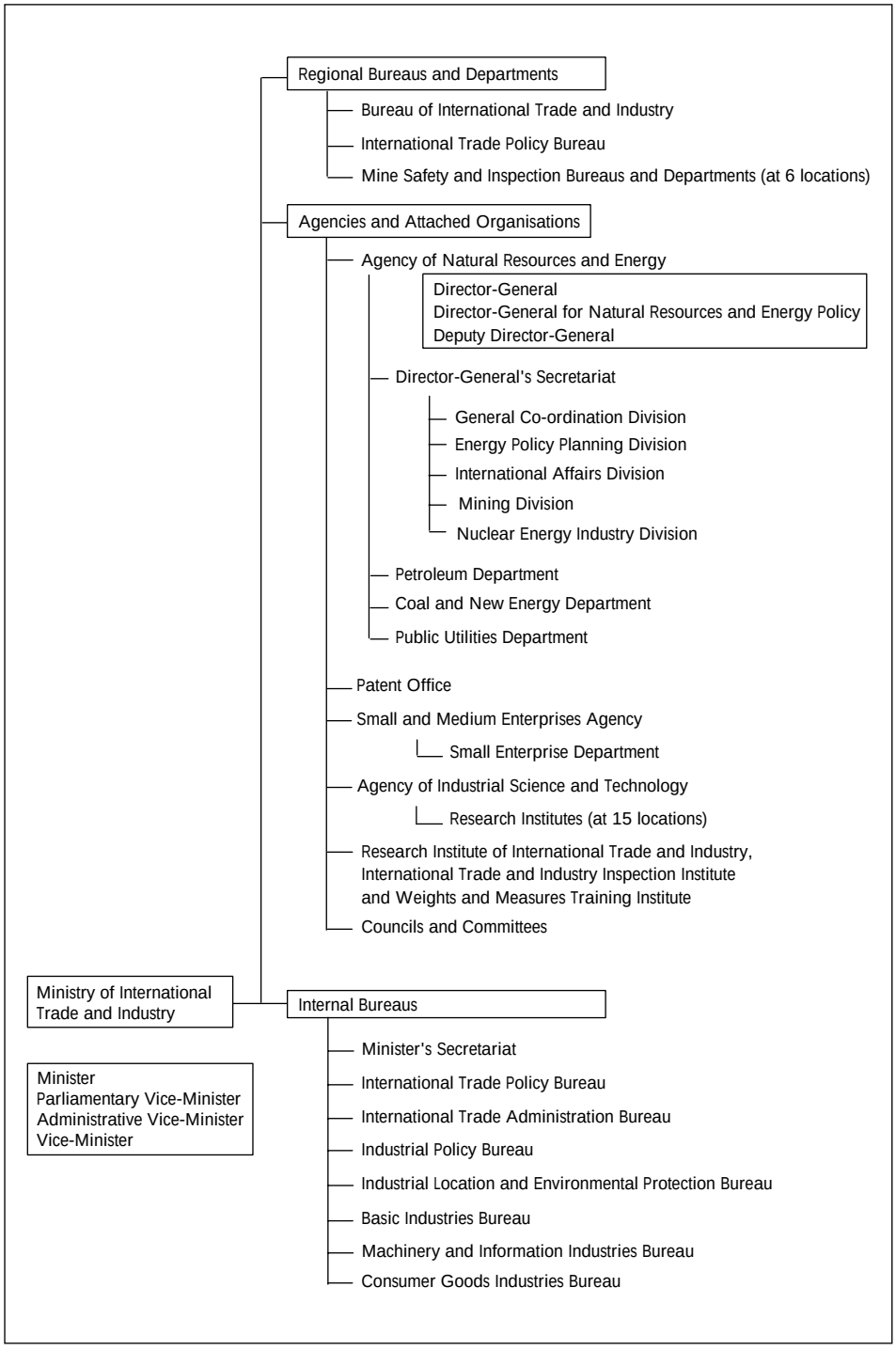
The fundamentals of Japan's energy policy are summarised as the *3 Es*: economic growth, energy security, and environmental protection. They are meant respectively to secure sustainable economic growth, stable energy supply, and to respond to climate change and other environmental issues. The *3 Es* are to be accomplished simultaneously and in a balanced manner, possibly involving trade-offs between the objectives. Energy security underlies Japan's policies on stockpiling and oil development by Japanese companies overseas (see Chapter 8). Security is an important consideration in policy on nuclear energy (see Chapter 6), since reprocessing, mixed oxide fuels and fast breeder reactors are seen as potential "domestic" energy sources.

MAJOR DEVELOPMENTS IN ENERGY POLICY

Since the IEA's last in-depth review in 1994, major developments in Japan's energy policy have been in two areas: reform of the regulatory framework and measures to respond to climate change. The strengthening of deregulation efforts was decided in May 1997, in the *Action Programme for Economic Structure Reform*. In line with this programme, measures have been implemented to restructure the supply side, which does not now meet international standards in terms of costs and services. Reform in the energy sector is an important component of overall policy on economic recovery and, increasingly, the market will be relied on to achieve a satisfactory outcome. The steps taken reflect, in part, a change in the focus of energy policy from contributing to improving international competitiveness towards a focus on domestic consumption as an engine of economic growth.

Figure 1

Ministry of International Trade and Industry (MITI)



Additional measures were decided in December 1997 to follow up the Action Programme and the Headquarters on Measures to Arrest Global Warming was established. In June 1998, a *Guideline of Measures to Prevent Global Warming* (see page 27) was announced, to promote measures to respond to global warming. Improvement of energy efficiency under the revised Law Concerning the Rational Use of Energy, promulgated in June 1998, is one element of the Guideline (see Chapters 4 and 5).

Wide-ranging discussion, covering many major aspects of energy policy, has taken place in a number of advisory councils. The councils concerned, and the subject matter under discussion, include: Advisory Committee for Energy – Subcommittee for Energy Supply and Demand (revision of the Long-Term Energy Supply and Demand Outlook); Electricity Utility Industry Council – Subcommittee for Energy Supply and Demand (revision of the Long-Term Electric Power Outlook); Electricity Utility Industry Council – Subcommittee for Basic Policy Directions (electricity supply system); and Petroleum Council – Subcommittee for Basic Policy Directions (basic oil and oil refining policy).

ENERGY SUPPLY AND DEMAND[2]

Primary Energy Supply

Japan has no significant energy resources and depends on imports for about 80% of energy supply. Japan depends on the Middle East for most of its oil imports, which accounted for about 53% of total primary energy supply in 1997. About 91% of Japan's energy supplies are from fossil fuels. Annex B provides information on Japan's energy balances and key statistical data.

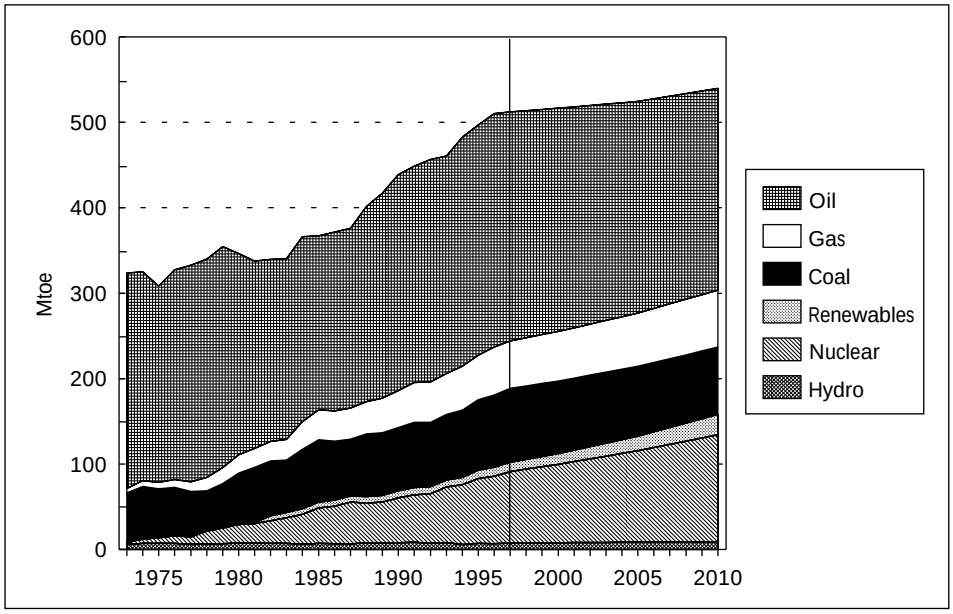
Total final energy consumption in 1997 was 334.9 Mtoe, a rise of only 0.65% from 1996, but still more than growth in Gross Domestic Product, which rose by 0.5% in the same period. In 1997, oil accounted for 62.8% of final consumption, electricity 23.4%, coal 6.6%, gas 6%, and renewable energy sources 1.1%.

Final Energy Consumption

In 1997, industry accounted for about 47% of final consumption, and transport for about 26%. Demand for energy in transport has risen by nearly 16% since 1990, and has nearly doubled (growing by over 98%) since 1973. Industrial demand for energy in Japan has risen by 17% since 1990, and just over 12% since 1973.

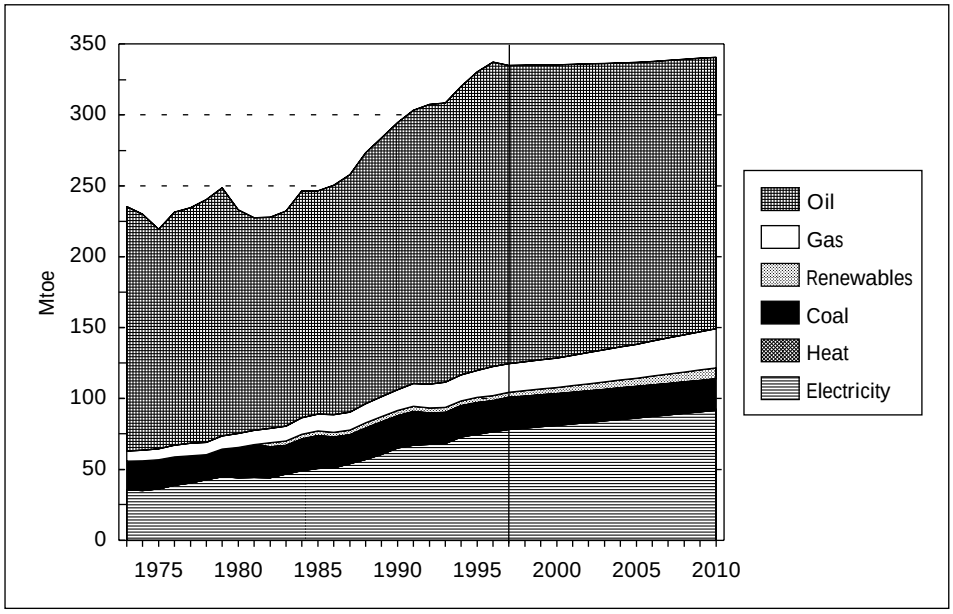
2. Forecasts shown in Figures 2, 3 and 4 were prepared by the IEA, and differ from those discussed later in this chapter. IEA statistics are prepared on the basis of a standard methodology and may differ from national statistics.

Figure 2
Primary Energy Supply



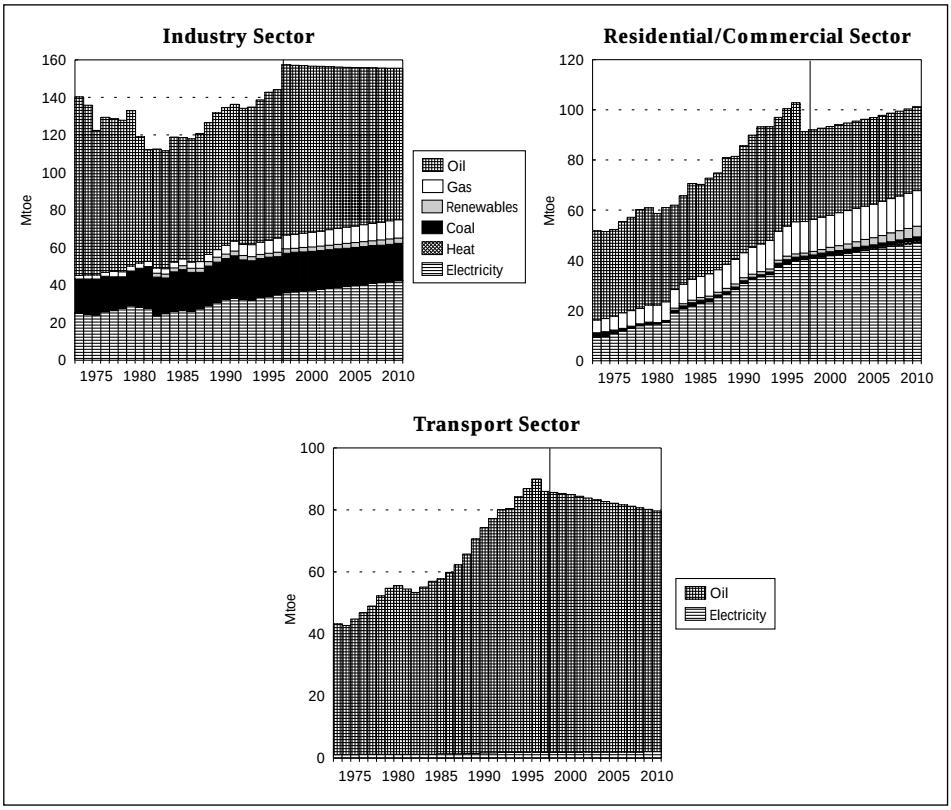
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

Figure 3
Total Final Consumption by Fuel



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

Figure 4
Final Consumption by Sector and by Fuel



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

LONG-TERM ENERGY SUPPLY AND DEMAND OUTLOOK

The Long-Term Energy Supply and Demand Outlook, which was originally presented in June 1994, was revised in June 1998, to present Japan's supply and demand outlook to 2010. The Outlook illustrates Japan's response to undertakings made at the Third Conference of the Parties (COP 3), Kyoto, December 1997. Major goals on the demand side are:

- to control energy demand through steady energy conservation measures, which are, to the extent possible, technologically and economically feasible (equivalent to about 56 million kilolitres of oil);

- to decrease growth in energy consumption to virtually level from 1996 to 2010.

On the supply side, major goals are:

- to maintain the previous target of 480 TWh for nuclear power generation;
- to virtually triple present supply (equivalent to 19.1 million kl of oil), while maintaining the previous target in the area of new energy resources;
- to reduce the dependence on oil, to decrease the use of coal, and to promote the introduction of natural gas, in order to shift to a more environmentally acceptable supply structure, while maintaining a stable and economically efficient supply of fossil energy.

Achievement of the targets in the Energy Supply and Demand Outlook would stabilise energy-related CO_2 emissions at the 1990 level, maintain economic growth at about 2% per year to 2010, and maintain energy security. The targets in the Outlook, however, are acknowledged to be very difficult to realise. The purpose of preparing the Outlook is to illustrate the effort required to achieve simultaneously the three goals of energy policy. The following tables show the key features of the Outlook.

Table 1
Primary Energy Supply Outlook to 2010

	FY 1990		*FY 1996*		*FY 2010*			
		%		*%*	*BAU*[1]	*%*	*Policy*[1]	*%*
Oil (Mkl[2])	307	58.3	329	55.2	358	51.6	291	47.2
Oil excl. imported LPG (Mkl)	288	54.8	310	51.9	337	48.6	271	44
Imported LPG (Mkl)	14.35	3.5	15.2	3.3	16.1	3	15.1	3.2
Coal (Mt)	115.32	16.6	131.6	16.4	145	15.4	124	14.9
Natural Gas (Mt)	37.91	10.1	48.2	11.4	60.9	12.3	57.1	13
Nuclear (TWh)	202.3	9.4	302	12.3	480	15.4	480	17.4
Capacity (GW)			42.5		66-70[3]		66-70[3]	
Hydro (GW)	91.2	4.2	82	3.4	105	3.4	105	3.8
Geothermal (Mkl)	0.5	0.1	1.2	0.2	3.8	0.5	3.8	0.6
New energy (Mkl)	6.73	1.3	6.85	1.1	9.4	1.3	19.1	3.1
Total (Mkl)	**526**		**597**		**693**		**616**	

1. The BAU ("business as usual") case takes into account policies and measures already in place. The Policy case assumes new policies and measures are introduced to achieve the targets.
2. Million kilolitres (Mkl); crude oil equivalent throughout.
3. The capacity of nuclear plant required to meet the production target varies with the assumed capacity utilisation factor. The base case capacity requirement is considered to be 70 GW at a capacity utilisation factor of 78%, but 66 GW is considered sufficient if the capacity utilisation factor can be raised to 83% (see Chapter 6).

Source: Institute of Energy Economics, Japan (for data on FY 1990) and MITI.

In the Policy case, the shares of oil and coal in primary energy supply decline. Growth in nuclear energy is substantial over the period (3.4% per year), and a more modest growth in the use of gas (1.2%) also occurs.

Energy consumption is assumed to be moderated in all sectors by efficiency measures but most of the burden is taken by industry and transport (see Table 2). The growth rates in energy consumption are in marked contrast to the substantial growth which occurred from 1990 to 1996 and also the growth rates expected in the absence of new policies and measures.

Table 2
Final Energy Consumption Outlook to 2010
(million kilolitres crude oil equivalent)

	FY 1990		*FY 1996*		*FY 2010*				
					BAU Case		*Policy Case*		
		Share (%)		*Share (%)*		*Share (%)*		*Share (%)*	*Annual Growth Rate 1996-2000*
Industry	183	52.5	195	49.6	213	46.7	192	47.9	0.1
Residential & Commercial	85	24.4	102	26	131	28.7	113	28.3	0.8
Transport	80	23	96	24.4	112	24.6	95	23.7	0.1
Total	**349**		**393**		**456**		**400**		**0.1**

Source: Institute of Energy Economics, Japan (for data on FY 1990) and MITI.

CRITIQUE

The MITI Long-Term Energy Supply and Demand Outlook is a critically important document for domestic energy planning and, because of the role played by Japan in world trade and economic activity, for foreign governments and businesses in planning their own activities. The Outlook is properly seen as an expression of Japan's energy policy aspirations, rather than as a forecast of expected outcomes. It would assist in promoting better understanding of its purpose and limitations, if the Outlook presented a range of possible outcomes based on a set of published key assumptions.

Key assumptions underlying the Outlook, which might be usefully considered in developing a range of possible outcomes, include the rate of economic growth and its relationship to energy consumption, the impact of slower growth in the contribution of nuclear power to primary energy supply, the role of new energy sources, and the oil price.

Some indication of the importance of these factors is given by the Institute of Energy Economics, Japan (IEEJ). Historically, energy demand in Japan has risen faster than GDP. Between 1990 and 1996, when real GDP grew by 1.7% per year, primary energy supply grew by 2.1% per year and final energy consumption by 2% per year. On this basis, the income elasticity of energy demand (the responsiveness of energy demand to a rise in income) was 1.2. The Outlook assumes growth in GDP to be 2.3% per year to 2010, and the income elasticity of energy demand to be 0.47 in the BAU case, and 0.1 in the Policy case. Achieving this outcome would only be possible with a dramatic turn around in historic trends in energy consumption. A wider range of assumptions would appear to be warranted, including a BAU case based on an historically consistent income elasticity of demand.

The current Outlook is directed principally to indicating how Japan might achieve its commitments to reduce greenhouse gas emissions. In this regard, it would be desirable if an indication of the cost (and the distribution of the cost) of achieving the different outcomes could also be given, as an integral part of the presentation of the Outlook. The range of possible outcomes, so far as greenhouse gas emissions are concerned, revolves around expectations for increasing nuclear power output. If growth in nuclear output is not as fast as planned, then recourse will be necessary to more oil-, coal- and gas-fired power to meet growth in electricity demand. Consequences would be higher carbon dioxide emissions from the power generation sector and an even higher dependence on oil. The utilities expect substantially higher growth in coal consumption than is assumed in the MITI Outlook, and the basis for differing expectations needs to be examined objectively. The IEEJ analysis suggests that the share of nuclear power in primary energy supply in 2010 might be as low as 11.4%, compared with 17.4% in the MITI Policy case. The IEEJ expects the shortfall to be made up by oil and coal.

RECOMMENDATIONS

The Government of Japan should:

- ☐ Give consideration to redefining the role and scope of the Long-Term Energy Supply and Demand Outlook, with a view to enhancing its value as an objective analysis of the energy outlook in Japan, with a range of possible outcomes for the future based on plausible, published assumptions.

4

ENERGY AND THE ENVIRONMENT

OBJECTIVES AND PRIORITIES

Approximately 90% of carbon dioxide produced in Japan is energy-related. In December 1997, at the Third Conference of the Parties (COP 3) held in Kyoto, Japan agreed to reduce greenhouse gas[3] emissions by 6% compared with 1990 during the first commitment period between 2008 and 2012. This represents a cut of about 150 million tonnes of carbon dioxide equivalent from 1995 emission levels. In order to achieve this goal, the Japanese Government established the *Guideline of Measures to Prevent Global Warming* in June 1998. Following the Kyoto Conference, the Outlook for Long-Term Energy Supply and Demand was revised in June 1998 on the basis of the contribution of all six greenhouse gases, giving rise to the aim of stabilising carbon dioxide emissions originating in the energy sector at the 1990 level by 2010. Further reduction of greenhouse gas emissions below 1990 levels to meet the COP 3 target is to be achieved by measures in non-energy areas.

For the energy sector, policy is focused on drastic energy conservation measures in the industry, residential and commercial, and transport sectors and, on the supply side, the promotion of nuclear power and new energies. The expected outcome of the measures is illustrated in Figure 5.

Outline of Guideline of Measures to Prevent Global Warming (19 June 1998)

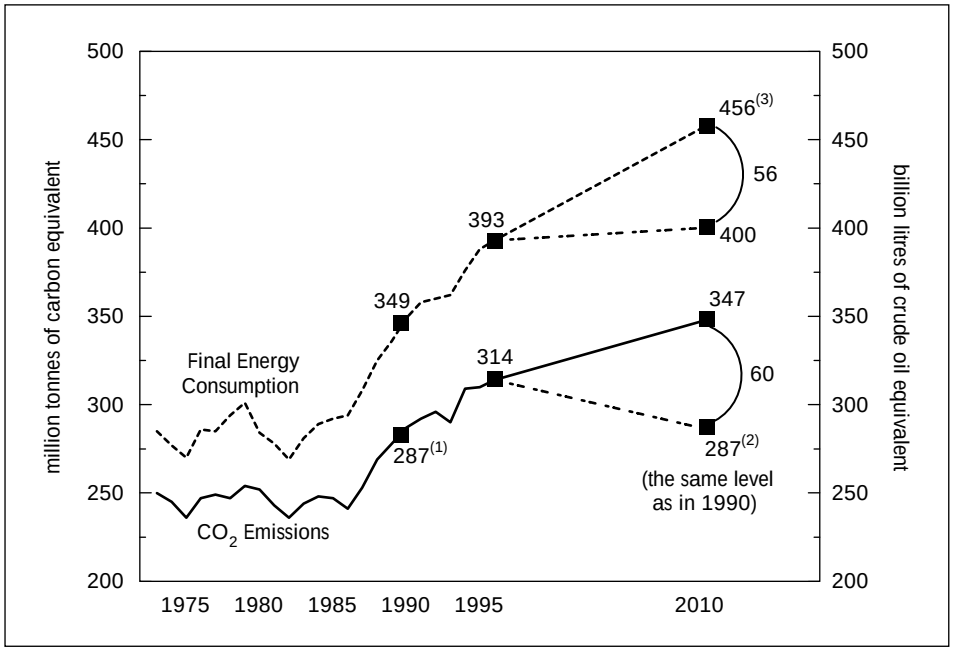
A high level committee, chaired by the Prime Minister (Headquarters on Measures to Arrest Global Warming), has been established and has agreed on the following policy outline to achieve a 6% reduction in greenhouse gas emissions in the period 2008-2012 from a 1990 base. Carbon dioxide emissions from the energy sector are assumed to stabilise at the 1990 level, since no reduction is considered possible. The plan is to be reviewed annually. The reductions outlined in the plan include:

- a 2.5% reduction in carbon dioxide, methane and nitrous oxide emissions to be achieved through a 0.5% restraint of methane, nitrous oxide and non-energy

3. Gases which contribute to the warming of the earth's surface. The Kyoto Protocol (December 1997) defines commitments to reduce emissions of the following six greenhouse gases: CO_2 (carbon dioxide), CH_4 (methane), N_2O (nitrous oxide), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons), SF_6 (sulphur hexafluoride). CO_2 is the single most important anthropogenic greenhouse gas. Fossil fuel production and use represent about three-quarters of CO_2 emissions from human activity. Other energy-related greenhouse gases include CH_4 from the production, transportation and use of natural gas and coal, and N_2O primarily from fuel wood use. The three other greenhouse gases covered by the Kyoto Protocol are not energy-related: HFCs (used as alternatives to ozone-depleting substances, such as coolants), PFCs (from aluminium smelters), and SF_6 (used in insulators for electrical transmission and distribution systems).

Figure 5

Trends and Outlook for Final Energy Consumption and CO_2 Emissions



1. Nuclear power: 202 billion kWh. New Energy: 6.79 billion litres.
2. Nuclear power: 480 billion kWh. New Energy: 19 billion litres.
3. Assumed average economic growth rate is about 2% per year from 2001 to 2010.

Source: MITI.

carbon dioxide emissions, and a 2% reduction through technology improvements (such as direct smelting, new cement-making technology, etc.) and changes in life style of the Japanese people, and voluntary energy conservation measures;

- a 0.3% removal by sinks in accordance with Article 3.3 of the Kyoto Protocol and additional removal by sinks to be expected based on Article 3.4 of the Protocol;
- a 2% *increase* in emissions of CFC alternatives (HFC, PFC and SF_6);
- the remainder of the reduction will be achieved through Joint Implementation, emissions trading and the Clean Development Mechanism.

The full package of measures proposed, in outline, includes the following items.

Energy demand-side measures:

- Introduction of the "top-runner" method (which sets efficiency standards just above the highest performance standard currently reached) to improve vehicle fuel efficiency and standards for household electrical appliances.

- Rationalisation of energy use at factories; development of action plans for energy conservation.

- Development of infrastructure to improve the efficiency of distribution; introduction of sophisticated road traffic systems to reduce traffic congestion.

- Development and diffusion of new energy conservation technologies, including clean energy vehicles.

Energy supply-side measures:

- Promotion of nuclear power.

- Rapid introduction of new energies.

- Promotion of measures for electricity load levelling.

- Promotion of diffusion of heat storage air-conditioning systems and gas coolers.

Reviewing life style:

- Stimulating public discussion about the introduction of daylight saving time.

- Promotion of safe and appropriate use of bicycles.

- Improvement of structures for education/awareness raising and information dissemination.

- Exemplary actions by Government.

- Expansion of "greening activities" generally.

- Model projects on innovation in societal systems.

Other measures:

- Promotion of measures for restraining carbon dioxide emissions from waste, including measures to reduce waste and encourage recycling.

- Promotion of measures to limit emissions of greenhouse gases other than carbon dioxide, including development of substitute substances.

- Promotion of measures for sinks of carbon dioxide, such as afforestation and forest management.

- Strengthening research and development of innovative new environmental and energy technologies including development of super efficient photovoltaic

power generation and technology for sequestration and utilisation of carbon dioxide.

- Promotion of international co-operation, including international efforts to utilise the flexibility mechanisms such as emissions trading, Joint Implementation, and the Clean Development Mechanism, as presented in the Kyoto Protocol.

The *Law for Promotion of Measures to Cope with Global Warming*, which was established on 9 October 1998, requires public reporting of plans to reduce greenhouse gas emissions and the status of their implementation by the national Government, local authorities and large businesses. The Law also contains measures to promote public awareness and to provide advice on measures in support of voluntary actions.

ENERGY SECTOR EMISSIONS

In the energy sector, because of the high oil share in energy supply and its carbon intensity, oil produces by far the largest proportion of carbon dioxide emissions. Carbon dioxide emissions by fuel are illustrated in Figure 6. In 1996, oil contributed 64% of emissions, coal 26% and gas 9.5%. Carbon dioxide emissions by sector are also illustrated in Figure 6. In 1996, electricity generation contributed one-third of all carbon dioxide emissions, and transport contributed 20% (of which road transport accounted for 16 percentage points).

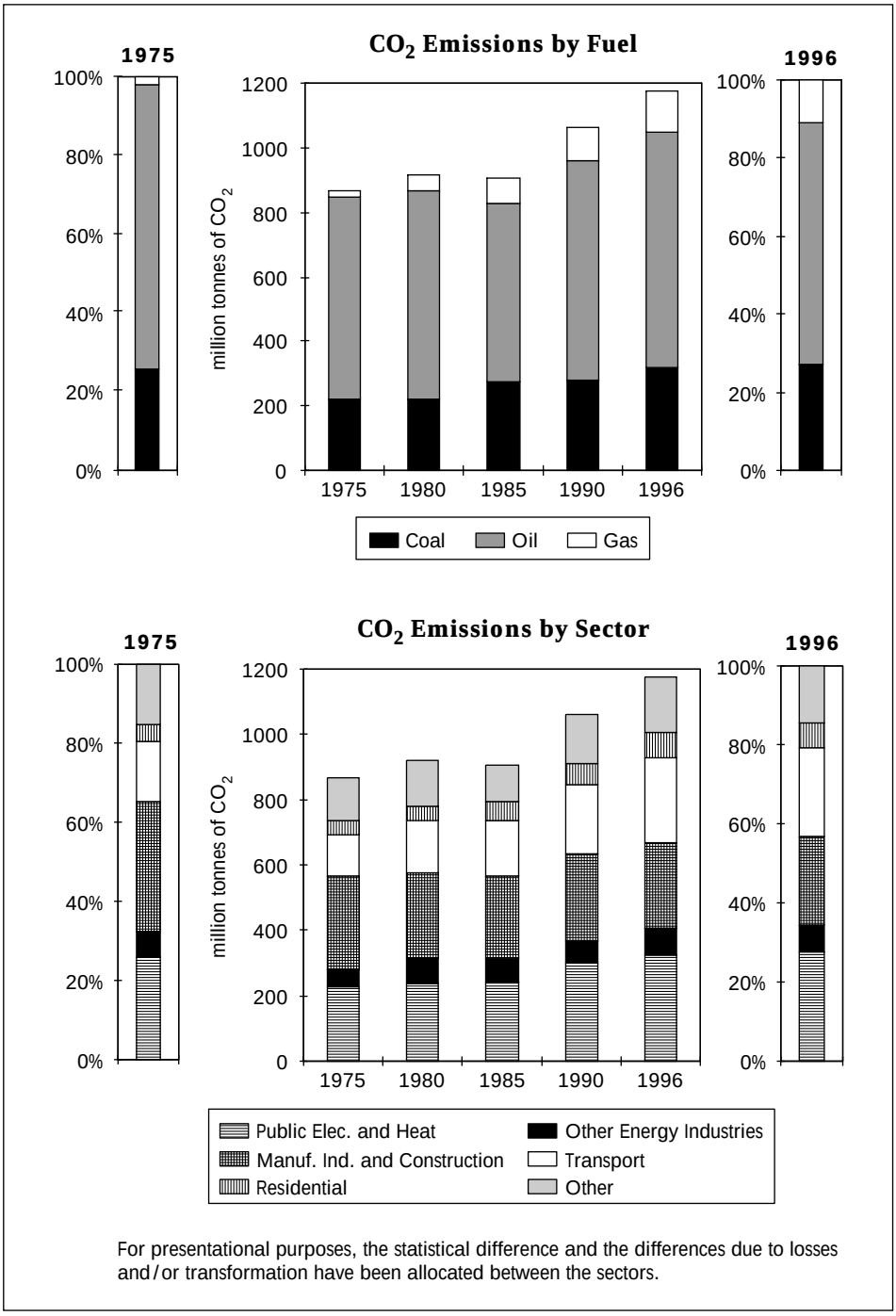
Table 3 illustrates MITI's expectation of the contribution of power generation to reducing greenhouse gas emissions by changing the fuel mix. Nuclear power is expected to make a substantial contribution from now to 2010. Hydro (both natural and pumped storage), geothermal and new energies (waste, photovoltaic and wind power) also are expected to increase their contribution to emissions reduction.

CRITIQUE

Environmental issues cut across most areas of energy policy, and the achievement of Japan's carbon dioxide emissions target is a theme in many of the chapters in this review. So far as the energy sector is concerned, the aim is to stabilise carbon dioxide emissions at the 1990 level. Reductions below the 1990 level of emissions will be achieved in other sectors, some of which have energy implications, most notably the expected contribution to be achieved through the use of flexibility mechanisms (Joint Implementation, emissions trading and the Clean Development Mechanism).

Like other IEA Member countries, Japan is seeking to achieve its greenhouse gas emissions targets through a combination of energy efficiency improvement and fuel

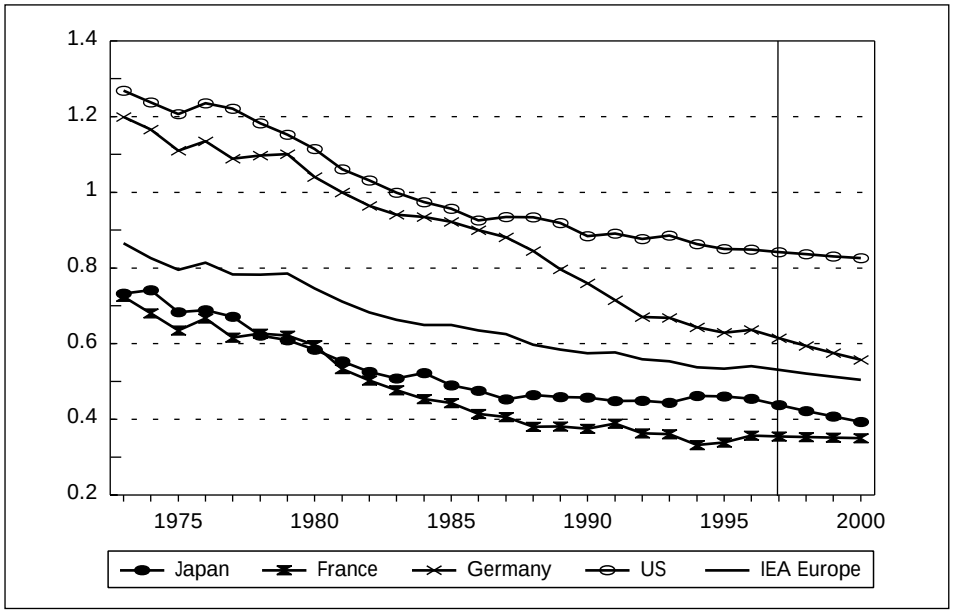
Figure 6
Carbon Dioxide Emissions by Fuel and by Sector



For presentational purposes, the statistical difference and the differences due to losses and/or transformation have been allocated between the sectors.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 1998.

Figure 7
CO_2/GDP (PPP)
(CO_2 Emissions/GDP using 1990 prices and purchasing power parities)



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998; *National Accounts of OECD Countries*, OECD Paris, 1998 and country submissions.

Table 3
Electricity Supply Outlook to 2010

	FY 1990		*FY 1996*		*FY 2010 (Policy Target Case)*		
	GWh	*Share (%)*	*GWh*	*Share (%)*	*GWh*	*Share (%)*	*Growth 2010/1996 (%)*
Thermal	**446.6**	**61**	**482.1**	**55**	**436**	**41**	**–0.7**
Coal	71.9	10	123.7	14	136	13	0.7
Oil	210.9	29	154.7	18	87	8	–4
LNG	163.9	22	203.7	23	213	20	0.3
Nuclear	201.4	27	302.1	35	480	45	3.4
Hydro	**88.1**	**12**	**83.8**	**10**	**119**	**11**	**2.5**
Natural	78.8	11	71.3	8	98	9	2.3
Pumped	9.3	1	12.6	1	21	2	3.7
Geothermal	1.5	0	3.6	0	12	1	9
Other*	0	0	1.3	0	9	1	14.8
Total	**737.6**		**872.9**		**1 056**		**1.4**

* Photovoltaic, solar heat, wind power, waste power generation, waste heat utilisation, temperature difference (power generation), and black liquor/waste wood.
Source: MITI.

switching. Japan has historically achieved high standards of industrial energy efficiency, so further improvement will be a challenging task. Improvements in the residential and commercial sectors are likely to require significant changes to life style, possibly running counter to the trend to higher levels of comfort in residences (for example, space heating and cooling) and in transport (for example, larger cars).

Options for fuel switching in Japan differ markedly from those in other IEA Member countries. Gas is an expensive fuel and the gas network is undeveloped. Coal is an important fuel in Japan for economic and energy security reasons, and although growth in coal consumption is expected by MITI to slow, coal will remain important. Moreover, forecasts by the electricity utilities differ from the MITI Outlook and show continuing rapid growth in coal consumption. Wind power is considered intrinsically unreliable at its present state of development and limited in its application by the availability of suitable sites. Solar energy is considered to have potential but to require substantial technological development before it can play an important role. For all these reasons, and for energy security reasons as well, the favoured alternative is nuclear.

Japan aims to reduce growth in energy consumption from about 3% per year (above the rate of economic growth) to 1% per year. Demand-side policies designed to achieve this goal are discussed in Chapter 5. In the past, energy consumption in Japan has been closely related to economic growth, with the only important deviations occurring in the wake of the oil crises of 1973 and 1979. The priority accorded to economic recovery will have an important influence on the outcome.

If the link between economic activity and energy consumption cannot be changed, as appears likely from historical trends, then even greater emphasis will have to be placed on the already ambitious supply-side measures proposed. Japan plans to build 16 to 20 nuclear reactors to achieve the COP 3 target, as well as to increase energy diversification. The programme faces considerable public opposition, although about 15 sites have been acquired by utilities for the construction of new reactors. The prospects for achieving the nuclear target are discussed in Chapter 6. The review team considers that it is unlikely that all 20 reactors could be built and operational by 2008-2012, when the emissions target must be met, but it is possible that the equivalent nuclear power output could be achieved in the time period.

Construction of new nuclear reactors is being planned at a time when Japan is also seeking to liberalise its electricity market. Nuclear power may be severely challenged in a free electricity market because of high capital costs and long lead times for construction. Some measures are likely to be necessary to quarantine the market for nuclear power. Independent Power Producers are likely to continue to favour burning coal, for economic reasons, contributing to greenhouse emissions.

Liberalisation of the electricity market may, however, have a favourable environmental as well as an economic impact, through cost-reflective pricing. By flattening the electricity load and moderating electricity consumption, cost-reflective pricing could be an effective means for achieving environmental targets, since rapid growth in electricity demand in the residential and commercial sectors

is one of the more important areas where a policy response is needed. Pricing externalities, and the use of "green" markets for new and renewable carbon-free sources of energy, are also efficient and effective means by which economic growth and environmental goals can be harmonised. These issues are discussed in Chapter 7 on electricity and in Chapter 5 on energy efficiency.

Flexibility mechanisms (such as Joint Implementation, emissions trading, and the Clean Development Mechanism) offer opportunities for Japan to achieve its goals in a way compatible with its economic growth objective. These mechanisms are under development and the manner in which they may be used by Japan is at present a matter for conjecture. (The Kyoto Protocol provides that certified emissions reductions from the Clean Development Mechanism, for example, can be obtained after 2000, but modalities and procedures will not be settled until 1999, and then only as an interim measure if the Protocol does not come into force in 2000.) However, Japanese companies are positioning themselves to use the mechanisms, and the present contribution to the emissions reduction target allocated to the flexibility mechanisms may well understate their potential.

Japan expects a major contribution to achieving its environmental targets to be made by technology development. Japan's research and development priorities were revised in 1998, to focus on developing technology that could assist in meeting its greenhouse gas emissions targets over two periods, in the period to 2010 and in the period after 2010. The programme is discussed in Chapter 9.

5

ENERGY EFFICIENCY

TRENDS IN ENERGY DEMAND

Following investments in energy efficiency after the oil crises of 1973-75 and 1979-82, Japan's final energy consumption had generally stabilised until 1982. Energy consumption then started to increase, and continued to rise steadily through the 1990s with economic growth, except in 1992 and 1993, which were years of economic adjustment. The rate of growth of energy consumption (mostly for electricity because of the increased use of air-conditioning) has been faster in the residential, commercial and the transport sectors. From 1990 to 1996, energy demand grew by 1% per year in the industry sector, by 3% per year in the residential and commercial sectors, and by 3% per year in the transport sector. The share of the industry sector is decreasing, dropping to a level of below 50% of total energy consumption for the first time in 1995, while the shares of the residential, commercial and transport sectors are rising.

Industry Sector

Consumption in the industrial sector decreased until 1982 as a shift occurred away from basic material industries (many being re-established offshore) and towards less energy-intensive industries, such as processing and assembling, electronics and information. The trend slowed as businesses responded to market demand for a wide variety of production activities requiring small quantities of output and the production of high value-added products, coupled with the general expansion of business encouraged by a government policy to expand domestic demand. As a result, industrial energy consumption started to rise again after the brief plateau following the oil crises.

Residential Sector

Energy consumption in the residential sector is closely related to the social structure, such as the number of households and the proportion of senior citizens in the population. As disposable income increased, the demand for a level of comfort, comparable with that of other IEA countries, continued to push up energy use in households. This trend has been particularly evident for electricity demand. The number of electrical appliances has increased significantly, even as the appliances have become more efficient in their use of energy. Principal areas of end-use growth have been in domestic electrical appliances and for heating and cooling. On the other hand, the shares of hot water supply and kitchen use are decreasing.

Commercial Sector

Energy consumption in the commercial sector, which is closely related to the level of economic activity, had flattened from the mid-1970s with the decrease in energy intensity per unit of floor space. However, consumption has been rising steadily since 1985 largely because of increases in office automation and the trend towards continuous 24 hour use of electricity, and an increase in the frequency of equipment use. The development of a service and information-oriented society has been the main driver behind consumption increases in the sector. The share of energy consumption by office automation equipment has risen from 23.9% in 1981 to 38.2% in 1996. As in the residential sector, demand for heating and hot water in the commercial sector has decreased dramatically. Hence, as for the residential sector, demand growth has been principally for electric power.

Government policy aims to improve energy efficiency in electrical appliances and lighting. Energy consumption for air-conditioning and heating is also being targeted for improvement through application of energy efficient technology.

Passenger Transport

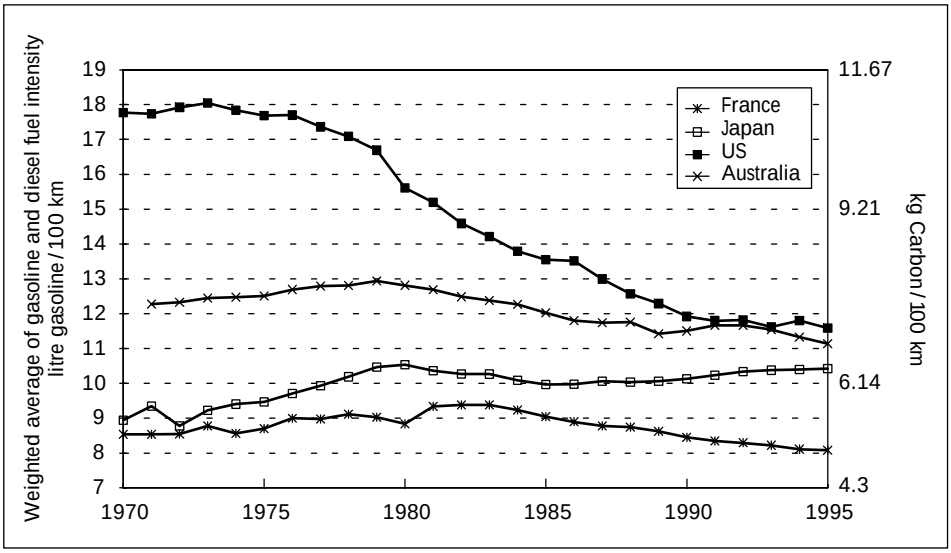
The increase of energy consumption for passenger transport is attributable to the growth in the number of private cars and to the increasing share of cars with engines of 2 000 cc or larger. The number of cars increased at an average annual growth rate of 4% from 1990 to 1996, while fuel efficiency decreased (see Figure 8). At the same time, the size of cars increased, raising energy consumption in this sector. There has been little change in actual on-road fuel economy, according to the Japanese Government, but in 1990 the Government reduced the tax on the largest new cars, and their market share grew significantly. The share of private passenger cars as a proportion of total passenger transport was about 60% in 1973, growing to about 70% in 1996. Issues related to energy consumption by cars are the frequency of car use; the demand for higher-performance, bigger, and safer cars; and the control of exhaust gases. These factors have accelerated the increase of energy consumption in the transportation sector. The effect of traffic congestion also needs to be examined. Traffic congestion is a deterrent to use of cars but idling engines are an inefficient use of energy.

Government policy is directed to reversing the decline in fuel efficiency by promoting fuel efficient cars, by improving the energy efficiency of trains, ships and planes, by improving distribution efficiency through promoting railroad transportation and coastal shipping, and by accelerating the use of public transport through the improvement of railway facilities.

Freight Transport

Energy consumption in the freight sector decreased until 1982, the end of the second oil crisis. However, it increased steadily in the 1980s, except during the

Figure 8
On-road Fuel Intensity of Automobiles and Household Light Trucks



Notes: Fuels are gasoline, diesel and LPG and are calculated on the basis of energy content (net heating value) expressed as gasoline equivalent. Light trucks that serve principally as private vehicles are included for the US only. Light trucks are not used significantly for this purpose in Japan.
Source: *Indicators of Energy Use and Efficiency*, IEA/OECD, Paris 1997.

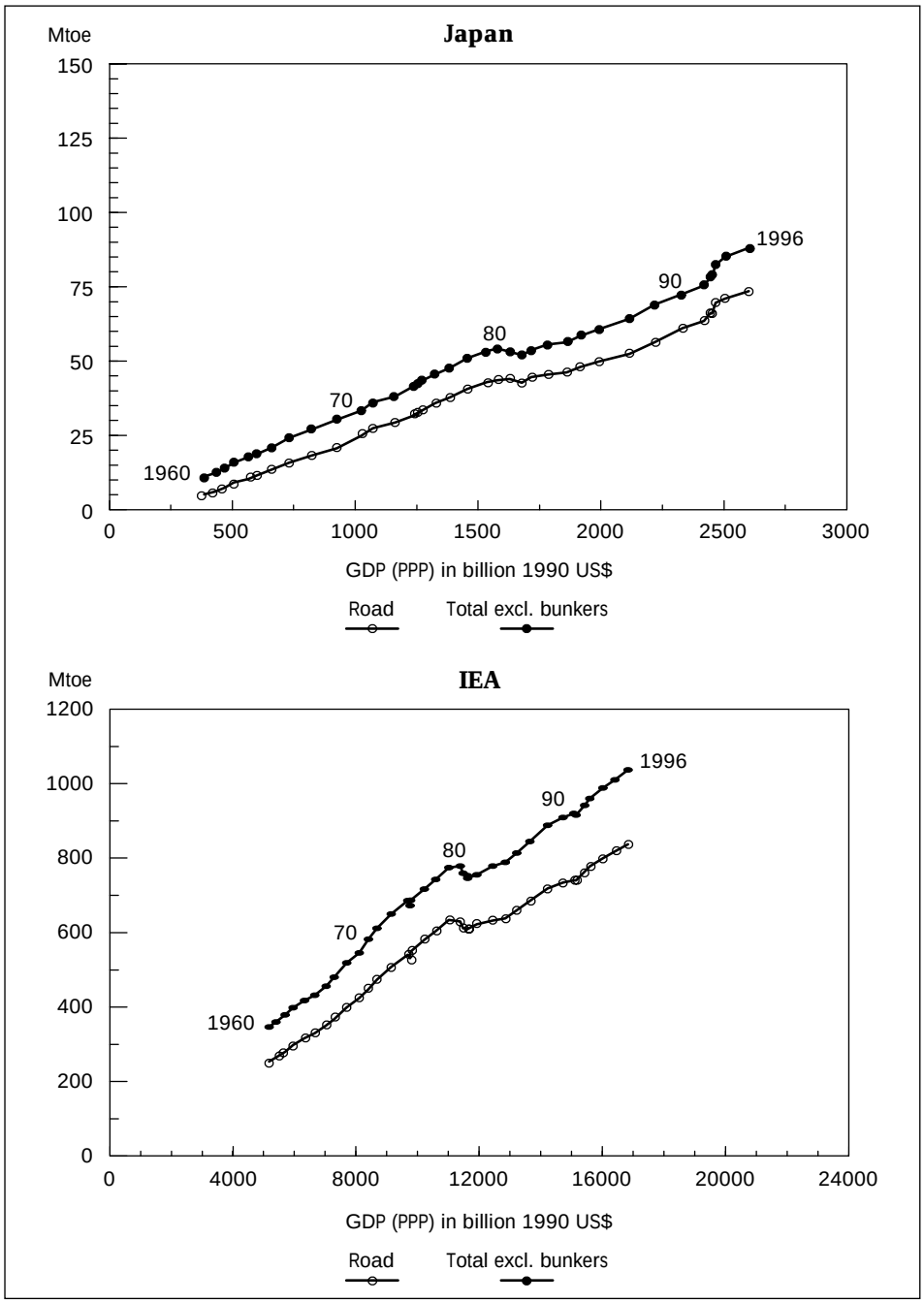
years of economic adjustment after the collapse of the so-called "bubble economy". Demand grew at an annual average rate of 1.5% from 1990 to 1996.

The increase of energy consumption in the freight sector mainly reflected the growth in the number of trucks. The share of trucks in total freight transport increased from about 70% in 1973 to about 90% in 1996. The fuel intensity of Japanese trucking is one of the highest in the IEA, a consequence of a relatively low maximum permitted gross weight and traffic congestion. The number of cargo flights has also risen, but the absolute quantity is still small.

ENERGY INTENSITY

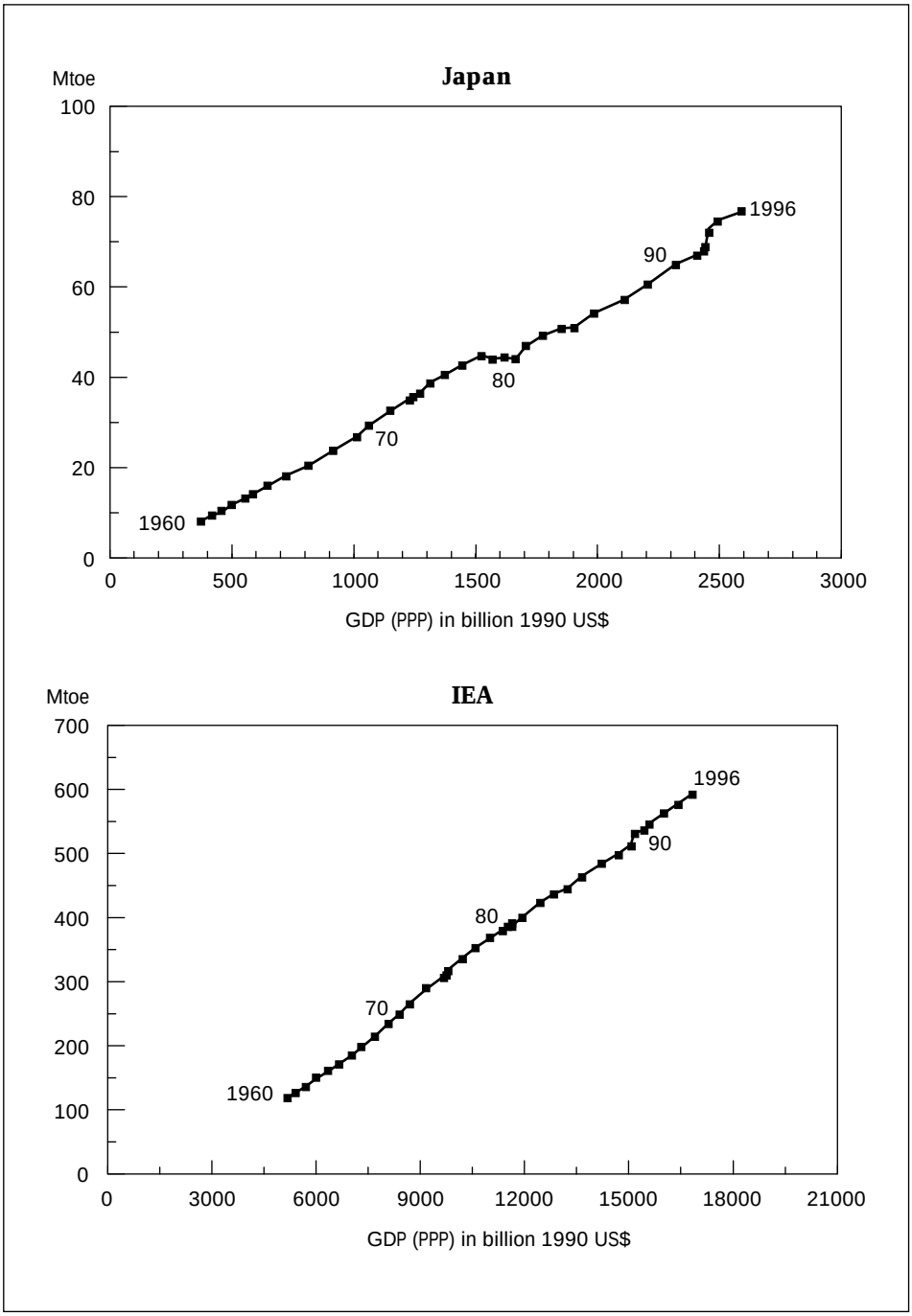
In terms of energy consumption per unit of GDP, the general trend in energy intensity in Japan is similar to that seen in other IEA countries: energy intensity fell markedly at the time of the oil crises and the subsequent recessions, i.e., 1973-75 and 1979-82, but stabilised in the 1990s. Figures 9, 10 and 11 show the historical relationship between energy use and GDP in the three main Japanese energy services: electricity demand, oil-fuelled mobility and stationary fossil fuel end-users. Changes in energy consumption are directly related to changes in GDP in all three sectors, except for the periods of the two oil shocks (1973-75 and 1979-82) for stationary energy consumption.

Figure 9
Total Final Consumption/GDP in the Transport Sector in Purchasing Power Parities (excluding electricity)



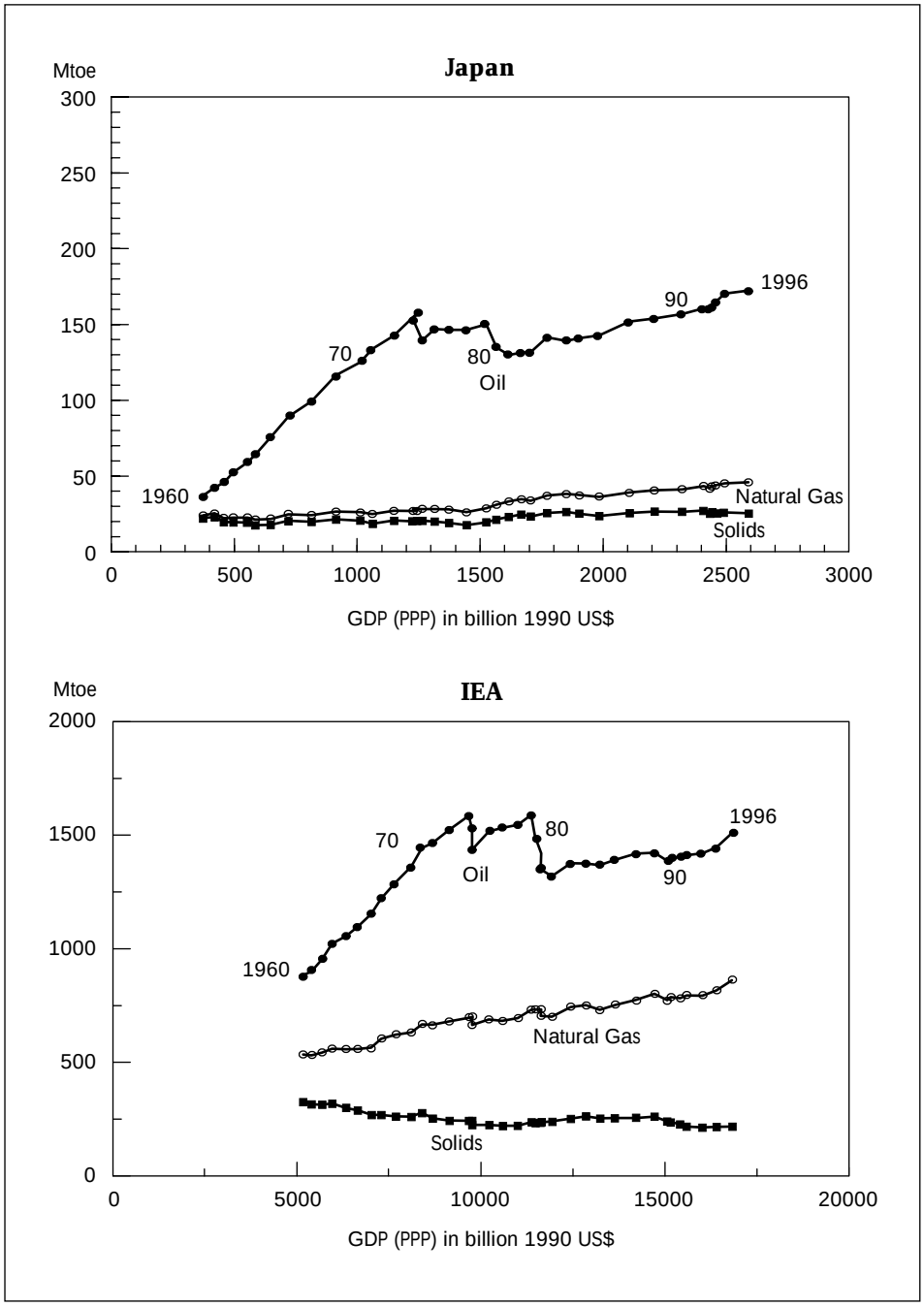
Source: *Energy Balances of OECD Countries*, IEA/OECD, Paris 1998 and *National Accounts of OECD Countries*, OECD, Paris 1998.

Figure 10
Electricity Consumption/GDP in Purchasing Power Parities



Source: *Energy Balances of OECD Countries*, IEA/OECD, Paris 1998 and *National Accounts of OECD Countries*, OECD, Paris 1998.

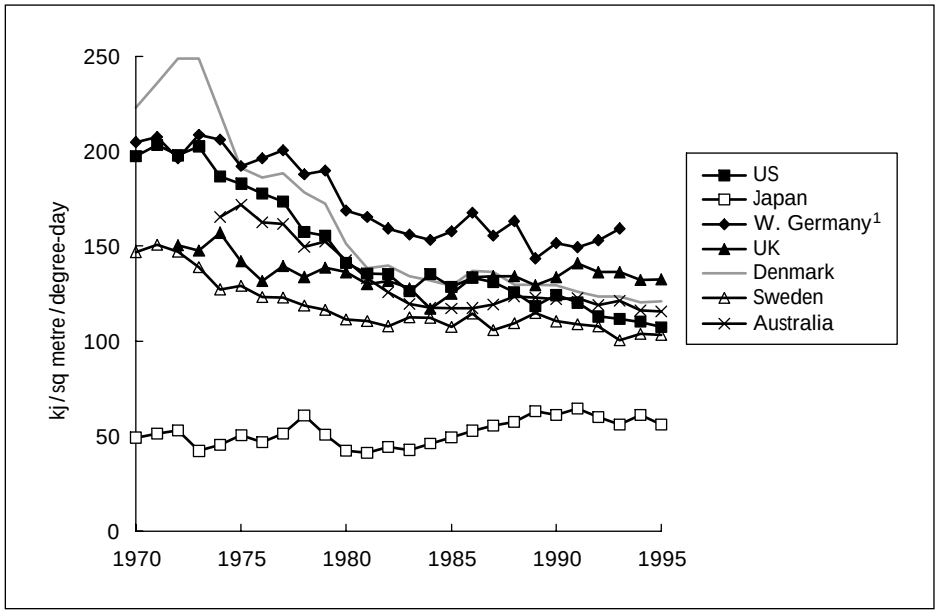
Figure 11
Stationary Fossil Fuels/GDP in Purchasing Power Parities



Note: Data inputs to production of electricity and heat Autoproducers in the US are estimated until 1990.
Source: *Energy Balances of OECD Countries*, IEA/OECD, Paris 1998 and *National Accounts of OECD Countries*, OECD, Paris 1998.

Figure 12 compares heat intensity in seven IEA countries. The figure demonstrates the difficulty Japan is facing in trying to reduce or limit energy use in households if households seek to raise the level of comfort to those experienced in other IEA countries.

Figure 12
Household Space Heating Intensity:
Useful Energy, Normalised to House Area and Winter Climate



1. Old Laender since 1991.
Source: *Indicators of Energy Use and Efficiency*, IEA/OECD, Paris 1997.

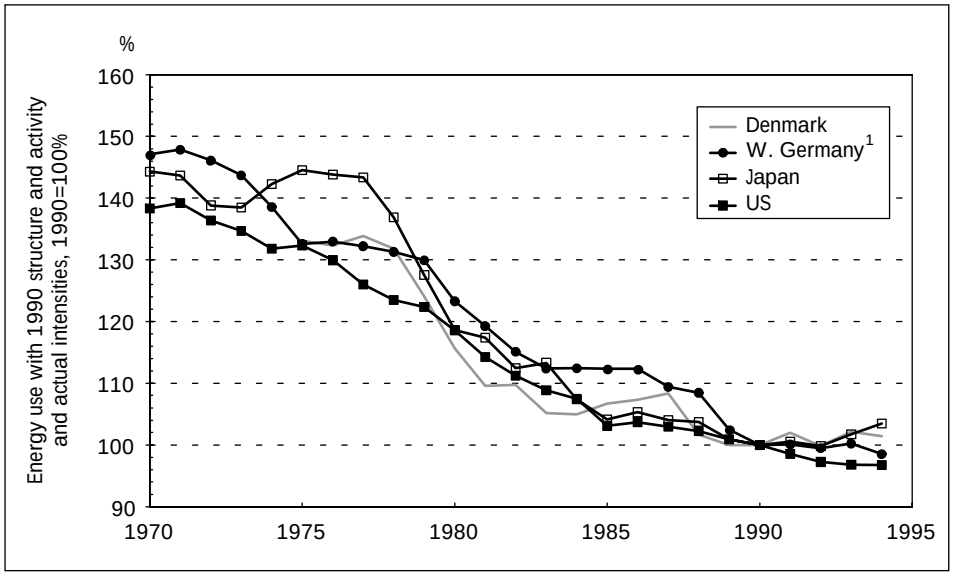
The index of economy-wide energy performance shown in Figure 13 shows how primary energy use has been increasing since 1990 as a result of worsening energy intensities during this period. The decrease prior to 1990 was primarily as a result of changes in manufacturing. Even after correcting for changes in the mix of output (i.e., the effect of relocation of manufacturing industry offshore), Japanese manufacturing had one of the greatest declines in energy intensity among IEA countries from 1973 to 1990.

GENERAL ENERGY EFFICIENCY AND CONSERVATION POLICY[4]

In April 1997, the National Energy Council of Ministers decided on a programme of *Comprehensive Energy Conservation Measures Towards the Year 2000*, covering

4. In Japan, the term "energy conservation" is used, rather than "energy efficiency", since one aim of energy policy is to reduce or minimise energy consumption.

Figure 13
Index of Changing Energy Intensities in 32 End-Uses



1. Old Laender since 1991.
Source: *Indicators of Energy Use and Efficiency*, IEA/OECD, Paris 1997.

66 new or enhanced measures for the industry, transport and residential/ commercial sectors. Highlights include:

- ***Industry*** Quantitative goals for energy efficiency improvements in individual factories; guidance for factories designated under the Energy Conservation Law.

- ***Transport*** Fuel efficiency targets for diesel cars; formulation of a general plan for urban traffic; promotion of more efficient physical distribution; enforcement of parking laws.

- ***Residential/commercial*** Energy conservation standards for residential houses and commercial buildings; introduction of an Energy Conservation Mark for residential houses and commercial buildings; support for energy conservation service providers; energy efficiency labelling; appliance standards; promotion of equipment to improve energy efficiency (such as heat storage and energy efficient air-conditioners).

- ***Other*** Support for local government activities; promotion of energy environment education in schools; enhancement of publicity programmes.

In June 1998, the revised *Law Concerning the Rational Use of Energy* established general objectives, policy principles, reporting requirements, financial incentives and sanctions on industry to achieve improved energy

efficiency. The law is administered by MITI (jointly with the Ministry of Transport, in the case of automobile fuel efficiency), and the Minister for International Trade and Industry (together with the Minister for Transport in the case of automobile fuel efficiency) are responsible for setting targets and monitoring progress.

Further improvements in the energy efficiency of cars and electrical devices are promoted by the "top runner" system. Under this system, energy efficiency targets are set higher than those achieved by the most efficient currently commercialised product. Sanctions on failure to comply with the Government's target are negative publicity, orders to comply and fines. Industry is expected to comply by recognising that more efficient products will have market appeal. Standards under the existing system cover gasoline-fuelled passenger cars and trucks, air-conditioners, fluorescent lamps, television sets, copying machines, computers, magnetic disc devices and video cassette recorders. The revised law extends the list to include refrigerators and diesel powered passenger cars and trucks.

Factories and businesses are required to submit plans for rationalisation of energy use. Some plants, designated as energy-control factories, attract particular attention. Two categories of energy-control factories are defined in the law:

- In the first category, there are about 3 500 factories consuming more than 3 Ml of crude oil or over 12 GWh of electricity.

- In the second category are about 9 000 factories consuming more than 1.5 Ml of crude oil or over 6 GWh of electricity.

Measures in the law include an obligation for the first category to:

- Employ energy management personnel.

- Prepare and submit energy rationalisation plans covering a three to five year period.

Measures in the law include an obligation for the second category to:

- Attend lectures on energy conservation.

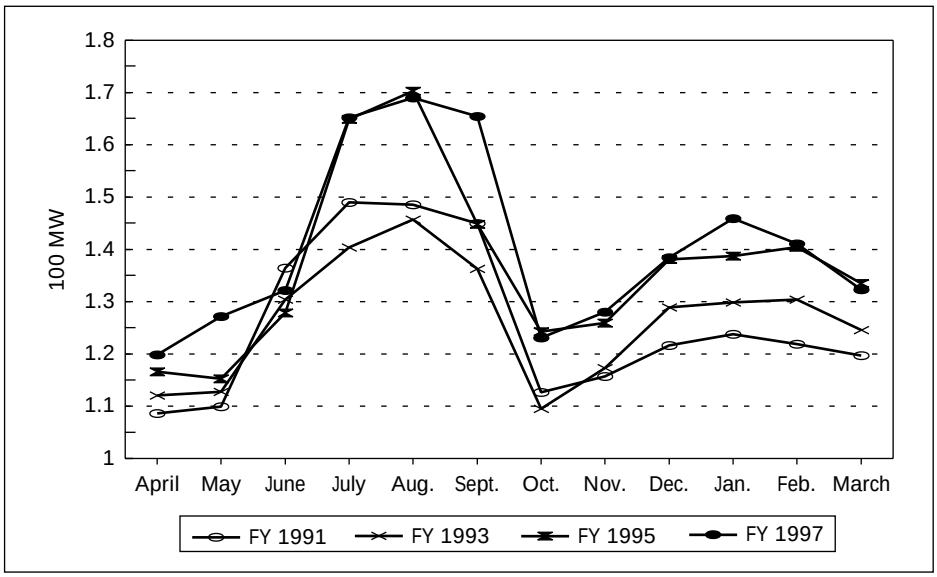
- Record energy consumption.

Other provisions of the law include fines and penalties, flexibility in enforcing the law to allow for changes in social and economic conditions, and the exclusion of solar power and wind power generation from the scope of the law.

ELECTRICITY LOAD LEVELLING AND PRICING

Peak load in electricity, caused by very high daytime demand in summer (see Figure 14), is being addressed by technology and a flexible rate system to level demand. At present, peaking devices (such as oil-fired plants and pumped hydro) and measures to change end-consumer technology (for example, by the development of gas air-conditioning) are the major means of addressing the peak problem. The use of pricing to encourage load levelling has been tested in trials. The use of pricing, which is generally considered to be effective for load levelling, was found to be limited to some extent during the daytime in summer. Utilities nevertheless have the option of using tariff structures to assist in load levelling.

Figure 14
Seasonal Peak Electricity Load



Source: MITI.

Low interest government loans and subsidies, and favourable tax measures are in place to encourage heat storage air-conditioning systems and gas air-conditioning, as a means of levelling the electricity load. Rationalisation of security regulations on the introduction of heat storage systems has been arranged, and reform of standards for public buildings are also being considered. Grants are available for diffusion of heat storage systems, which would assist in load levelling. The Government and gas and electricity utilities also fund public information campaigns to raise consumer awareness of the issue.

Under MITI's flexible rate system, utilities notify MITI of tariff structures designed to promote load levelling. For example, Tokyo Electric Power Company (TEPCO) uses the following typical forms of contract:

■ Load adjustment contracts (117 contracts, 4 235 MW).

- Time-of-use special contract (encourages day to night load shifting), contract capacity 0.5 MW.
- Appointed load curve contract (customer must adjust day load on request) 10 MW.

■ Interruptible contracts (1 684 contracts, 2 283 MW).

- Instantaneous load adjustment (for above customers who can reduce load by at least 10 MW).
- Emergency load adjustment – industrial customers (customers with contract capacity 0.5 MW, who can reduce demand at one to three hours' notice, on the same day).
- Emergency load adjustment – commercial customers (customers with contract capacity 0.5 MW, who can reduce demand at one hour's notice, on the same day, June-September).

■ Load management contracts (3 966 contracts, 1 839 MW).

- Summer peak days – one-year contracts (industrial customers with contract capacity ≥ 0.5 MW, who can reduce demand 30 to 50%, for two to five days (at a higher discount if over 5 days) during July, August and September).
- Summer peak days – three-year contracts (as for one-year contracts).
- Scheduled load adjustment (for time-of-use customers who can meet the conditions of summer peak days contracts).
- Summer peak hours contracts (for customers with contract capacity ≥ 0.5 MW, who can reduce demand 10% or more, and customers with contract capacity < 0.5 MW, who can restrict power demand by 50 kW at times appointed by TEPCO).

■ Load shift contracts (2 881 contracts, 3 055 MW).

- Heat storage type, commercial customers (day to night load shifting by use of heat storage).
- Heat storage type, industrial customers (day to night load shifting by use of heat storage).
- Rate incentive for ice storage air-conditioning (reducing discount rate for customers with new equipment).

VOLUNTARY MEASURES

In December 1996, Keidanren (The Federation of Economic Organisations) presented the *Industry-wise Voluntary Action Plans* for 29 industries, representing 131 organisations. The subsequent Keidanren Voluntary Action Plan on the Environment includes seven additional industries, increasing to 36 industries and

137 organisations the number of participants in the voluntary plans. The plans have the following features:

- Commitments are entirely voluntary and subject to prevailing economic and political conditions. There is no government regulation of the plans.
- Industries covered include distribution, transport, construction, foreign trade and non-life insurance.
- The plans are subject to an annual review process, the results of which are made public.
- The plans include waste disposal and recycling, as well as measures to enhance energy efficiency and to reduce greenhouse gas emissions.

CRITIQUE

Importance of Policy Evaluation

In considering future energy policies, evaluating the outcome and effectiveness of existing measures is clearly important. For example, the relationship of energy consumption to economic growth, the effectiveness of public campaigns designed to influence consumer opinion, and the record of industry in meeting voluntary commitments all need to be evaluated objectively.

Japan faces an even larger challenge than other IEA countries in reducing growth in energy consumption. Because of high end-use prices, which have encouraged energy conservation, and a strong tradition of promoting energy efficiency, Japan's energy use per unit of GDP is well below the IEA average. Low housing space compared with other IEA Member countries, and fewer kilometres driven per passenger relative to GDP, contribute significantly to this low ratio. The ratio of energy use per unit of GDP improved significantly at the time of the two oil shocks (1973-75 and 1979-82) and during the recession and restructuring which followed, partly because of industry relocation offshore. Since 1982, however, energy consumption has been rising, fuelled by economic growth. The annual increase of 3% in the residential, commercial and transport sectors is above the average growth in GDP over the period, making the target of reducing growth in consumption to 1% annually very difficult to attain. In the residential sector, the trend to improve comfort levels to those experienced in other IEA countries will continue to push up energy use.

Factors Likely to Influence the Success of Energy Efficiency Policies

Energy efficiency policies have taken on a new significance in Japan because of the role they are expected to play in meeting Japan's COP 3 commitments. Energy

efficiency improvements achieved to date make the achievement of still further improvements extremely difficult. Moreover, higher standards of performance are expected to be achieved at a time when economic performance has declined. Both the Government and Japanese industry can be expected to give primary attention to raising domestic consumption and expanding industrial output. Past trends have shown a close relationship between GDP growth and energy consumption, and there is a high probability that economic recovery and a rise in energy consumption will coincide.

The Government expects the industry sector to reduce energy use by 21 million kilolitres of oil equivalent by 2010, as part of a balanced package of measures which includes energy conservation standards and technical assistance. Industry is free to achieve the target by voluntary means, but failure to do so would eventually result in the application of strict sanctions. Standards and obligations are supported by sanctions such as negative publicity for firms that fail to achieve the standards (regarded as highly punitive in Japanese society), orders for manufacturers to rationalise energy use, and fines. Tax incentives and low interest loans are also available for industry to introduce energy efficient facilities. Should voluntary measures fail to deliver the results necessary to reduce carbon dioxide emissions, then there will necessarily be a call for more stringent measures on both the demand and supply sides.

The most important area of demand growth is in electricity, and voluntary measures are expected to be effective at a time when the electricity industry is being liberalised and more decision making passed to companies. Liberalisation has the goal of reducing costs and prices. If prices are not also adjusted to value external costs, then the liberalised market will not result in prices which reflect all costs and an economic incentive to improve energy efficiency will be lost. Full cost-reflective pricing would assist in flattening the electricity load level.

One legacy of Japan's economic success has been a rise in consumer expectations. Rising consumer expectations for comfort, especially for air-conditioning in summer, is affecting energy use. Cooling puts heavy pressure on electricity supply (peak load) during summer. Increasing demand for electrical appliances, the growing number of appliances, and increased use of bigger and more energy intensive cars on increasingly congested roads, have been important contributory factors to rising energy demand.

These influences – the priority of economic recovery, market liberalisation and changing lifestyles – suggest that further improvements in energy efficiency will be very difficult to achieve with current policies and may not be sufficient to make the contribution expected to reducing greenhouse gas emissions.

Voluntary Measures

It is commendable that the Government has strengthened its energy efficiency policies by the amendment of the energy conservation law. In addition to the

Government's direct measures, Keidanren (the industry body principally responsible for collating the industry measures) has released an industry-wide Voluntary Action Plan on energy conservation and the environment. The Government has decided to monitor and quantify progress of the Plan. Sanctions on the failure of industry to fulfill its obligations are minimal, but the law on energy conservation would eventually impose sanctions for non-compliance with government targets. More direct government support for the Voluntary Action Plan could encourage industry to respond more effectively on energy conservation.

Problems of ensuring the effectiveness of voluntary measures to improve efficiency are common to many IEA Member countries, and Japan may benefit from drawing on experience elsewhere. In some IEA Member countries, voluntary measures are subject to formal agreement with industry organisations or enterprises after negotiation of efficiency measures to be implemented. Tax incentives may be used, generally with monitoring and even compliance mechanisms, to ensure that commitments are fulfilled, that investments in energy efficiency are genuinely undertaken in response to government policies, and that they would not have otherwise been undertaken.

Role of Prices

Reflecting economic growth and the convenience of electricity, electric power demand in Japan is expected to continue growing in the years ahead, while the capacity utilisation factor is worsening due to acute increases in summer peak demand. Summer air-conditioning demand is not unique to Japan and other countries also often have to manage winter heating demand. But Japan is the only country which has such an enormous peak load problem. The use of optional rules for the use of rates and other conditions of supply have been effective in Japan, and their wider application is to be encouraged. The experience of other countries, particularly France, shows that adequate tariffs, supported by sophisticated metering technology, can contribute greatly to lowering peak demand[5]. Higher energy prices, coupled with policies such as information to end-users to encourage energy efficiency, will have a better chance of succeeding than price alone. Energy may not represent a high enough share of end-users' budgets for prices alone to change habits, lifestyle or decisions to improve energy efficiency.

Prices along with other measures are the only effective means by which long-term changes in patterns of energy use are likely to be brought about and sustained. Competitive energy markets will ensure that energy prices reflect the real economic costs of energy services. Prices can be adjusted by governments to also reflect the value placed on external benefits and costs arising from judgements on environmental and security considerations. Prices need time to be effective and

5. In France, the peak occurs during winter. Unlike Japan, increased use of air-conditioning would flatten the peak.

may need to be supplemented by direct government measures. For example, households can be expected to respond to additional, and more varied, cost-reflective electricity price menus (lower night-time tariffs matched with higher prices for peak electricity supply) by changing the pattern of appliance use, particularly use of air-conditioners. Consumer efforts could be further supported by programmes to accelerate turnover of the stock of appliances, so as to increase the use of more efficient models, or to develop heat storage air-conditioning and gas air-conditioning. Current regulatory reform of the electricity sector will play a key role in focusing attention on cost-reflective tariffs to improve energy efficiency as well as economic performance.

Energy Conservation Standards and Labelling

Co-operation from several areas of government will be necessary if stronger and strictly enforced standards are to be introduced. Energy conservation standards are a major area requiring consideration in this regard. Energy conservation standards in buildings in Japan include lower standards for insulation than in many IEA countries. This was understandable to some extent when heating was the main energy use in a house, since most of Japan has a warmer climate than many IEA countries. Heat demand growth is low, despite the trend to whole-room and whole-house heating and away from traditional (under-table) heating. In part, heat demand has been kept under control by better house design, including better insulation and better windows. Japan would benefit from wider application in its warmer regions of the experience it has gained in colder regions like Hokkaido, with some adaptation. A more air-tight house envelope, protected from moisture, will demand less air-conditioning than is currently used in the warmer parts of Japan.

Moderating the demand for air-conditioning is now the principal consideration. Bringing energy conservation standards up to the standard of mid to north European countries, for example, would also do much to curb peak electricity demand. Such standards would encourage demand for energy efficiency investments such as insulation and double glazed windows. Experience in other IEA Member countries may also help in developing policies related to energy conservation standards, such as energy labelling for houses and house components (for example, doors and windows).

Energy conservation codes and standards for residential houses and commercial buildings in Japan are completely voluntary. Housing which meets the standards receives preferred treatment in public finance. In FY 1995, only 22% of the applications for public finance were for houses meeting the energy conservation standards. In the first half of FY 1996, this fraction increased to 28%, and after the financing incentive was made more generous in mid-1996, it increased to 42%. Even so, more than half the houses for which financing was sought under the more generous incentive did not meet the energy conservation standards. The long life of buildings means that the energy performance of these houses will be low for decades to come.

Other IEA Member countries have sought to place a value on the energy efficiency performance of buildings by efficiency-certification systems. Energy audits are conducted for new buildings and before resale, as a means of raising consumer awareness of energy efficiency.

Transport

Transport demand growth has been high in most IEA countries. Fuel costs are only part of the cost of mobility, and the oil price is a small component of fuel costs, allowing for transport, refining, retailing and taxes. Hence, the sensitivity to a carbon value is very small and, on a purely cost-reflective basis, transport is unlikely to provide a significant share of carbon dioxide reductions in the immediate future. The contribution of the transport sector to meeting environmental goals is likely to prove far more difficult to achieve (or be far less cost-effective) in this sector than in other sectors. Nevertheless, high use of public transport in Japan is encouraging, as are efforts being made to encourage cargo transportation by rail, which is less carbon intensive than by truck. Comfortable public transport is one area in which Japan provides an example to other countries.

RECOMMENDATIONS

The Government of Japan should:

- ☐ Through electricity and gas market liberalisation policies, encourage the widespread use of cost-reflective energy pricing, including time-differentiated electricity pricing to encourage energy conservation in summer and also to assist in levelling electricity loads.

- ☐ Review policies to achieve improved energy efficiency, taking care to distinguish between improvements attributable to government policies and improvements that would have happened otherwise, and utilise the results of reviews undertaken to adjust the package of policies intended to meet Japan's COP 3 target, in particular the possible need to adjust the balance between energy demand and energy supply policies.

- ☐ Evaluate the applicability to Japan of policies used in other IEA Member countries to monitor and enforce voluntary agreements with industry.

- ☐ Consider strengthening energy conservation standards for buildings, adopting energy conservation information systems for residential buildings and developing a process of energy audits/certification for buildings as part of the documentation prepared when buildings are sold.

6

NUCLEAR ENERGY AND NEW ENERGY SOURCES

NUCLEAR ENERGY

The Government of Japan rates nuclear power plants highly on the grounds of the stability of fuel supply and fuel price, economical performance and environmental protection. On the supply side, nuclear is regarded as the best option for meeting both energy security and climate policy objectives. Advanced Boiling Water Reactors (ABWR) are being developed in the standardisation programme to improve on earlier designs. This type of plant will be the mainstay of Japanese nuclear power generation in 2000 and beyond.

Table 4
Commercial Nuclear Power Plants in Operation

Company	*Facility*	*Type*	*Output (MW)*
JAPC	Tokai II	BWR	1 100
	Tsuruga - 2 units	BWR/PWR	1 517
Hokkaido	Tomari - 2 units	PWR	1 158
Tohoku	Onagawa - 2 units	BWR	1 349
Tokyo	Fukushima - 6 units	BWR	4 696
	Fukushima II - 4 units	BWR	4 400
	Kashiwazaki-Kariwa - 7 units	5 × BWR, 2 × ABWR	8 212
Chubu	Hamaoka - 4 units	BWR	3 617
Hokuriku	Shika	BWR	540
Kansai	Mihama - 3 units	PWR	1 666
	Takahama - 4 units	PWR	3 392
	Oi - 4 units	PWR	4 710
Chugoku	Shimane - 2 units	BWR	1 280
Shikoku	Ikata - 3 units	PWR	2 022
Kyushu	Genkai - 4 units	PWR	3 478
	Sendai - 2 units	PWR	1 780
Subtotal	**51**	**23 × PWR, 26 × BWR, 2 × ABWR**	**44 917**

Note: BWR - Boiling Water Reactor
PWR - Pressurised Water Reactor
ABWR - Advanced Boiling Water Reactor
JAPC - Japan Atomic Power Company
Source: MITI.

Table 5
Commercial Nuclear Plants Under Construction and in Planning

Company	*Facility*	*Type*	*Output (MW)*	*Status*	*Planned Start-up**
Tohoku	Onagawa	BWR	825	Under construction	2002
	Higashidori	BWR	1 100	Under construction	2005
	Maki	BWR	825	In planning	2008
Chubu	Hamaoka	ABWR	1 380	In planning	2005
Hokuriku	Shika	ABWR	1 358	In planning	2006
Total			**5 488**		

* Planned start-up dates are according to the schedule in the Electricity Supply Plan, 1998.

Note: For plants in planning, this table includes only those plants which have been authorised by the Electric Power Development Coordination Council (EPDCC).

Source: MITI.

Table 6
Other Nuclear Plants

Company	*Facility*	*Type*	*Output (MW)*
Power Reactor and Nuclear Fuel Development Corporation*	Fugen	ATR	165
	Monju	FBR	280

Note: ATR - Advanced Thermal Reactor
FBR - Fast Breeder Reactor

* The Power Reactor and Nuclear Fuel Development Corporation has been reorganised as the Japan Nuclear Cycle Development Institute (see Critique, below.)

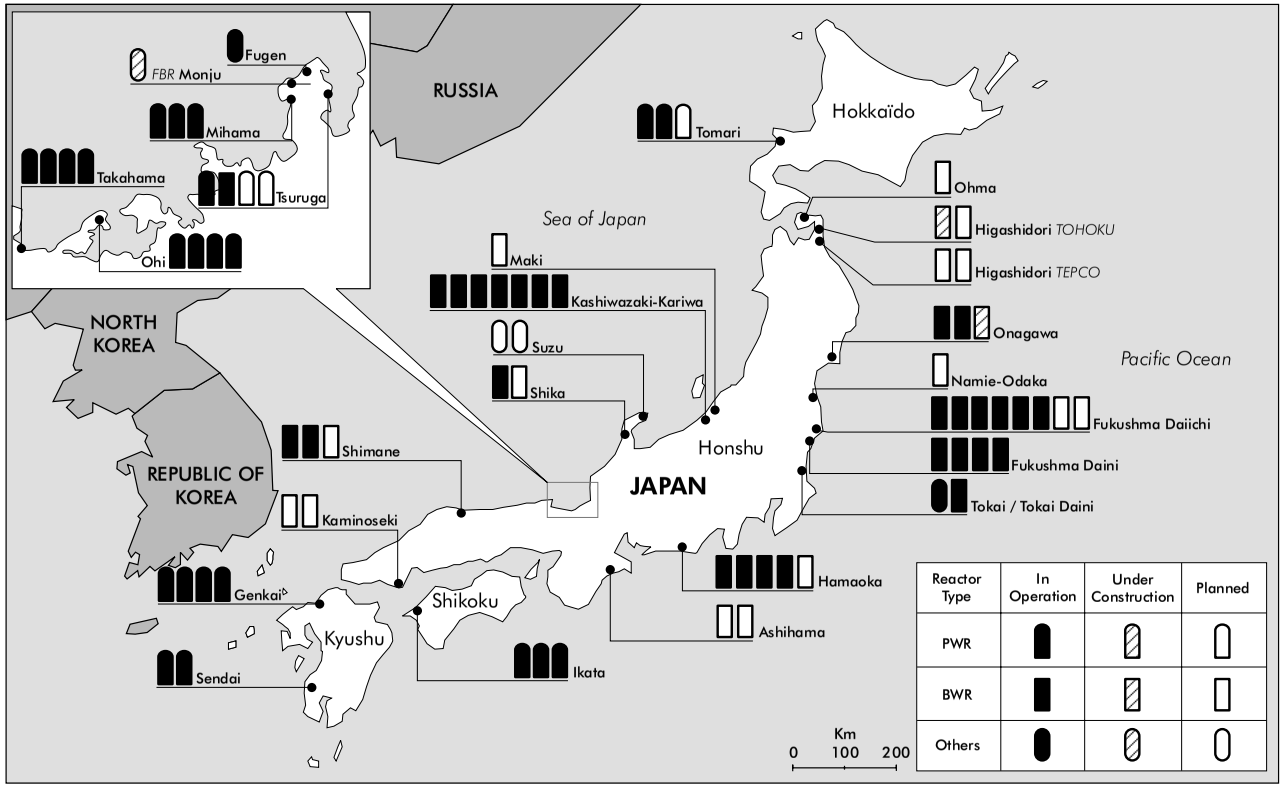
Source: Science and Technology Agency.

There are 51 commercial reactors in operation in Japan. Installed nuclear capacity is 45 GW, producing over one-third of Japan's power requirements and about 10% of primary energy supply (coal, by comparison, contributes about 16% to primary energy supply). The Government plans to increase the proportion of electricity generated from nuclear to 42% by 2010. To achieve this goal, the private electricity utilities are expected to build additional capacity, requiring about 16 to 20 new nuclear power reactors. Of these, five are in the existing Electric Power Development Coordination Council plan, and three of these are to be built at existing nuclear sites. A further six units, not yet authorised in the EPDCC plans, are also planned for existing sites. Of the new sites, Higashidori, in the north of Honshu, has been given the go-ahead by the Governor of the local Aomori prefecture; construction of the first of four reactors is under review by MITI.

By early 2008, nine new reactors are planned to be operating, providing an additional 11.3 GW capacity. By the end of FY 2010, a further 12 reactors are planned to be operating, with an additional 14.6 GW capacity.

Figure 15

Nuclear Power Plants in Japan



Note: Based on the Electricity Supply Plan, 1998. Plants shown as in planning may not yet have been authorised by the Electric Power Development Coordination Council (EPDCC) and in total exceed those listed in Table 5.

Source: MITI.

Administration of Nuclear Power in Japan

The Atomic Energy Basic Law (1955) established the Atomic Energy Commission (AEC), the Nuclear Safety Commission and other institutions for nuclear power development, as well as basic regulations for control of nuclear substances and reactors.

The AEC was established in the Prime Minister's office with authority for "planning, deliberation and determination" of nuclear power development and utilisation[6]. Its decisions are reported to the Prime Minister. The Nuclear Safety Commission was established by amendment of the basic law in 1978. It has authority for "planning, deliberation and determination" of safety assurance and regulations related to the work of the AEC. Its decisions are also reported to the Prime Minister.

MITI conducts work involving nuclear power research, development and utilisation. The Public Utilities Department (see Figure 1, Chapter 3) is responsible for work related to nuclear power generation and the promotion of power source development. MITI, with its eight regional bureaus, is in charge of the whole sequence of work concerning commercial nuclear reactors, from the basic design to detailed design, inspection procedures and operation.

The Science and Technology Agency (STA) has two bureaus concerned specifically with nuclear power. The Atomic Energy Bureau is responsible for planning, formulating and promoting basic policy on nuclear power research, development and utilisation. The Nuclear Safety Bureau is responsible for regulating and determining safety measures for nuclear source materials, nuclear fuel materials and reactors (at the stage of research and development) and the use of radioactive isotopes.

The Ministry of Transport is responsible for regulating the safe transport of radioactive materials and the development of nuclear-powered ships and nuclear reactors in ships. The Ministry of Foreign Affairs deals with diplomatic issues related to nuclear power, and the Planning Bureau of the Economic Planning Agency formulates basic policy and plans for power source development and takes responsibility for their overall co-ordination.

Plutonium Recycling

Japan has in operation an uranium enrichment facility and a facility for disposal of low-level radioactive waste; a reprocessing facility is under construction. The facilities are in Rokkasho village in Aomori prefecture. The uranium enrichment facility started operation in March 1992, and the final disposal facility for low-level radioactive waste in December 1992. The reprocessing facility is planned to start operation in 2003.

6. *Nuclear Power Development in Japan*, Agency of Natural Resources, MITI, March 1997.

The Japanese Government regards recycling plutonium in light water reactors as a basic element of its nuclear policy, since it adds to energy security and reduces the generation of high-level radioactive wastes to a minimum. The *Pluthermal Programme* promotes the use of mixed oxide fuel, containing extracted plutonium, in light water reactors. The report of the Nuclear Power Sub-committee, January 1997 noted that Japan depends on overseas supplies for almost all energy resources, including uranium, and therefore the foundations for Japan's energy supply are extremely fragile. The report further noted that from the viewpoint of social acceptance, direct geologic disposal of spent fuels is more difficult than disposal of volume-reduced vitrified high-level radioactive waste after uranium and plutonium are extracted through reprocessing, because spent fuels contain resources of uranium and plutonium, which are also long-life radio-nuclides.

Preparations are being made for the use of plutonium in light water reactors, by mixing uranium and plutonium oxides to produce mixed oxide (MOX) fuel. Tokyo Electric Power Company (TEPCO) and Kansai Electric Power Company are expected to start recycling plutonium in light water reactors in 1999. Kansai has received the first formal consent from the Fukui prefectural government and the municipal government of Takahamacho to seek MITI permission for the basic design to use mixed oxide fuel in these plants. If it is licensed by MITI, and the final consent is given by the local government, Kansai is scheduled to begin using mixed oxide fuel in its Takahamacho No. 4 reactor in 1999 and in the No. 3 reactor in 2000. By 2010, all the electric power utilities in Japan are scheduled to join in this programme. Mixed oxide fuels are expected to be the principal use of plutonium in Japan for several decades.

Recycling of plutonium in light water reactors uses about 25% of the plutonium extracted from the spent fuel elements. Fuel recycled in this way still leaves a large proportion of unburnt plutonium, which could be further recycled in a fast reactor. To multiply the effectiveness of uranium resource utilisation, a fast reactor step is regarded by the Government of Japan as a necessary part of the fuel cycle. Japan's fast breeder reactor programme is therefore an integral part of its overall approach to the environment, electricity production, nuclear non-proliferation commitments and nuclear waste disposal.

Public Perception

In August 1996, the residents of the town of Maki in Niigata prefecture voted down the construction of a nuclear power plant by referendum, the first such instance in Japan. Opinion polls indicate that while 70% of the people acknowledge the need for nuclear power to one degree or another, some 40% have concerns about its safety. In some cases, opposition from local and other interest groups is strong. Local residents are mostly positive where local development measures are made available.

The problem of public acceptance for major facilities is not related to nuclear energy alone. Outlying communities have also begun to raise objections to the

location of industrial waste disposal sites. Two incidents have undermined public support for nuclear power in Japan. In December 1995, a sodium leakage occurred at the Monju prototype fast reactor run by the Power Reactor and Nuclear Fuel Development Corporation (PNC), and in March 1997, an explosion occurred in PNC's Bituminisation Demonstration Facility at Tokai Works. Treatment of both incidents was regarded as unsatisfactory by the general public.

MITI and the electricity-generating companies have responded by seeking to improve information disclosure and dissemination, and the transparency of procedures in the nuclear programme. For example, public meetings have been convened to discuss the plutonium utilisation programme in local areas adjacent to power stations, in which the local people are invited to participate.

Government policy on the public acceptance of nuclear power was set out in the report of the Nuclear Power Sub-committee in January 1997. The committee emphasised policies directed towards the communities where nuclear plants are located. Discussions focused on three points. The first was the need to enhance measures to build up the regional economy in areas where nuclear plants are located. The second was the awareness gap between residents of the regions where nuclear power sites are clustered and energy consumers in major urban centres like Tokyo and Osaka, who take stable energy supply for granted. The third was to improve transparency on nuclear policy-making by improving arrangements for publicity and public comment.

Operating and Capital Costs

Within TEPCO, the capacity utilisation factor of nuclear plants reached as high as 84.5% in 1996. If the capacity utilisation factor can be raised by one percentage point, an extra 1.2 TWh of nuclear power can be produced, reducing correspondingly the need for fossil-fired generation. This would result in cutting back fossil fuel costs by about ¥4.5 billion[7] and the avoidance of 660 000 tonnes of carbon dioxide emissions.

TEPCO achieved a 15% cost reduction in the construction of the latest Advanced Boiling Water Reactor, which is now operating at the Kashiwazaki Kariwa site. Safety was simultaneously upgraded.

To enhance the economics of nuclear power generation, TEPCO aims to realise and stabilise at over 80% the capacity utilisation factor achieved in every reactor. The intention is to reduce outages and improve safety performance. If outages can be reduced to 50 days and reactors operated for 13 months without shutdown, a capacity utilisation factor of nearly 90% could be possible. Fuel costs and the cost of services related to nuclear generation are also being targeted for reduction.

7. In 1998, on average ¥ 100 = US$ 0.763. As at 4 January 1999 ¥ 100 = € 0.7478.

NEW ENERGY SOURCES: RENEWABLE AND NON-CONVENTIONAL FUELS

"New energy" sources are defined in Japan as oil-alternative energy sources which have not yet been used widely, mainly because of economic constraints and instability of supply, but whose introduction is necessary in order to reduce Japan's oil dependence and to assist in environmental protection. The Government's target for the share of new energies in total primary energy supply has been set at 3.1% in financial year 2010. *The Law Concerning Promotion of the Use of New Energies* was enacted in June 1997, as a framework for encouraging the introduction of renewable and non-conventional fuels. The law includes financial assistance measures for businesses which use new energy sources.

Current and targeted use of new energies are set out in Table 7.

Table 7
Targets for New Energy
(MW or kl Oil Equivalent)

Technology	*FY 1996*	*FY 2010 Target*
Supply side new energy sources		
Photovoltaic power generation	55 MW	5 000 MW
Wind power generation	14 MW	300 MW
Thermal energy conversion[1]	30×10^3 kl	580×10^3 kl
Waste power generation	890 MW	5 000 MW
Solar heat utilisation	$1\,040 \times 10^3$ kl	$4\,500 \times 10^3$ kl
Thermal use of power	44×10^3 kl	140×10^3 kl
Other[2]	$4\,900 \times 10^3$ kl	$5\,920 \times 10^3$ kl
Total share of total primary energy supply	$6\,850 \times 10^3$ kl (1.1%)	$19\,100 \times 10^3$ kl (3.1%)
Demand side new energy sources		
Clean energy vehicles[3]	12 000 units	3.65 million units
Cogeneration	3.85 GW	10 GW

1. Thermal energy conversion utilises thermal energy held by a body of water (such as a river or the sea), which is cooler than the ambient air in summer but warmer than the air in winter.
2. Black liquor and bark produced in paper manufacture.
3. Electric vehicles, natural gas-fuelled vehicles and methanol-fuelled vehicles.

Source: MITI.

The 1998 Budget allocated ¥74.8 billion (up from ¥56 billion in 1997) for new energy promotion. National and local tax incentives, subsidies for approved enterprises and loan guarantees by the New Energy and Industrial Technology

Development Organisation (NEDO) are available. Details of the measures for the promotion of photovoltaic power generation for residences, for diffusing clean energy vehicles, and for the introduction of new energy in local areas are set out in Table 8.

Table 8
Measures for Promoting New Energy, Financial Years 1997 and 1998
(billion ¥)

Measure	*1997*	*1998*
Clean energy vehicles	**3.1**	**9.0**
Subsidies for businesses which take the initiative in introducing clean energy vehicles	2.8	8.4
Development of high efficiency new energy vehicles (multi-fuel and LNG vehicles)	0.3	0.6
Reduction in acquisition tax on hybrid vehicles		
Photovoltaic power generation systems	**20.3**	**26.1**
Promotion of residential photovoltaic systems	11.1	14.7
Field test of photovoltaic systems for industrial use	0	2.4
Technological development related to photovoltaic power generation (cost reduction, efficiency improvement and mass production of solar grade silicon; technical conditions for connecting photovoltaic systems to commercial grids).	7.7	8.8
Other	1.5	0.2
Support for businesses introducing new energies	**1.1**	**5.4**
Support for projects in local areas	**4.1**	**7.5**
Subsidies to local government	2.2	4.4
Support for regional new energy systems and energy conservation	0.6	0.8
Field tests of wind generation technologies	0.5	1.5
Other	0.8	0.8

Source: MITI.

Tax deductions or special depreciation allowances apply to the acquisition cost of new energy facilities. Local property taxes are also lower for new energy projects. Capital subsidies apply to geothermal, and also to small to medium sized hydro, power station projects. Electric power companies purchase photovoltaic and wind power at premium prices and do not charge back-up costs.

CRITIQUE

Nuclear Power

Of the IEA Member countries, Japan and France are the only ones to have a policy interest in promoting domestic development of nuclear power as an economic and carbon-free source of power[8]. Unlike France, which already generates about 80% of its electricity from nuclear energy, Japan has the potential to expand its nuclear capacity, while maintaining a high level of diversity of energy sources for power generation.

Little discussion has taken place among IEA Member countries on the merits of nuclear power as a means of abating greenhouse gas emissions, perhaps because many IEA Member countries oppose its use on environmental grounds (because of waste disposal problems and the possibility of accidents) and because of negative public attitudes. Even where these arguments are not necessarily supported (in the United Kingdom, for example), new nuclear power stations are considered not to be economically competitive with other conventional sources of power on the basis of levelised cost comparisons. From a "business-as-usual" perspective, existing plants are expected to run their economic lives and not be replaced. The economic rationale for disregarding nuclear as a potential measure to reduce greenhouse gas emissions stands in contrast with the active support of many IEA Member countries for the development of renewable sources of energy, even though they can also emit carbon (wastes and biomass, for example).

Illustrative "Kyoto" scenarios in the IEA *World Energy Outlook* suggest that coal in power generation will decrease in all OECD regions. In these scenarios, the most plausible way for emissions targets to be met is to replace coal and other fossil fuels with nuclear energy. Advanced coal-fired technology is not a complete solution because it does not achieve sufficient reduction in carbon dioxide emissions.

Achieving the Target for New Nuclear Plants

The reduction of carbon dioxide emissions that Japan expects to achieve through nuclear power production is 26 million tonnes, about 17% of the total reduction required to achieve its COP 3 target. Achieving that scale of nuclear power development should at least avoid the need to further review the structure of power sources and to pursue further energy saving in the industry, residential and commercial, and transport sectors. Japan's energy efficiency goals are already extremely ambitious (see Chapter 5) and gas penetration is hampered by its high cost. Although the nuclear production target was set before environmental considerations became prominent, the Japanese Government believes that it is

8. IEA Shared Goal 1 notes that "non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group". IEA Shared Goal 4 notes that "A number of IEA Members wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide".

compatible with the goals of economic growth, energy security and environmental protection. Issues which may affect the achievement of the nuclear production target, and hence the greenhouse gas emissions target, are:

- The economics of nuclear power.
- The value to be placed on other nuclear fuel cycle costs, including waste reprocessing and/or disposal.
- The extent to which a liberalised electricity market will allow continued development of nuclear power.
- Public acceptability.

Economics of Nuclear Power

According to the latest MITI estimates, fossil-fuel plants and nuclear plants have similar levelised costs, with a small advantage for nuclear in Japan. If a value were attached to emitting carbon dioxide, nuclear power could gain an economic advantage.

Japan has the highest investment costs for nuclear, gas and coal-fired power in the OECD based on the generic assumptions used in a recent OECD NEA/IEA study[9]. Japan is seeking to reduce the capital costs of nuclear plant by standardisation of plant design. There is scope for reducing the per unit capital costs of nuclear plants. Increasing the capacity utilisation factor of generating plant decreases the levelised cost of electricity generation. Options which are more capital intensive are more sensitive to load factor variation than less capital intensive options. Hence, according to the OECD NEA/IEA study, increasing the capacity utilisation factor for nuclear plants from 65% to 80% decreases costs by some 15%; for coal-fired plants the effect is lower, about 10%, since fuel costs represent a larger share of the overall levelised electricity cost.

The cost of generating electricity from fossil fuel plants is very sensitive to fuel price escalation, whereas nuclear generation costs are not very sensitive. The cost of uranium accounts for 5 to 8% of total nuclear generation costs, while the cost of coal accounts for about 25% of coal-fired generation costs in Japan. Although the late 1970s and early 1980s saw relatively high uranium prices, prices began to fall well before the oil price fall in 1986. Real prices have fallen from over $US 150/kg contained uranium in 1980 to about $US 30/kg in 1996 (1990 US dollars). In principle, consideration of fuel costs may support nuclear power, but any benefit is difficult to quantify since fossil fuel prices might reasonably be expected to remain flat.

The prospects for economic use of reprocessing and mixed oxide fuels are less favourable. The cost of reprocessing and recycling has to be considered in the

9. A comparison of the costs of generating electricity from different sources is provided in a series of reports entitled *Projected Costs of Generating Electricity* (see 1998 update, OECD NEA/IEA, 1998).

context of the world uranium market. Uranium can be sourced in many countries, is relatively low in price and has a stable supply outlook. Spent nuclear fuel can be stored at low cost, so that reprocessing or recycling can be deferred until justified economically, provided the technology is established. The latter consideration might justify an active research and development programme, but not necessarily immediate application of the technology beyond a demonstration stage.

Commercial Interest in Building New Reactors in a Liberalised Electricity Market

At present, Japanese electricity utilities operate at a high debt-to-equity ratio, which might be expected to cause concern in a more liberalised electricity market. Companies facing more intense competition may wish to avoid the additional burden of debt involved in high capital costs and charges necessarily incurred in building both coal and nuclear power plants. The utilities are confident that the financial markets in Japan will support the programme to build additional nuclear plants and appear to be prepared to invest in nuclear power. The utilities take the view that the discount rate they consider appropriate to apply to investment in nuclear plants is lower than for fossil fuelled plants, which they regard as not contributing as much as nuclear to energy security. They consider that the expected economic, safe life of nuclear plants is therefore longer than might generally be assumed outside Japan. The costs involved in the back end of the nuclear cycle (reprocessing and recycling nuclear fuel) are viewed by the industry as a responsibility for government and it does appear likely that companies will seek some form of assistance in return for accepting responsibility for building the plants. Ways in which the Government might take into account the external environmental benefits of nuclear energy (in terms of contributing to reducing carbon dioxide emissions in the energy sector) and the energy security benefits are discussed in Chapter 7. Neither the industry nor the Government of Japan favour a carbon tax.

Public Acceptance

There are widely held concerns about the nuclear fuel cycle which need to be addressed objectively. It should not be assumed that public views are necessarily irrational or ill-informed. The policy to promote nuclear power should also address the development of technologies to ensure safe and economic reprocessing and waste disposal, and the improvement of the safety and economic performance of reactors.

Both the Monju and the Bituminisation Demonstration Facility incidents pointed to a common problem: the lack of adequate local communication by PNC. PNC has been reorganised as the Japan Nuclear Cycle Development Institute, to manage Japan's nuclear fuel recycling technology programme. Several organisations are responsible for improving public acceptance of nuclear energy, including MITI's Office for the Public Acceptance of Nuclear Energy, the Japan Atomic Energy Relations Organisation and the Information Centre for Energy and the Environment. It is clearly important that the views of these organisations be separated from any

commercial interests and that their activities be co-ordinated. Public opinion is likely to be more readily influenced by information coming from an organisation which is known to be neutral and accountable to public opinion (for example, directly to the Diet).

From site selection for a new reactor to commencement of operation may take 20 to 30 years in Japan. Four steps are involved, in which local opinion plays a prominent role:

- Site selection requires the consent of the local community to permit a survey, an environmental review and a first public hearing (where local opinion is considered), the consent of the local community to permit construction, and the consent of the prefectural governor for the Electric Power Development Coordination Council to include the proposal in the Electric Power Development Plan.

- Preparation for construction requires a safety review by the Atomic Energy Commission and the Nuclear Safety Commission, and a second public hearing where local opinion is considered.

- Construction, involving technical inspections.

- Operation, involving periodic inspections.

MITI has authority for regulating power generation reactors. Divisions entrusted with nuclear safety regulations are legally separated within MITI to ensure an effective separation between the functions of safety regulation and nuclear promotion. The Atomic Energy Commission and the Nuclear Safety Commission within the Prime Minister's Office also seek to ensure neutrality of safety regulation. The members of both these commissions are appointed by the Prime Minister with the consent of the Diet. Ensuring transparency of the safety regulation regime is critically important to gaining public acceptance of nuclear power.

There are difficulties encountered because of the lack of public acceptance of new nuclear plants, which leads to lengthy delays. However, generating 480 TWh is not out of reach, on the basis of 15 new plants to be built on sites already acquired by the utilities, if the overall capacity utilisation factor exceeds significantly the 78% mark, which corresponds to an installed capacity of 70 GWe. In fiscal year 1997, the capacity utilisation factor was about 82%. By 2010, more than 85% is probably achievable, although by no means certain. Of course, whether or not 480 TWh will constitute 35% of total electricity consumption in 2010 will depend on economic growth and on the effectiveness of energy efficiency policies and measures.

The length and periodicity of regulatory inspections (during refuelling outages) have a significant effect on the overall capacity utilisation factor. It may be possible (without diminishing safety and reliability) for Japanese utilities to increase the length of the power cycle between two refuelling operations, from 13 to 18 months or more, as is the present trend in other OECD countries.

Even if the capacity utilisation factor is raised, and the number of reactors required to achieve a given nuclear production target reduced, actions to increase public acceptance of new sites, and nuclear power generally, will remain of paramount importance. More reactors could be required to offset higher than expected growth in demand, to contribute even further to reducing greenhouse gas emissions if other policies (notably to improve energy efficiency) cannot achieve their very ambitious targets, and to replace existing reactors.

New Energies

In 1996, new energies (as defined earlier) accounted for only 1.1% of primary energy supply and are expected to account for 3.1% in 2010. Black liquor used for in-plant power generation in the pulp and paper industry accounted for 70% of new energies in 1996 and is expected to account for 30% in 2010. The only carbon-free new energies are solar and wind energy, which together accounted for only 15.5% of new energies in 1996. The capacity of solar energy is expected to increase nearly ten-fold by 2010, but would still account for less than 30% of new energies. Total carbon-free renewable energies (hydro, geothermal, photovoltaic, solar heat and wind power) accounted for 2.3% of primary energy supply in 1996 and are forecast by MITI to increase their contribution to 3.7% in 2010, but forecast by the Institute of Energy Economics, Japan (IEEJ) to *fall* to 2.1%.

Whatever the forecast, the new energies should be viewed as part of the energy research, development and demonstration programme with a very long-term goal. Strong government support will be needed on the basis of positive judgements about the long-term prospects for the new energies. Assessment of the long-term prospects should take into account the economics of the new energies. The prospects for achieving the targeted increase in photovoltaic power generation by 88 times, for example, looks over-ambitious on economic grounds. The IEEJ considers that photovoltaics might increase their contribution to power generation by perhaps 11 times in the period 1996 to 2010.

Wind power capacity currently amounts to about 14 MW, and is expected to double by 2010. An additional 23 MW of wind capacity is currently under construction. Wind power is considered unreliable in Japan and its development is impeded by the fact that suitable sites are remote (principally in the north of Honshu), making transmission expensive.

RECOMMENDATIONS

The Government of Japan should:

- ☐ Give consideration to means by which the Government could improve the overall capacity utilisation factor of nuclear plants, consistent with good safety

and reliability by, for example, allowing utilities to increase the length of the power cycle in nuclear plants between two refuelling operations, from 13 to 18 months or more as is the present trend in other OECD countries.

- ☐ Continue efforts to ensure full transparency and accountability for regulating safety of nuclear power reactors.

7

ELECTRICITY

INDUSTRY STRUCTURE

Participants

There are nine general electric utilities covering the four principal islands of Japan. A tenth company covers Okinawa. All of the utilities are privately owned and vertically integrated, from generation to retail supply, and they have mutually exclusive supply areas. There are no independent distributors of electricity. There is a small amount of inter-utility trade, amounting to about 55 TWh, or about 5% of total generation.

Table 9 shows sales of the general electric utilities. Tokyo has the largest sales, followed by Kansai, which covers Osaka, Kyoto and Kobe, and Chubu, which covers Nagoya.

Table 9
General Electric Utility Sales, 1997

Company	*Customers ('000)*	*Installed Capacity (MW)*	*Electricity Sales (GWh)*		
			Residential	*Commercial & Industrial*	*Total*
Hokkaido	3 579	5 431	9 623	16 179	25 802
Tohoku	7 219	12 437	19 953	46 377	66 330
Tokyo	25 285	53 975	76 531	186 719	263 250
Chubu	9 525	29 274	28 360	87 211	115 580
Hokuriku	1 869	5 509	5 866	18 286	24 151
Kansai	12 157	37 051	40 574	97 273	137 847
Chugoku	4 869	10 936	14 623	42 230	56 853
Shikoku	2 690	6 314	7 809	17 152	24 961
Kyushu	7 700	16 983	22 534	51 003	73 537
Okinawa	688	1 434	2 358	3 648	6 006
Total	**75 610**	**179 515**	**228 231**	**566 087**	**794 318**

Source: *Electric Power Industry in Japan 1997/98*, Japan Electric Power Information Center, Inc. Tokyo, 1997.

Electric Power Development Company (EPDC) owns and operates large-scale hydroelectric (mainly peaking) plants, coal-fired generating stations, geothermal generating stations and associated transmission assets. Its generating capacity amounts to 13 915 MW or about 6% of total capacity. EPDC sells power at cost to the ten utilities through long-term contracts. The Government owns two-thirds of EPDC (the nine utilities i.e., excluding Okinawa, own the other third) and had provided most of the financing. The Government has announced plans to privatise EPDC by 2003. A broad privatisation is planned, including a listing on the Tokyo Stock Exchange. The company is currently restructuring its finances to become independent of the Government.

The Japan Atomic Power Company (JAPC) was established in 1957 by the nine general utilities, EPDC and other nuclear enterprises to commercialise nuclear power development in Japan. Its three plants have a total capacity of 2 617 MW. JAPC sells power at cost to the nine utilities.

There are 34 public enterprises owned and operated by local governments which generate and sell power to the nine utilities. Their total capacity is about 2 492 MW (at the end of FY 1996) of mostly hydroelectric capacity.

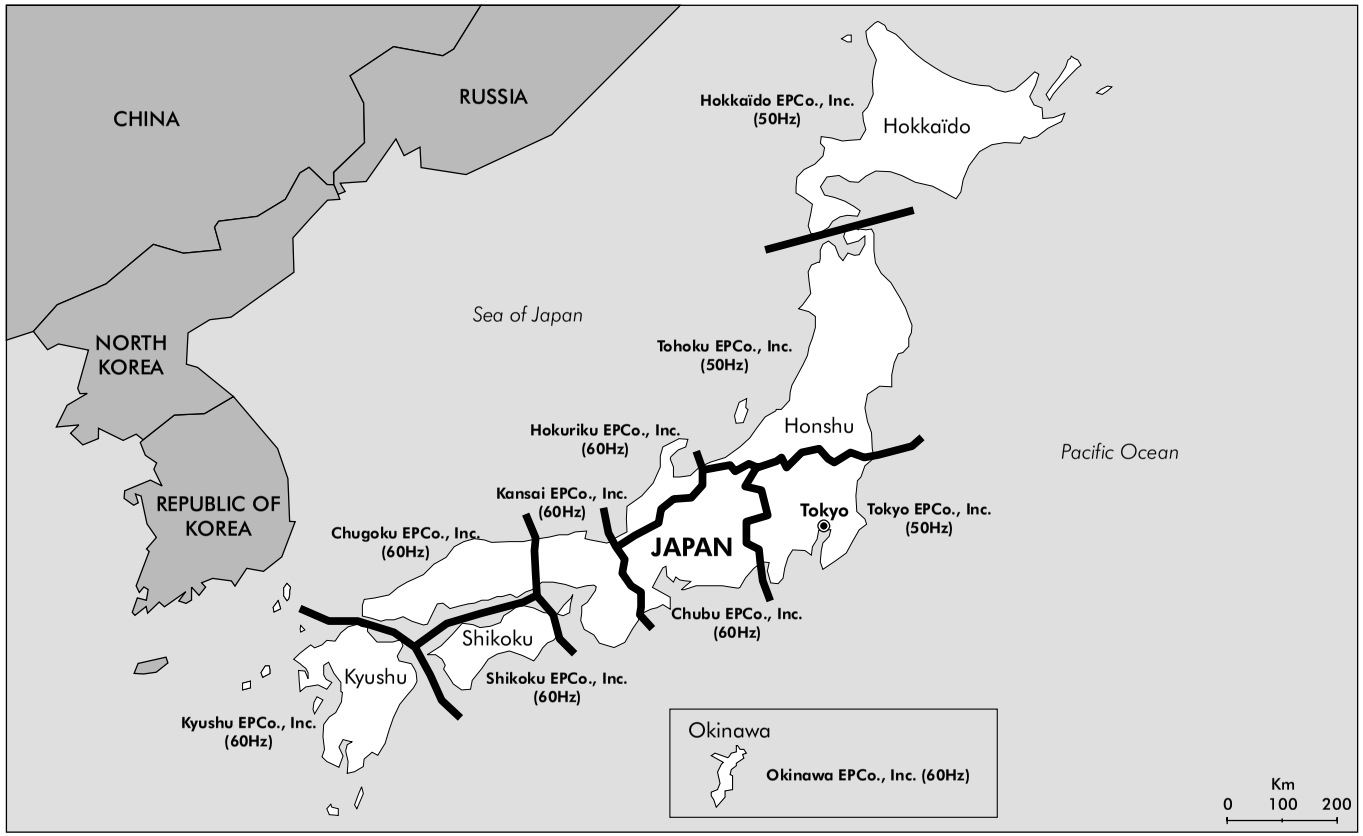
Autoproduction by the industry sector accounts for 24 400 MW (at the end of FY 1996) of capacity, mostly from oil and coal cogeneration. Steel makers, chemical companies, oil refiners, cement producers and pulp and paper companies are all major producers of electricity for in-house consumption and/or sale to a utility through joint venture arrangements. Autoproduction supplies 28% of the total electricity used by industry.

Grid Structure

The utilities serving the eastern part of Japan (Hokkaido, Tohuku and Tokyo) deliver electricity at a frequency of 50 Hz. Western Japan uses 60 Hz. All four main islands of Japan and the nine electricity generation regions have transmission links, making national inter-regional power exchange possible. Frequency converter stations are operated by EPDC at Sakuma and TEPCO at Shin Shinano, but total interconnection capacity between the two frequency areas is limited to 900 MW[10]. Transmission links have been upgraded to improve reliability, but are limited by the mountainous terrain and the elongated shape of Japan, which restricts opportunities for enhancing the networks through parallel transmission lines. Seven large transmission projects are under construction or have been planned to increase inter-regional linkages. Okinawa is not connected to the main grid. There is no grid connection with other countries.

10. Source: *Electric Power Industry in Japan 1997/98*, Japan Electric Power Information Center, Inc., Tokyo, 1997.

Figure 16
Electric Utilities

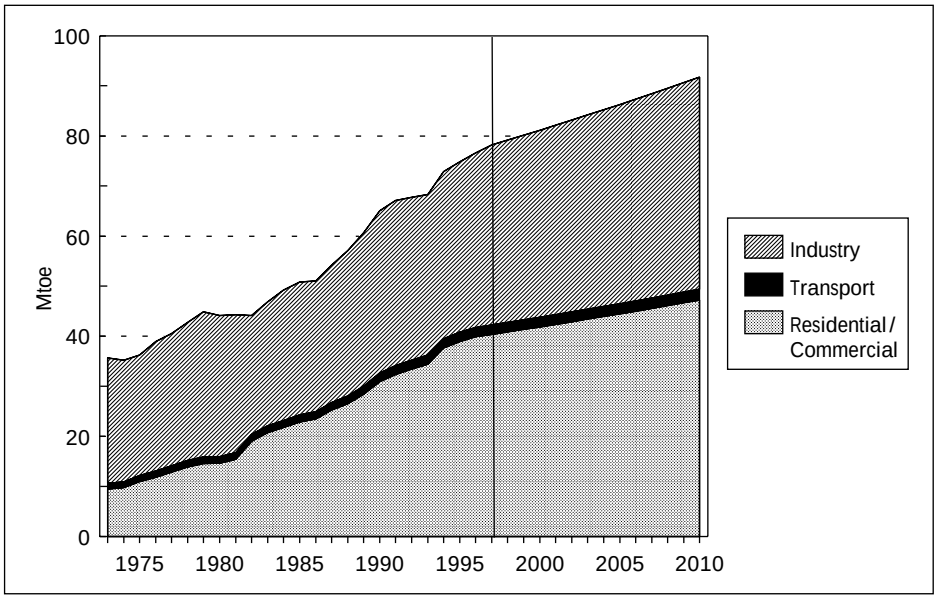


Source: MITI.

Supply and Demand

Figure 10 in Chapter 5 shows that electricity demand has been growing in line approximately with Gross Domestic Product (GDP). Electricity consumption by sector is shown in Figure 17. Growth in demand has been rapid, especially in the residential/commercial sector. In recent years, air-conditioning demand has risen rapidly, sharpening the peak in demand on a hot mid-day in summer.

Figure 17
Electricity Consumption by Sector

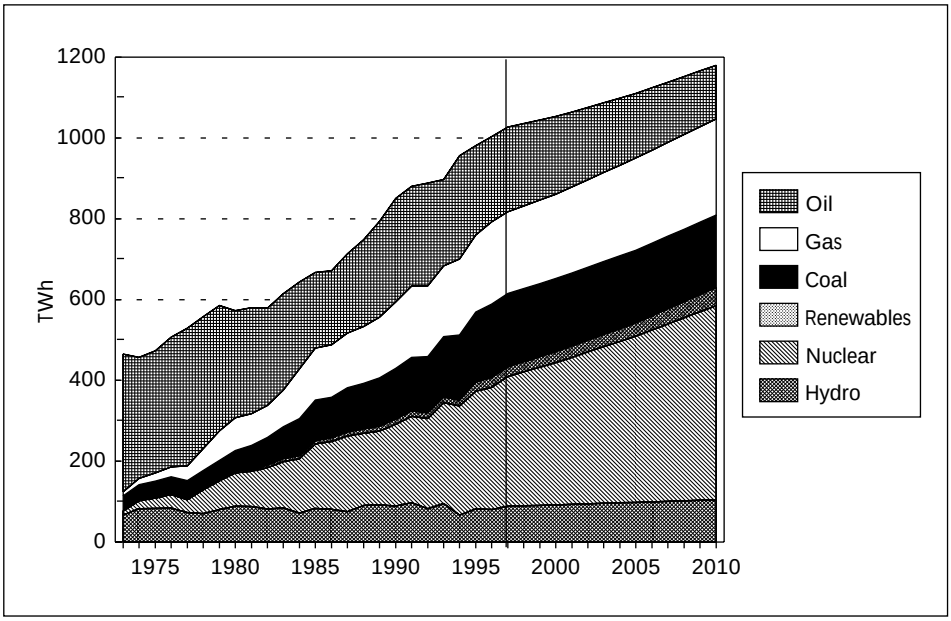


Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

Figure 18 indicates a fall in the share of oil-fired power generation from the most important fuel for electricity generation to an increasingly marginal role of meeting peak demand. Policy initiatives to promote this shift have included strong government policy support for nuclear power, bans on building or replacing oil-fired baseload generation, low interest loans from the Japan Development Bank for utilities to invest in other power sources, and substantial research and development funding. These policies encouraged a more diversified fuel mix, although Japan's dependency on oil-fired power generation remains as one of the highest among OECD countries.

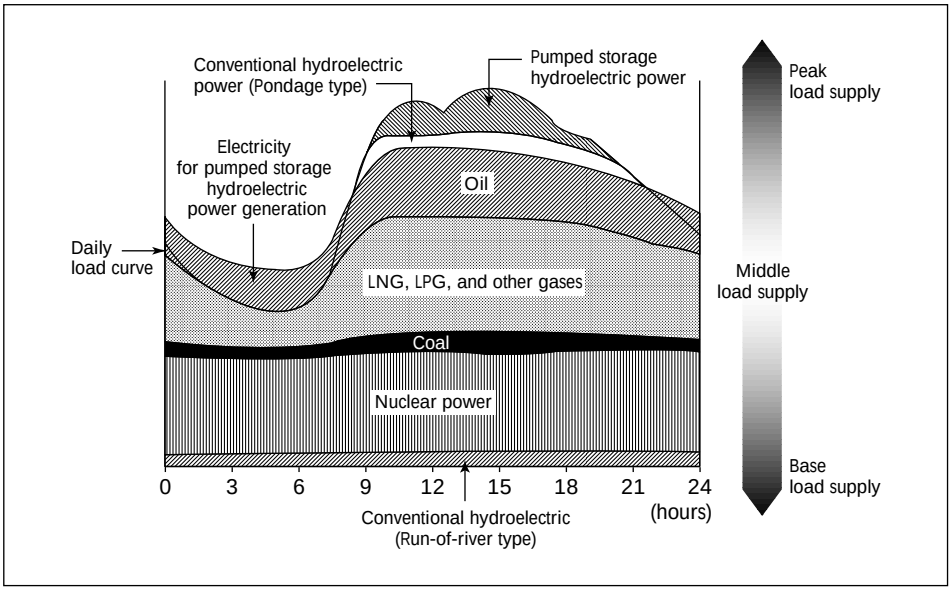
Base load power generation is mainly provided by nuclear power and a modest amount of run-of-river hydroelectric power. Coal also provides base load energy and some mid-load generation. Natural gas is a mid-load fuel, operated during the day. Peaking loads are principally provided by oil-fired generation along with peaking hydroelectric capacity. Substantial pumped storage hydroelectric capacity is used to meet the very steep daytime peak loads, using electricity generated at night (often oil-fired).

Figure 18
Electricity Generation by Fuel



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

Figure 19
Daily Load Curve



Source: *TEPCO Illustrated, 1997*, Tokyo Electric Power Company, Tokyo, 1998.

PRICES AND COSTS

Electricity prices in Japan are the highest in the OECD (Figures 20, 21 and 22).

There are a number of reasons for these relatively high prices.

- High generation capital costs: Japan has the highest investment costs for nuclear, gas and coal-fired power in the OECD. Expensive land, compensation payments made to local communities, and high safety standards (including earthquake resistance) contribute to increased costs. In addition, Japanese utilities used to rely on a limited number of suppliers and only recently have been actively encouraging foreign participation in their equipment procurement tenders. Very high technical standards for equipment compared with other countries force prices up and limit the number of competitors.

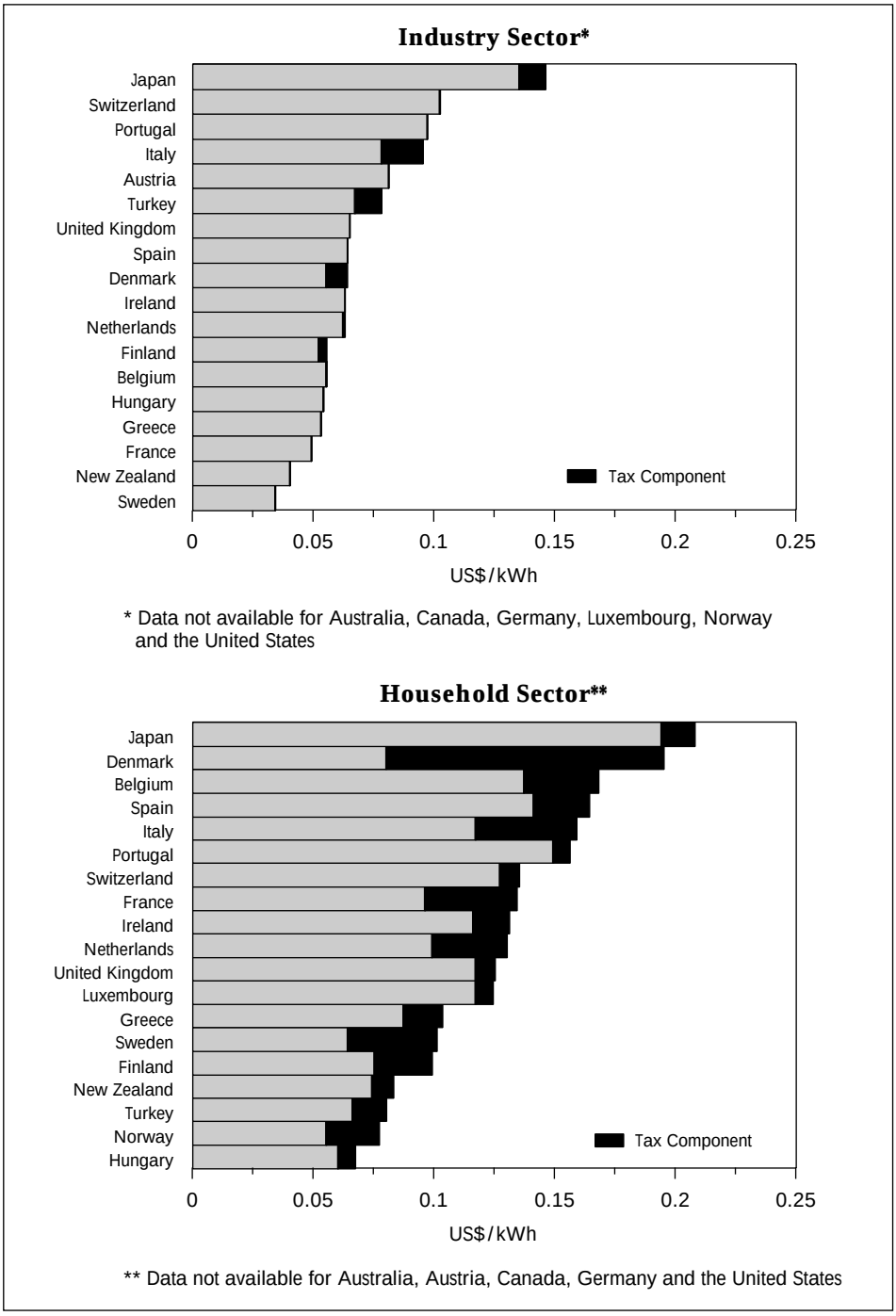
- High fuel costs: Japanese utilities pay 20% more for oil than the OECD average and 80% more for coal. Natural gas costs are also much higher than in many OECD countries. Customs duties on oil, revenues from which go towards restructuring of the coal industry, contribute to high oil costs. Oil costs would be even higher except a number of Japanese oil-fired plants are capable of burning heavy sweet crude oil, at a saving of approximately 50% over heavy fuel oil. High coal costs are partly attributable to the use of the highest quality, lowest sulphur coal to meet environmental standards, to technical requirements for Japanese utility boilers and to the use of long-term contracts incorporating price premia for security of supply purposes. Natural gas costs are higher because of the necessity to import gas as liquefied natural gas (LNG) and because of taxes. The costs associated with LNG means that natural gas prices are much higher than natural gas prices in OECD countries that use pipeline gas.

- High transmission and distribution costs: Costs for transmission and distribution infrastructure are high because of high land costs, mountainous terrain, the remote siting of new power stations, very high construction standards to withstand earthquakes and typhoons, and very high operating standards.

- Additional regulatory costs: Japanese environmental regulations are quite strict. As a result, nearly all coal-fired and most oil-fired power stations have equipment to greatly reduce SO_x emissions (through flue gas desulphurisation). The majority of coal-fired plants also have advanced NO_x removal technologies (principally selective catalytic reduction). The Air Pollution Control Law allows local government to set even stricter limits still, resulting in additional utility expenditures. For example, despite the use of advanced SO_x emissions control equipment, utilities still use coal and oil with lower sulphur content.

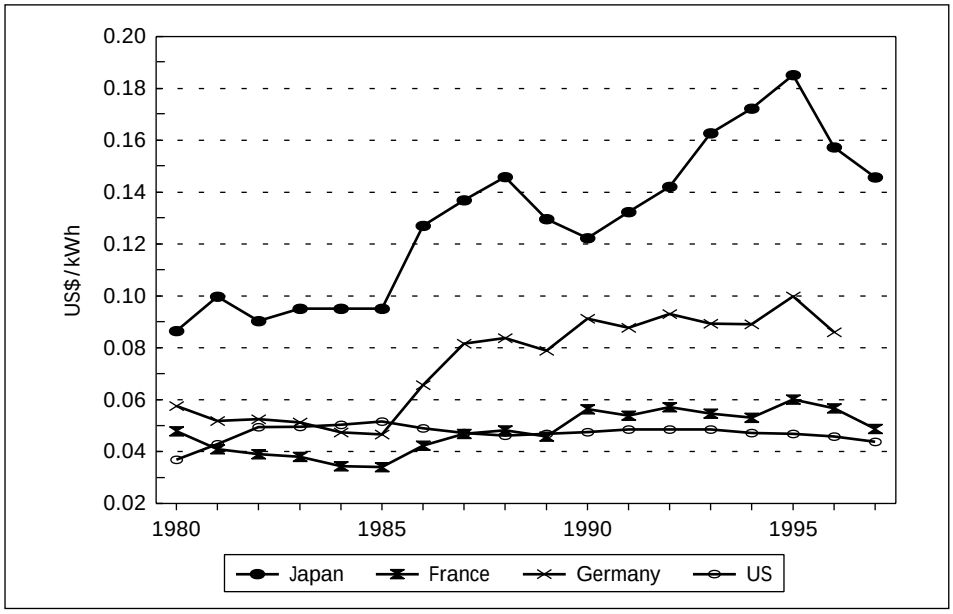
  Regulations regarding maintenance of power plants are highly prescriptive. For example, nuclear plants are required to have a refuelling outage every 13 months, although longer fuel cycles have been proven to be both safe and feasible. Government regulations also require natural gas turbines to be

Figure 20
Electricity Prices in IEA Countries, 1997



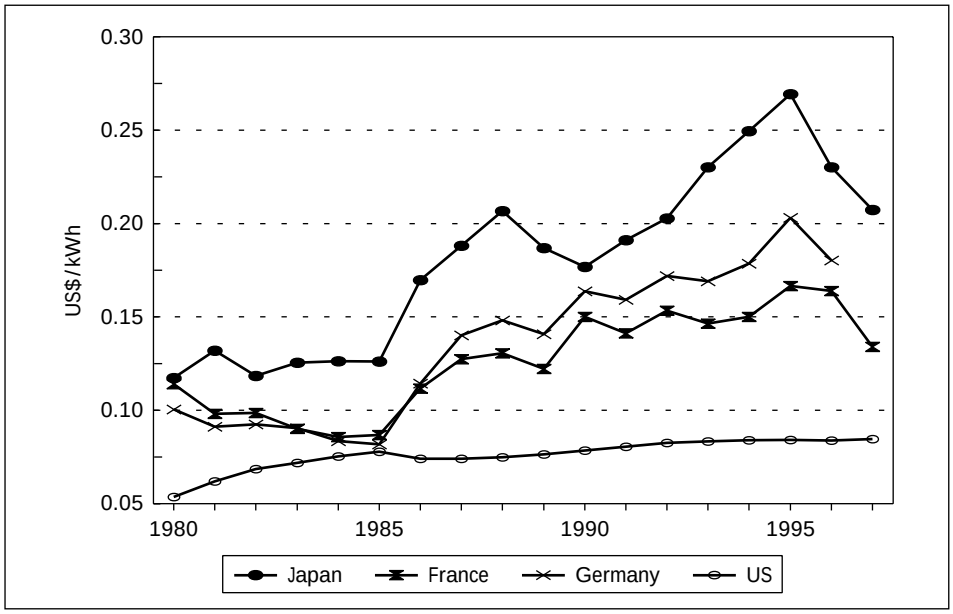
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 21
Electricity Prices in the Industry Sector, 1980-1997



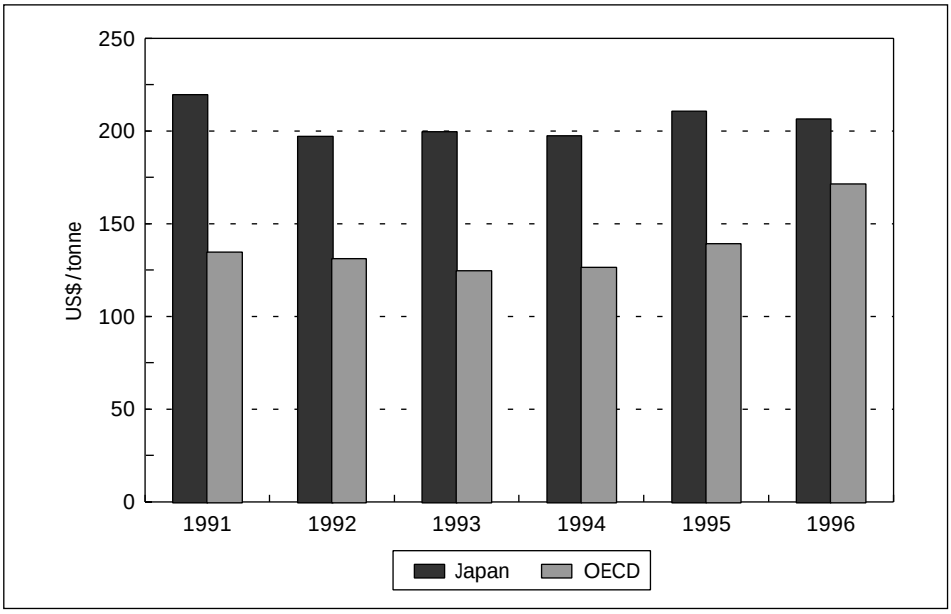
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 22
Electricity Prices in the Household Sector, 1980-1997



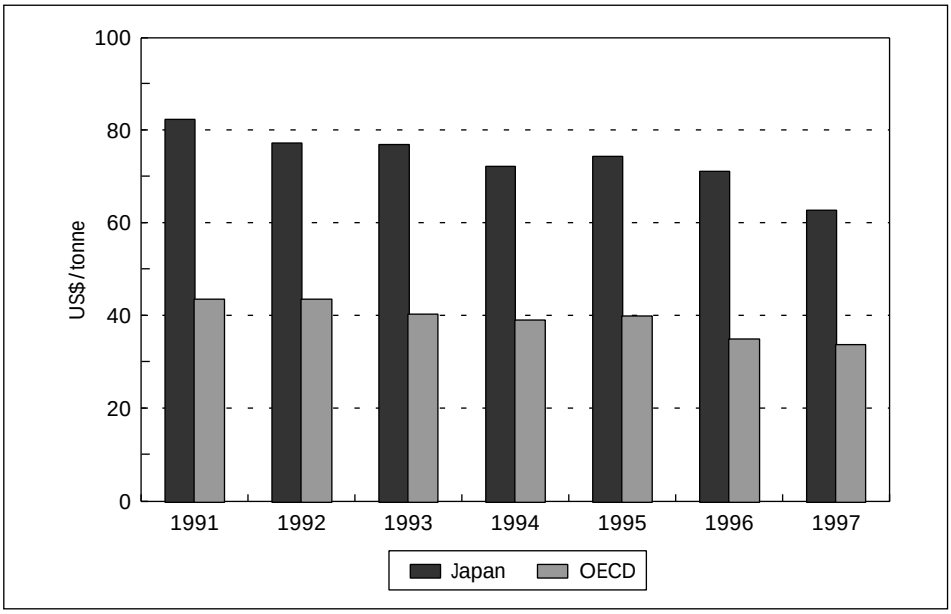
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 23
Heavy Fuel Oil Costs for Power Generation (Japan versus OECD)



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 24
Coal Costs for Power Generation (Japan versus OECD)



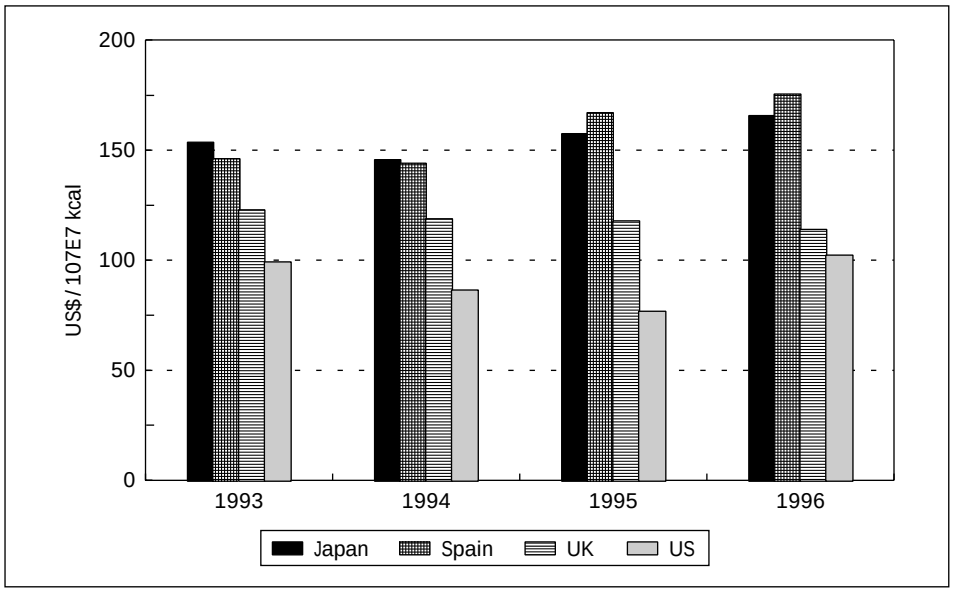
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

completely disassembled for inspection every 30 months – a requirement not duplicated elsewhere and not recommended by the manufacturer.

- Low load factor: The load factor in Japan (the ratio of average electricity demand to the annual peak demand) is extremely low in comparison with other industrialised countries, principally because of air-conditioning use. Additional generation, transmission and distribution capacity has been constructed to meet the increasing peak demand. Each 1% decrease in the load factor increases costs of service by approximately 1%.

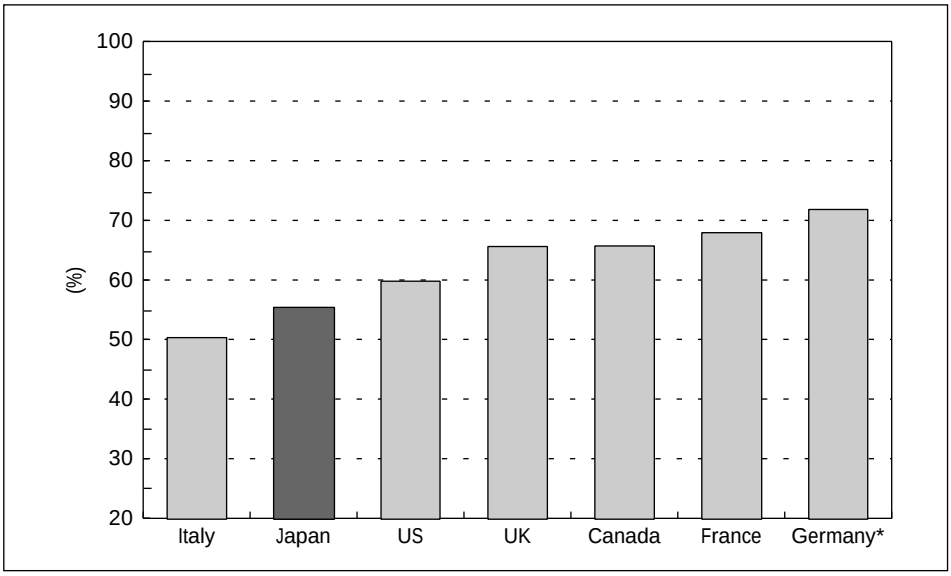
- Tax and purchase of domestic coal: Subsidies for power development, primarily funds paid to communities near new power plants for regional development, are recovered through a special electricity power development tax of ¥0.445 per kWh (1998 budget for subsidies was ¥224 billion). The remainder of tax revenue from this source (¥238 billion) goes towards measures for development and diffusion of alternative energy to oil. Electric utilities are also committed to purchasing domestic coal (4.25 million tonnes in 1997, about 10% of total utility requirements) at a price approximately three times the imported coal price. Domestic coal prices were recently cut to ¥15 800 per tonne, with a commitment to cut prices a further ¥1 800 per tonne by FY 2001. This compares to imported coal prices of approximately ¥5 500 per tonne. The cost premium (¥69.8 billion in FY 1996) is shared among all the utilities, although the coal is actually used by only three general utilities and three wholesale utilities. The utilities also purchase power above cost from renewable sources, although the amounts involved here are quite small.

Figure 25
Natural Gas Costs for Power Generation (Japan versus selected countries)



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 26
International Comparison of Annual Load Factor, 1995



* Old Laender
Source: Federation of Electric Power Companies.

Costs per kWh have changed little since 1990 despite significant growth in electricity demand, and reductions in interest rates and fuel costs. These factors have been nearly entirely offset by increases in personnel and maintenance costs as well as higher depreciation costs from new plants coming into service (Table 10).

Table 10
Average Costs per Kilowatt-hour Generated at 10 Japanese Utilities, 1990 versus 1996

Average Costs (¥ per kWh)	*1990*	*1996*
Personnel	2.06	2.21
Fuel	3.83	2.58
Repair and Maintenance	2.11	2.40
Interest Charges	2.29	1.80
Depreciation	3.11	3.77
Taxes	1.69	1.72
Other (mainly power purchases)	4.45	4.93
Total	**19.55**	**19.41**

Source: Derived from information in *Electric Power Industry in Japan 1997/98*, Japan Electric Power Information Center,Tokyo, 1997.

REGULATION AND REGULATORY CHANGE

The electricity sector is regulated by the Ministry of International Trade and Industry (MITI). Within MITI, the Agency of Natural Resources and Energy oversees the sector.

Electric Utilities Industry Law and 1995 Amendments

The Electric Utilities Industry Law is the main legislation governing the electricity industry. There are also a variety of MITI ordinances. The law makes clear the central role played by MITI in developing the structure of the industry (as regards entry, exit and expansion), the co-ordination of utilities, and the regulation of tariffs.

Regulation under the Electric Utilities Industry Law follows a form relatively common in Japan[11], in which entry into a sector is restricted so that supply and demand are balanced. The law defines three main types of businesses in the electricity industry: the general electric utility supply business (general EUSB), the wholesale EUSB, and the special EUSB. MITI issues permits for these businesses. For MITI to issue a permit, there must be demand for the service; in the case of a general or a wholesale EUSB, the new business "must be necessary and appropriate for the comprehensive and rational development of the EUSB or otherwise for the promotion of the public interests"; in the case of a special EUSB, the new business must not harm the interests of electricity consumers in the general EUSB's service area and it must be "appropriate in view of the public interests." Permission from MITI is also needed to exit; permission is granted if the exit does not impair public interests. Entry into non-utility business activities by the utilities requires the permission of the MITI Minister.

No new general EUSB have been created since 1951 (with the exception of Okinawa). One special EUSB (which serves a few large customers within a general utility's area) has been created.

If a general EUSB wishes to supply outside its service area, it needs the permission of MITI. MITI will not grant permission unless, *inter alia*, such supply would "not be easy to accomplish and not apposite to undertake" for the general EUSB in whose area the supply is to be made. Conversely, a general EUSB cannot, without good reason, refuse to supply electricity in its own service area.

A key part of the 1995 amendments to the Electric Utilities Industry Law was to liberalise entry rules for independent power producers (IPPs), i.e., independent generators which sell power to the utilities. IPPs are no longer required to get a permit from MITI to enter the generating business (although they are expected to sign a contract of at least 10 years' duration). Utilities have been required to

11. See *OECD Regulatory Reform Review of Japan*, Chapter 3, OECD Paris, 1999.

conduct tenders to meet additional thermal power needs that would arise within a seven-year period. Two sets of tenders have been conducted to date (see section on the Impact of the 1995 Amendments).

MITI has decided to open the bidding system still wider in 1999, and plans to allow, barring a significant change, both utilities and IPPs to bid for thermal power plants coming on stream in 2008 and beyond. The amount of capacity to be tendered will be set by the utility as part of its normal planning process. The bidding process will be overseen by a neutral party. The utilities will be required to implement separate accounting for bidding on new plants.

In addition, the 1995 amendments simplified approvals for specified supply by the autoproducers.

Grid Access Regulation

The Electric Utilities Industry Law requires designated utilities to notify tariffs to MITI. MITI can order transfer supply[12] if it is refused without good reason. MITI must approve tariffs and other conditions for back-up power supply to a special EUSB, and can impose tariffs and other conditions if a general EUSB and a special EUSB cannot negotiate an agreement.

Tariff and Profit Regulation

Standard tariffs and other conditions of supply must be approved by MITI. In order to be approved, the tariff "for supply of electricity shall be the sum of the fair and proper cost of electricity and the fair and proper profits under efficient management". Also, "there shall be no discrimination against specific persons." If, because of social or economic changes, the tariffs and conditions for the supply of electricity have become unfair and improper to the extent that advancement of public interests is thereby impeded, MITI may order the EUSB or wholesale supplier to submit an application for a change in the tariffs or conditions.

Utilities are permitted to offer optional tariffs to contribute to the efficient use of facilities. Interruptible supply contracts for large consumers and time-of-use rates have both been offered to contribute to load levelling.

The basic regulatory scheme for the Japanese electricity sector is rate of return. As of September 1998, the regulated rate of return on capital was set at 4.4%; by contrast, the rate of return on government debt at that time was under 1%. The asset price is based on a MITI assessment. MITI sets out the accounting system to be used by electric utilities.

12. Transfer supply allows a customer who generates power at one site to use a utility's transmission lines to transfer the supply for use by the same customer at another site. Also known as self-wheeling.

The 1995 amendments adjusted the rate of return approach to allow slightly augmented incentives to reduce costs. These incentives are called "yardsticks" because they rely, in small part, on comparisons among the utilities. The current rate regulation process is summarised in the box below. The net impact of the latest yardstick assessment was to reduce utility revenues by 0.6% from what they would have been absent the yardstick aspect.

Process of Price Regulation in Japan

Electric utilities file a rate application that sets out:

Costs (all operating and financial expenses) related to utility operations.

An estimate of a fair rate of return on capital.

Revenue requirement (the sum of the first two items less certain other revenues such as sales to other utilities).

An allocation of costs into rates which sets out rates according to voltage (and appears to show different costs attributed to different power facilities). Customer classes are:

- extra high voltage (> 20 kV)
- high voltage (6 to 20 kV)
- low voltage (under 6 kV, i.e., business)
- lighting (i.e., residential demand for any use).

Standard consumer rates vary by voltage, but not by location. (Homogeneity across location is imposed to meet the policy objective of fairness.) Optional time-of-use rate packages are offered to customers but are not regulated *per se*.

MITI holds public hearings. The yardstick assessment involves comparing the utility to its own past performance and to the performance of the other utilities, on the basis of three categories (generation; transmission, transformation, and distribution; and general administration) where the costs compared are those over which the utility is considered to have control. For each category, the range of costs is calculated. For each category, the costs for each utility determine whether it is in the bottom third of the range, middle third, or upper third. Those utilities in the bottom third, i.e., among the most efficient or most improved, are allowed to receive revenues equal to the value of their costs in that category. Those utilities in the middle third are allowed to receive revenues equal to 99% of the value of their costs in that category. Those utilities in the top third, i.e., among the least efficient or least improved, are allowed to receive revenues equal to 98% of the value of their costs in that category. Rankings are published.

A fuel cost adjustment mechanism passes on most, but not all, changes in fuel costs to customers. Changes in average fuel costs exceeding 5% are reflected in prices. The mechanism ensures that customers benefit from falling fuel prices but, because it shifts the majority of the risk of changing fuel prices on to customers, it reduces direct incentives for utilities to manage their fuel costs.

System Security Regulation

Supply reliability is also regulated by MITI. Ministry ordinances set power quality standards (voltage and frequency). MITI can order utilities to improve facilities if service quality to customers is impaired.

Each utility submits an annual ten-year plan to MITI regarding electricity supply, and the installation and operation of facilities. MITI may, if the plan is "not proper and apposite for promoting rational and integral development of the electric utility supply business through ... wide-area operations, recommend the designated electric utility supply business operator to change or alter the plan." In the case of non-compliance with its recommendations, MITI may order utilities to supply, transfer, or receive electricity or to loan, borrow or share electrical facilities.

Technical Regulation

MITI is also responsible for the safety and technical regulations of electrical appliances and facilities, nuclear fuel, boilers and pressure vessels. Delays arising from inspection of new generating plants before commencing operation have been a major concern of the utilities. The 1995 amendments reduced requirements for these inspections, but remain more strict than most other OECD countries, resulting in longer outages at power plants.

Impact of the 1995 Amendments

The 1995 amendments to the Electric Utilities Industry Law have brought the entry of IPPs to supply the utilities. Two sets of tenders have been conducted to date. The average quantity of capacity bid exceeded the average quantity tendered at least fourfold. The prices of successful bidders were between 10 and 40% less than the "upper limit prices" calculated by the utilities, averaging almost 30% lower. The successful IPP bids total about 3% of all installed capacity and about 19% of all capacity outside the major utilities (including EPDC as described above). The summary of the IPP projects accepted by fuel is given in Table 11.

Average prices in the second set of tenders were 25 to 40% lower than upper limit prices[13]. According to MITI, there is a total 40-50 GW potential available, with the lower estimate taking into account environmental constraints and other constraints

13. Based on information provided by Nippon Steel.

Table 11
IPPs by Fuel (Successful Bids from 1996 and 1997 Tenders)

Fuel	*Number of Projects*	*Capacity (MW)*	*Share (%)*
Coal	13	2 844	46
Oil	17	2 425	39
Gas	5	842	14
Other	1	55	1
Total	**36**	**6 165**	**100**

(water for generation and fuel supply). The upper estimate, about 25% of the existing capacity of the utilities, is large enough to account for most of the forecast increase in power demand between 1998 and 2010. The actual need for capacity could be considerably reduced if Japan is successful at increasing its load factor to a level comparable with other IEA countries.

The majority of capacity bid and the potential for new IPP capacity is coming from the steel industry (mostly coal-fired generation) and the petroleum refining industry (oil-fired generation). A number of these industrial companies are already autoproducers of electricity. Both industries have idle industrial land available and relatively easy access to fuel sources, allowing them to overcome two major hurdles with building new generating plants and bringing them on-line quickly. The lengthy time needed to obtain approval and construct coal-fired green-field plants (10 years or more) gives these companies an advantage over utilities using greenfield sites.

Unlike most countries with IPPs, new gas-fired development plays a relatively limited role. Of the 36 successful IPP projects to date, only five use natural gas. The high cost of liquefied natural gas in Japan is a major factor. Also, at present, there is no third party access to LNG terminals in Japan. Furthermore, there is no instance to date of an electric utility, each of whom owns at least part of an LNG terminal, selling natural gas to an IPP.

The success of coal and oil-fired capacity in the bidding has raised concerns at the Environment Agency, who suggest that the IPP policy could raise Japan's CO_2 emissions by 1%. Emissions from IPPs are as high as 0.225 tonnes of carbon per MWh versus an average of 0.098 tonnes of carbon per MWh for utility plants (with the current fuel mix)[14]. MITI plans to ask the utilities to treat lower CO_2 emitting plant more favourably than coal, perhaps by limiting the tender to certain kinds of fuels or requiring them to consider fuels in evaluating future bids.

14. Based on Environmental Agency information reported in *International Environment Reporter*, 154, v. 21, no.4, 1998.

Barring any remarkable changes, MITI is planning to allow both utilities and IPPs to bid, commencing in 1999, for all thermal power plants coming on stream in FY 2008 and beyond. The utilities believe that they can compete with IPPs partly through repowering existing plants, e.g., with combined cycle, to avoid the high costs of greenfield projects.

Another source of entry into generation is by industrial users, who build power plants either separately or as a joint venture with an electric utility.

Special electricity supply businesses are power utilities created to supply specified customers rather than offer general public service. In June 1997, Suwa Energy Service Company became the first firm to obtain a licence from MITI as a special electricity supplier. The company was formed by Suwa Gas Company, a regional city gas company, to supply a hospital and retirement homes in a limited area with both electricity and heat produced by a cogeneration facility. The facility will open in February 1999 with a capacity of 3 MW. Other companies that plan to become special suppliers include East Japan Railway Co., Toyota Motor Corporation, and Tokyo Gas Co., Ltd.

Competition Law

Competition law enforcement can protect competition in the new markets created by electricity sector liberalisation. The Japan Fair Trade Commission's (FTC) principal statute, the Anti-monopoly Act, prohibits unreasonable restraints of trade, "private monopolisation" and monopoly, as well as unfair practises and anti-competitive mergers. The FTC has substantial associated powers to enforce these prohibitions, including powers to investigate and prosecute violations, which can lead to fines or even imprisonment.

While the FTC might appear to have both the scope and the powers to police anti-competitive behaviour in the electricity sector, Section 21 of the Act appears to exempt electric utility services as an example of a natural monopoly. The FTC's involvement to date has been limited to the role of competition advocate, reviewing and commenting on electricity competition issues with the assistance of study groups, and generally favouring market reforms and particularly the amendment of Section 21.

Subsidies

The Government is financially involved in the electricity sector in a number of ways. It is a direct owner of two-thirds of EPDC and of part of Japan Atomic Power Company (JAPC). The Government is financially indirectly involved in the electricity sector through its involvement in fuels, notably in support of nuclear generation and coal-fired generation (through support of the domestic coal

industry). The Japan Development Bank has historically provided utilities with low-interest loans for power generation, particularly from non-oil fuels; its loans total about 6% of power sector investment. The bank's policy to offer low-interest loans has now been extended to independent power producers, who can receive low-interest loans to cover up to 50% of their investment.

The Electric Power Development Company (EPDC) was created to assist in power development, and has since played a leading role in investment in leading edge power generation technologies such as "clean coal" generation facilities. Sixty percent of EPDC's capacity is hydroelectric, of which 60% is pumped storage, but more than two-thirds of its energy sales come from coal-fired generation. The average capacity factor for hydroelectric (excluding pumped storage) was 30% in FY 1997[15]. Since the price of electricity during peak times would be much higher than the average price, if peakload pricing were instituted, EPDC's hydroelectric facilities may be quite valuable. However, EPDC currently sells its hydroelectric energy at cost, which is less than ¥9 per kWh (excluding pumped storage), through long-term agreements with the nine utilities. This is far less than the estimated cost of new peaking facilities of ¥32 per kWh. Currently the excess rents of this low-cost high-value energy accrues to customers in the form of lower rates. However, if generation is liberalised, the utilities, rather than the customers, will enjoy these benefits.

ADVISORY BODIES

There are several advisory or policy institutions of interest. The Electric Utility Industry Council is a consultative body created by statute in MITI to "investigate and deliberate on important matters" relevant to the sector. The Council investigates and deliberates at the request of the MITI Minister, and sends recommendations to which the Minister must give due consideration. The recommendations of the Council usually become government policy. The Council is composed of presidents of the electric utilities, power equipment suppliers, large users of electric power, academics, journalists, small business owners and household consumers.

The Committee on Basic Policy, a body within the Electric Utility Industry Council, was established in response to the Government's Action Plan for Economic Structure Reform to deal specifically with current reforms. The Committee was established to advise on the following question: "How best should the electricity supply industry be organised in the future to realise internationally comparable levels in electricity prices by the year 2001, and to establish the foundation for reducing our country's electricity costs on a medium- to long-term basis?". The Committee returned an interim report in May 1998 and made further recommendations in December 1998.

The Electric Power Development Coordination Council (EPDCC), chaired by the Prime Minister, settles annual electric power development plans, which identify

15. Implying that hydro facilities are used mainly for peaking or midload operation.

planned facilities developments over the following 10 years. Utilities must also obtain agreement from the prefectoral governor before commencing construction. The Electric Power Source Siting Committee (composed of several ministers, academics, and representatives from industry) was formed in 1993 to advise the Prime Minister on the suitability of proposed sites.

The Administrative Reform Committee, reporting to Office of the Prime Minister, is responsible for developing policy recommendations and monitoring progress on broader structural reforms to the Japanese economy. The Committee is a driving force behind the Government's programme for structural reform: its recommendations have shaped the *Program on Economic Structure Reform* adopted by the Government in December 1996 and the *Action Plan for Economic Structure Reform* of May 1997. The Action Plan identified the pursuit of enhanced efficiency through competition as a basic principle for reform in the electric power sector. The Committee recently indicated that it will review reforms in the electric power sector with the intention of proposing more long-term reforms in March 1999.

THE CURRENT STATUS OF REGULATORY REFORM

The interim report of May 1998 produced by the Committee on Basic Policy of the Electric Utility Industry Council recommended partial liberalisation of retail supply, which means allowing only some customers to choose suppliers while the rest would remain customers of their utilities exclusively (i.e., captive customers). The report ruled out full liberalisation and the introduction of a pool market as inappropriate and premature for the time being. The Committee decided that it would further study a system of partial liberalisation with the objective of presenting recommendations to the full Council in December 1998. The study made recommendations on partial liberalisation, within the three constraints of:

- Ensuring maximum management autonomy and minimising administrative intervention.
- Guaranteeing equal and effective competition.
- Spreading the results of efficiency to all users and that partial liberalisation not adversely affect users to which such liberalisation does not apply.

The report of the Committee and of the Council in December 1998 is expected to form the basis of future amendments to the Electric Utilities Industry Law in 1999.

CRITIQUE

The variety of policy goals and objectives in Japan with respect to the electricity sector presents a challenge both for the traditional form of regulation in the sector and for reforming that regulation. One of these challenges is the harmonisation of the three goals of energy security, environmental protection and economic growth.

An emphasised element in economic growth is the target of internationally comparable prices by 2001, which is very ambitious in light of the exogenous factors which contribute to high costs in Japan, including high fuel and siting costs.

Tendering for IPPs

The 1995 amendments to the Electricity Utilities Industry Law have begun a process of change in the Japanese electricity sector. The tendering for new "thermal" capacity, which the amendments enabled, was very important in revealing the extent of potential lower costs in generation.

The decision that tendering for new thermal capacity will be opened up to all bidders, including utilities, is a logical step forward. Care will need to be taken, however, to ensure that utilities do not subsidise this activity from their regulated activities. Where an IPP is selling only peaking energy to the utility, the IPP should be able to sell power at other times to other customers. Access to fuels, particularly to natural gas, is a vital factor in establishing IPPs. Third party access to the LNG terminals may be one way of introducing competition and may lower the cost of natural gas, thereby increasing the number of IPPs using natural gas.

Contracted IPP capacity represents only 10% of all new capacity scheduled to come into service over the next several years, and the tendering process, in and of itself, will not be enough to meet the Government's objective of reducing power costs to internationally competitive levels by 2001. Therefore, moving beyond this tendering process to a partial retail liberalisation is a necessary step.

Price Regulation

The present mechanism based on rate of return, even with a yardstick approach for setting the rate, gives utilities very limited incentives to reduce their costs, as nearly all cost savings are passed on to customers. While partial liberalisation of retail supply can be expected to provide some competitive pressure to reduce generation costs, there will be no corresponding pressure to reduce network costs. Furthermore, there are no competitive pressures on utilities to reduce supply costs for captive customers by purchasing power from other utilities or from IPPs.

Other forms of yardstick regulation do provide a stronger incentive for a utility to reduce costs, particularly regulation that makes a more direct link between one utility's regulated maximum price and other utilities' costs. This form of regulation allows more of a utility's cost savings to be retained in the form of greater profits and thus provides greater incentives for a utility to be cost efficient.

Similarly, the fuel-cost adjustment mechanism, while it ensures that customers obtain the benefits of a fall in fuel prices, reduces the incentive for the utility to

reduce fuel costs, by changing fuel purchase strategies. The Government should consider whether to modify the mechanism to provide the utility with stronger incentives to reduce fuel costs.

Tariff Reform Reflecting Time of Use

Although the load factor continues to deteriorate, the high cost of producing electricity at peak periods has not been reflected in prices, except through a variety of optional programmes. Over 170 optional programmes have been developed, but they have affected less than 10% of contracted capacity. At the same time, substantial pumped-storage hydroelectric capability continues to be developed to increase capacity at peak periods. Peaking capacity for power generation is very costly. TEPCO estimates the avoided costs of peaking capacity at ¥32 per kWh or triple the cost of base load power. Changing standard tariffs to reflect costs by time of use could reduce peak load significantly over time, saving Japanese electricity consumers billions of yen, and reducing the need for additional peak capacity. Implementation of this reform can be phased in, beginning with larger customers. As the cost of time-of-use metering is falling, it will become more economic for it to be used by smaller and less price sensitive customers.

A reform based on pricing by time of use is also needed for the utility services required by IPPs and liberalised customers. At present, back-up power is charged as a premium to ordinary rates, and wheeling (transfer supply) charges are a flat rate per kWh transmitted. These approaches are too simple to capture the costs which vary by time of use. Under partial liberalisation, large industrial customers purchasing power from IPPs, who have a flatter demand than commercial or residential customers, may actually be paying more for network services than the costs they are incurring. Tariffs for these services should also reflect time of use to ensure that the costs for transmission, distribution and ancillary services such as backup supply are fully recovered from each customer segment.

Partial Liberalisation

It is expected that Japan will partially liberalise retail supply, while at the same time broadening tendering so that it includes not only IPPs but also utilities. Clearly, these changes will need to be accompanied by a variety of changes in regulation of the utilities in order to prevent cross-subsidies from regulated activities to competitive activities, and to ensure cost-reflective, non-discriminatory access by third parties to transmission and ancillary services.

The decision to move forward with partial liberalisation of retail supply shows that the Government recognises the need for reform. The move will provide valuable information about the ability to operate the Japanese network with an increased number of participants. It may bring the benefits of lower generating costs to major

industrial consumers and may provide some information for further steps in liberalisation. This is an important step for Japan to take towards international comparability in electricity prices, consistent with its other major goals of energy security and environmental protection.

Partial liberalisation of retail supply means that certain customers may purchase power at a negotiated price from their local utility, from another utility or from an IPP. This means:

- such prices will no longer be set by regulated tariffs (except for network services) but through negotiation with the customer;
- these customers will have a choice of suppliers: their local utility, other neighbouring utilities and IPPs;
- these customers would, in principle, be able to contract for a variety of terms, not just 10-15 years as required by the current agreements between IPPs and utilities;
- the customers contracting with other suppliers could manage their risks with respect to their supplier (in effect managing their own security of supply) provided that they still have access to back-up power at a cost-reflective price.

Partial liberalisation of retail supply requires a series of interlocking changes to ensure that the liberalisation has the intended effects:

- access to transmission and ancillary services (including backup) needs to be cost-reflective, economically efficient, and non-discriminatory in tariffs, terms and conditions;
- regulation is needed to avoid the cross-subsidisation of competitive activities of utilities by their regulated activities, and to encourage efficient use of system services;
- competition enforcement is needed to curb anti-competitive behaviour;
- liberalisation of generation would mean that generators, including the utilities, IPPs and new entrants, are free to compete for liberalised customers.

Under partial retail liberalisation, utilities will continue to be responsible for the long-term security of supply of their captive customers. Customers in the liberalised market could become responsible for their own long-term supply security through contracts. Short-term supply security will be provided by the utilities through their network services.

Transmission and Ancillary Services

Transmission and ancillary services must be accessible at tariffs that reflect costs and that are non-discriminatory, in order to ensure that independent generators can

compete with the utilities to supply to liberalised end-users. For liberalised customers and IPPs, efficient pricing of the use of network services is the key to ensuring efficient use and augmentation of the transmission network. The Japanese electricity system, despite its high reliability, is heavily constrained with respect to its transmission network. While a vertically integrated utility has no need to price transmission separately for its own use, IPPs and liberalised customers use only a part of the services provided by a vertically integrated utility, e.g., the transmission network, making such pricing necessary.

Investments in Nuclear Plants

The Government of Japan has identified increased investment in nuclear power as important to meeting its energy security goals and greenhouse gas emission objectives. Utilities will continue to require assurances that they will be able to recover costs from investments in new nuclear plants. A cost recovery mechanism will continue to be required for any excess costs associated with renewable energy and, possibly, with nuclear power.

If economic incentives are insufficient in promoting investment, one option would be to guarantee that a share of the demand is met by nuclear-generated electricity. This could be accomplished by requiring all customers to purchase a portion of their supplies from nuclear-generated power. The nuclear share would be set by the Government. It could be made consistent with the expected contribution by nuclear power to meeting the Kyoto target. In effect, this would create two markets, a market for non-nuclear power generation and a separate market for nuclear-generated power.

A market for nuclear-generated power would assure utilities that there would be a market for the power generated from their nuclear power plant investments. In conjunction with the liberalisation of retail supply, this market would encourage utilities to compete with one another to supply this nuclear power in the most cost-efficient way. For example, they could either increase output from existing plants, or build more efficient new plants. The Netherlands has recently passed legislation that introduces a system to guarantee that a specific share of total electricity is generated by renewable fuels. Such a system may be useful for Japan to study.

Eligibility of Consumers

The issue of customer eligibility is crucial to partial retail liberalisation. In Japan's case it would be administratively convenient if, at the first stage, liberalised customers were limited to "extra high voltage" customers, i.e., industrial and commercial customers taking power at 20 kV or above. Delivery costs for these customers are already disaggregated as part of the regulatory process. They would constitute a 28% share of energy sales of the utilities, already a significant step.

Alternatively, eligibility could be based on the equivalent annual consumption level. This consumption level could be set so that eligible customers included all customers in the extra high voltage category as well as customers with multiple

sites whose aggregated annual consumption exceeds a certain level. It could also include groups of small and medium companies, if they decide to purchase electricity jointly. Allowing groups of customers to participate could provide valuable experience to both customers and utilities, despite being more demanding from an administrative point of view. Hence, the Government should encourage the utilities to implement, on a voluntary basis, a programme that would allow such aggregation.

Regulatory Institutions

Changing the structure of a network-based industry such as electricity from a monopoly to a competitive market requires a sophisticated regulatory structure. A market environment requires regulatory institutions that make decisions that are neutral, transparent, and not subject to day-to-day political pressures. The new environment will increase the responsibilities of the regulator. In addition to regulation of tariffs to captive customers, the regulator will need to ensure non-discriminatory access conditions and economically rational pricing for those services (such as transmission and ancillary services) that are used by IPPs and large users. The regulator will need to ensure that there is not cross-subsidy from regulated to competitive businesses. Either the competition authority or the regulator will need to prevent anti-competitive behaviour.

In order to make fair and reasonably predictable decisions, the regulator must have analytical expertise and not rely on the expertise of the regulated utilities. The regulator must also be functionally separate from policy-making and from electricity industry promotion functions in order to maintain a neutral regulatory regime. To be seen to be fair, the regulator should have well-defined obligations for transparency, notably with respect to its decision-making processes and information on which the decisions are made. Further, the objectives of the regulator must be clearly stated, more specifically than, for example, "the public interest" and progress towards these objectives should be monitored. Finally, the powers of the regulator should be clearly stated. The combination of transparencies of objectives, powers, processes, decisions, and information, gives the public clear performance criteria to evaluate the extent to which the regulator is fulfilling its role.

The utilities' behaviour in a partially liberalised market should be made subject to the Anti-monopoly Act. This act should be amended to make it clear that it also applies to the electricity sector. The precise areas of joint or primary responsibility of the regulator and of the Fair Trade Commission (FTC) should be specified, after due consideration of the institutions' legal bases, objectives, powers, degrees of transparency, and expertise. A possible division of responsibility is for areas where the FTC has expertise (such as with mergers and unfair practices, including market power abuse) to remain within its jurisdiction, while network regulation, including prices and terms and conditions of access, would be the responsibility of the sector regulator. Each institution should exercise its powers in consultation with the other institution. The FTC thus would continue and increase its role as an independent institution.

To provide a solid basis for market regulation, many countries have established or are examining the establishment of "independent" regulatory bodies to regulate electricity after reform. For example, Australia, Finland, Italy, Norway, the Netherlands, Spain, Sweden, the United Kingdom and the United States use an independent electricity regulator. Germany and New Zealand use the competition authority to regulate electricity[16]. While specific arrangements differ in each country, to meet their specific situations, the essential features of independent regulation are: complete independence from the regulated companies; a legal mandate that provides for separating the regulators and the regulatory body from political control; a degree of organisational autonomy; well-defined obligations for transparency (e.g., publishing decisions) and for accountability (e.g., appealable decisions, public scrutiny of expenditures).

The current policy of the Japanese Government is to have MITI remain the electricity sector regulator, with regulatory activities kept separate from the policy-making activities. However, at present, safeguards from political pressures that would instill market confidence are limited. Transparency needs to be ensured to regulate a competitive market in an open and fair manner. Significant reform of the institutional arrangements is needed to support partial liberalisation of retail supply.

The role of the Electric Power Development Coordination Council in deliberating fossil fuel utility generation projects should be reconsidered after the schemes of partial liberalisation and expansion of IPP bidding are established so that IPP and competitive utility projects are on equal footing.

Competition in Generation

Reform in the electricity sector should enhance efficiency through competition in generation and retail supply. Developing competition in generation is the main purpose of reform of the sector.

Effective competition in generation requires several elements:

- non-discriminatory access, including economically rational pricing, to the transmission grid and provision of ancillary services;
- sufficient grid capacity to support trade;
- electricity industry law and competition law and policy that effectively prevent anti-competitive conduct;

16. The purpose of independent regulation is to provide participants in the relevant sector, as well as potential investors, with confidence that regulatory decisions on, for example, the network tariffs, are fair, non-discriminatory, reasonably predictable, and not subject to political pressures. These require regulation to be regarded as independent of both the regulated utilities and day-to-day political pressures. Over time, the regulatory decisions made in this way can help build the credibility and legitimacy of the regulatory regime, encourage investment, and help reforms to progress.

- a sufficient number of generation market players to give rise to competitive rivalry.

Competition in generation is enhanced by:

- low barriers of entry into generation;
- a non-discriminatory efficient market mechanism for electricity trade;
- a stranded cost recovery mechanism, if necessary, that is non-distortionary and fair;
- greater elasticity of demand with respect to price changes; and
- end-user choice, with competition to supply end-users.

Discriminatory access to the transmission grid creates two types of inefficiencies: 1) higher-cost generators may be used instead of lower-cost generators, and 2) efficient entry by generators may be discouraged. Both of these effects increase costs which could be avoided with non-discriminatory access. However, a vertically integrated utility has strong incentives to discriminate in favour of its own generating assets, providing them with preferential access to its transmission grid.

Vertical Separation

A combination of regulation and vertical separation of utilities can be used to counter discrimination in transmission access. There are trade-offs between regulation and degree of vertical separation: where there is less vertical separation, there is a need for greater regulation, and vice versa. These two policy tools can be used to reduce the incentives and the ability to discriminate. Divestiture, that is, separation of ownership of generation from transmission, eliminates incentives to discriminate. Also, the ability to discriminate can be reduced in various ways and to varying degrees by the other types of separation (see box below).

Approaches to Vertical Separation Between Transmission and Generation

OECD countries are trying various approaches to vertical separation between generation and transmission. These approaches include (ordered by degree of separation):

Accounting separation: keeping separate accounts of the generation and transmission activities within the same vertically integrated entity. In this case, a vertically integrated entity charges itself the same prices for transmission services, including ancillary services, as it does others and states separate prices for generation, transmission, and ancillary services.

Functional separation: accounting separation, plus 1) relying on the same information about its transmission system as its customers when buying and selling power and 2) separating employees involved in transmission from those involved in power sales.

Operational separation: operation of and decisions about investment in the transmission grid are the responsibility of an entity that is fully independent of the owner(s) of generation; ownership of the transmission grid remains with the owner(s) of generation.

Divestiture or ownership separation: generation and transmission are separated into distinct legal entities without significant common ownership, management, control or operations.

Different strategies for vertical separation of generation and transmission are being employed in different countries. Japan has decided to implement accounting separation, and should carry this out as quickly as possible, making sure it is effectively implemented. In many OECD countries that have restructured their publicly-owned electricity systems, the transmission business has been made a separate company – United Kingdom (England and Wales), Norway, Sweden, Spain, Hungary, Finland, most states of Australia, New Zealand. However, other countries with publicly-owned utilities, such as France, Italy and Austria, have opted for accounting separation, albeit with an independent network manager as required by the European Union Electricity Directive.

There are fewer examples of electricity reform in countries where utilities are predominantly privately owned, as in Japan. Accounting separation is used in both Germany and Scotland (United Kingdom). In the United States, federal regulators require functional separation of transmission and encourage operational separation. In certain US states that have implemented full liberalisation of retail supply, utilities have been encouraged (and in the case of Connecticut and Maine are legally required) to divest much or all of their generating capacity. As the utilities in Japan are privately owned, the Government of Japan considers that it has no legal authority to require private electric utilities operating in the ordinary circumstances to divest their property and assets. The box below discusses how accounting separation can be made to work.

Making Accounting Separation Work

Current proposals would make discrimination illegal in Japan under the Electric Utilities Industry Law. But beyond keeping separate accounts, no changes in the structure or operation of the electric utilities would be mandated in the current proposals.

Accounting separation does not require large changes in the structure of companies. Thus it can be implemented relatively quickly and, for privately owned firms, without intruding into private property issues. In order to be successful, accounting separation needs to be accompanied by appropriate regulation to ensure non-discrimination and cost-reflective pricing. The accounting information made available to the regulator must reliably detect anticompetitive or discriminatory behaviour that might occur.

Functional separation, i.e., separate business units within the same corporate structure, reduces the ability to discriminate through the separation of personnel and of information systems. This should reduce the burden of regulation designed to control discrimination. For example, functional separation reduces the ability to misuse information in an anticompetitive way, because the information systems of the two parts of the companies are distinct.

Operational separation further reduces the ability to discriminate in grid operations and grid investments by creating an organisation responsible for independent management of the system known as an independent system operator (ISO). ISOs are new institutions, with a limited operational history in institutional and legal environments very different from those of Japan. There is not yet widespread agreement on key aspects of ISOs, notably with respect to forming a governance structure that ensures non-discrimination, and a management incentive system that leads the ISO to adopt correct transmission and ancillary services pricing policies. In Japan, there would also be the problem of ensuring sufficiently deconcentrated control of an ISO, and the limited interconnection between the 50 Hz and 60 Hz areas suggests that, if operational separation were implemented, at least two ISOs would be needed for the main islands. There can be no certainty that an ISO could be put into practice in Japan and the Government of Japan consideres the concept inappropriate to Japanese circumstances.

Ownership separation, or divestiture, is intended to eliminate the incentive to discriminate, to reduce the need for regulatory oversight, and to deconcentrate markets when there are sales to multiple owners. Yet divestiture may raise issues of supply reliability because co-ordinated planning of generation and transmission investment is made more difficult. Divestiture can be either mandatory or voluntary[17].

17. Divestiture raises important issues of property rights in Japan, where electricity companies are private entities. Under the current legal system, the Government states it has no legal authority to force the private utilities to divest their assets. Thus, if some day Japan were to turn to divestiture, changes in law would be required. Further, supply reliability is important in Japan, where customers place a high value on reliability. Given the large planned increase in the number of nuclear power reactors in Japan, it is possible that divestiture would affect the ability to make these long-term investments. If divestiture causes coal and oil-fired plants to shift to base load use, the Government of Japan is concerned that there would be environmental effects. Finally, the Government of Japan is concerned that voluntary divestiture based on economic incentives may increase the price of electricity. The Government of Japan states that it does not consider requiring separation through divestiture to be a feasible option.

Competitive Rivalry in Generation

In addition to some degree of vertical separation, competitive rivalry among generators is a necessary condition for effective competition. Competitive rivalry is enhanced by the entry of IPPs selling to liberalised customers. It is also enhanced if many customers respond to liberalisation by installing their own generating capacity, using e.g. cogeneration or trigeneration[18], to displace their use of utility electricity and generate surpluses that could be sold to other customers. This can also be done as part of a district heating and cooling business. Such action, or even the credible possibility of such action, would put competitive pressure on the utility to change its prices and reduce its costs to those customers who can credibly self generate.

An alternative means of increasing competitive rivalry is to enlarge the geographic scope of the electricity market to include several utilities. For example, if all six utilities in the 60 Hz frequency zone of Japan were in a single electricity trading region, no utility would have more than 35% of the generating capacity, much less concentrated than at present. The eastern 50 Hz zone has only three utilities, with the largest, Tokyo, possessing nearly 80% of the capacity. A nation-wide power market would, in principle, reduce the dominance of the large utilities further. However, interconnections between utilities are not strong (for seven out of nine utilities, interconnection capacity is less than 25 % of peak load[19]) reducing the scope for power trading between service areas. Strengthening interconnections between utilities should be encouraged.

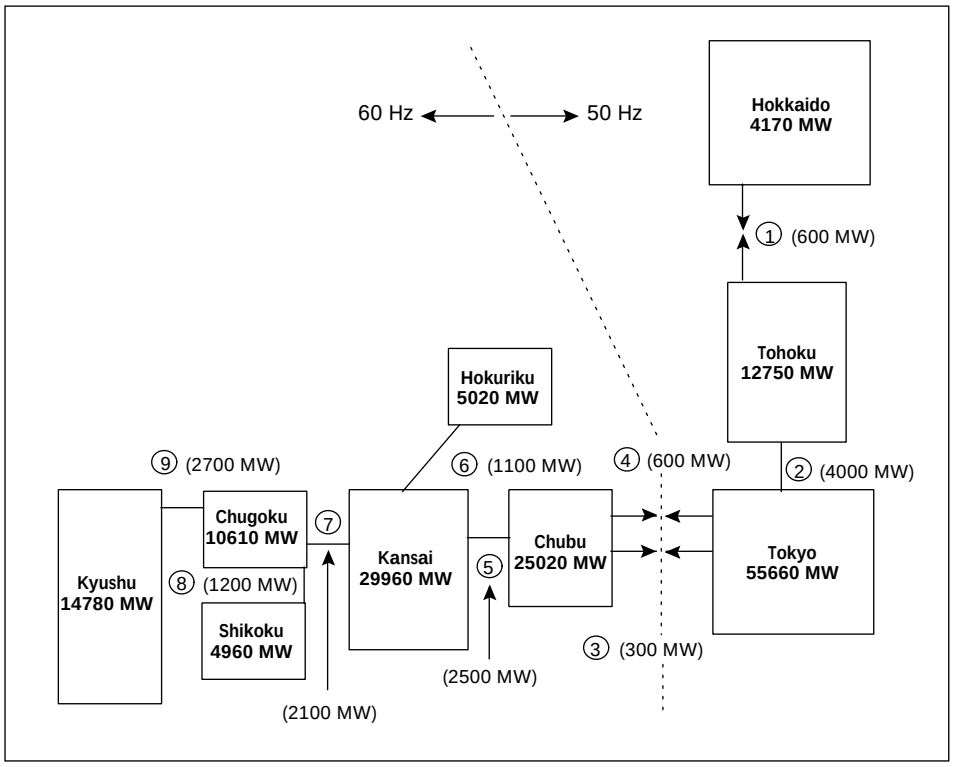
Finally, a more severe approach is to create several competing generating companies by dividing the assets of an existing large utility. In some countries where the publicly-owned electricity systems have been reformed, such as the United Kingdom (England and Wales), Australia (most states) and New Zealand, the decision has been made to divide the generating capacity of large publicly-owned utilities into several companies in order to create more effective competition. There are also instances (the United Kingdom and the United States) where privately-owned utilities have, in response to incentives, agreed to sell generating assets to address regulatory concerns about the effectiveness of competition in the electricity market. As noted above, the Government does not consider requiring such separation through divestiture to be an option for Japan.

Electricity Markets

Open transparent markets for trading electricity, combined with a legal framework which facilitates direct bilateral contracting between customers and suppliers, forge a critical link between generation competition, competition in supply and end-user choice. Even under partial retail liberalisation, power generators and

18. Cogeneration refers to the simultaneous production of both electricity and useful heat. Trigeneration refers to the simultaneous production of electricity, useful heat, and cooling.
19. Based on interconnection capacity and peak load information provided by Tokyo Electric Power Company.

Figure 27
Transmission Interconnection Capacities and Peak Loads for the Nine Utilities



Source: Tokyo Electric Power Company.

liberalised customers could encounter difficulties in ensuring that supply and demand are perfectly matched. This problem could be severe in a system such as Japan's, where transmission constraints can severely limit the physically possible trades of electricity during certain peak demand times. A limited spot "balancing" market could provide a practical means of managing such imbalances. Similarly, such balancing markets could be used to sell surplus IPP energy to utilities and liberalised customers and could be used to displace higher marginal cost resources. Appropriate governance (and, potentially, regulation) of the market would be important to ensure non-discrimination among participants, and efficiency, if balancing markets were developed.

Stranded Costs

"Stranded costs" are unamortised costs of prior investments or ongoing costs from contractual obligations, prudently incurred under a prior regulatory regime that will not be recovered under a new, more market-based regulatory regime. If stranded costs are to be recovered from customers, the recovery mechanism and the amount

to be recovered must be determined. Japan is in a position to avoid one source of stranded costs that other countries face, because IPP contracts have only been allowed since 1996.

Consumer Protection

Because consumers will have more choices under a liberalised electricity sector, effective consumer protection may require that consumers be provided with more information and confidence-building measures[20]. Co-operation with consumer protection authorities in the course of the reform planning is essential.

Evaluating the First Step

Partial liberalisation of retail supply places an enormous responsibility both on the regulator and on the utilities if it is to function effectively. The Government should develop a comprehensive reform plan for the industry that lays out the options for reform steps which might be taken, and the timing and criteria for evaluating progress towards its major policy goals and objectives for the electricity sector.

As part of this reform plan, the Government should monitor the progress of the first step against measurable indicators and, if there are problems with this progress, the Government should take further steps.

If the following indicators are found, they probably show that sufficient competition has not been introduced:

- Limited switching by liberalised customers: The extent of customer activity, particularly by large industrial customers, is an indicator of the health of the market.

- Limited entry by IPPs: The extent of IPP activity is also an indicator of market health.

- Complaints by IPPs about discriminatory activity by utilities with respect to network services: Accounting separation does not affect the incentive for a utility to discriminate in favour of its own generating capacity and only slightly limits its ability to do so. Problems with discrimination would suggest that accounting separation is ineffective.

- Complaints by IPPs about abuse of market dominance: As utilities control most of the generating capacity, IPPs will be concerned about pricing practices by

20. In some countries, abuses against consumers have caused backlashes against reform itself. This is because many countries neglected to install consumer protection regimes that work well in new market conditions. This failure stems from the mistaken notion that market liberalisation means that all kinds of regulation will be reduced. On the contrary, in some areas it may mean more.

utilities that limit their ability to access liberalised customers, or the availability of backup power or ancillary services.

- Limited activities by utilities to compete with one another for customers: The utilities themselves are a potential source of competition for liberalised customers. Limited utility activity may be an indication of either anti-competitive behaviour or limited transmission capacity.

- Regulatory difficulties with accounting separation: The regulator may well find it difficult to separate the various regulated activities of the utilities (e.g., supply to captive customers, competitive procurement, sales to liberalised customers) when the utility has not separated underlying functions. Inevitably, there is a degree of arbitrariness about how exactly costs are attributed to the liberalised customers and what is for captive customers. Therefore, the regulator cannot be expected to uncover all of the cross-subsidies with an aim of reducing discriminatory behaviour by the utility as much as possible. Utilities may also find such accounting cumbersome.

The Second Step

If the first step is experiencing several of the difficulties listed above, the Government should be prepared to move quickly with other measures taking into consideration the policy goals and objectives such as economic growth, energy security, environmental protection, universal service and supply reliability.

The key elements of this second step are listed below.

- Additional liberalisation of supply by enlarging the number of eligible customers and, if possible, making all customers eligible.

- Strengthening protection against the cross-subsidisation of liberalised activity by regulated activity and of anticompetitive behaviour by strengthening of regulatory enforcement, by using a more strict application of accounting separation or by adopting other combinations of vertical separation and regulation. Functional separation or, if possible, operational separation of network services (transmission, distribution, and system operations) with appropriate regulation may bring more benefits of competition. All feasible forms of separation should be considered. Circumstances may arise where divestiture becomes feasible, for example, and this too should remain open for consideration.

- Regulation, independent of policy-making functions, designed to enhance the transparency and credibility of the regulator to all market participants.

- Promoting electric power trading by introducing, at least on a limited basis, a wholesale market, expanding interconnections and by requiring utilities to purchase power for captive consumers from the most economic source.

- Ancillary services which require the utility to offer, and the customer to purchase backup power and other system services.

- Nuclear power and renewables should continue to be supported by all customers.

The evolution from the current system to the second step is described in Table 12.

Table 12
Evolution of the Japanese Electricity Sector

Area	*Current*	*Step 1*	*Step 2*
Liberalisation of Retail Supply	No customer choice except for self-wheeling and special retail supply.	Extra high voltage customers (average 28% of market) liberalised. Captive customers supplied by utility.	Expansion of eligible customers. If possible, extend to all customers.
Tariffs	Regulated standard tariffs. Optional time-of-use rates for all customers. Fixed tariff for self-wheeling.	Regulated time-of-use tariffs for captive customers to manage peak loads. Time-of-use system tariffs for liberalised customers.	As in Step 1.
Network Access/ Separation	Vertically integrated with generation and retail supply.	Accounting separation of transmission, distribution and system operations. Regulated non-discriminatory terms of access to the grid (location-sensitive transmission and distribution, and ancillary services tariffs).	Functional separation of transmission, distribution and system operations (or, if possible, operational separation with oversight by a neutral national governing board).
Trading Electricity	Generation dispatched by each utility based on fuelling cost. Inter-utility trade to reduce costs. Optional time-of-use contracts to reduce peak load.	Time-of-use pricing for system services (liberalised customers) and retail electricity (captive customers). Liberalised customers negotiate contracts and purchase ancillary services as required. Inter-utility trade encouraged through expansion of interconnections.	Markets introduced by system operators to manage imbalances and cut utility generating costs. Time-of-use pricing for all customers. Inter-utility trade expanded through increased links and regulatory incentives to reduce costs.

Table 12 (continued)
Evolution of the Japanese Electricity Sector

Area	*Current*	*Step 1*	*Step 2*
Competition in Generation	IPP entry liberalised. Annual utility tender for 10% of system expansion needs through 2004. Beginning in 1999, barring a significant change in the situation, current plan is for utilities to compete with IPP for all thermal power needs through tender.	IPPs able to contract directly with liberalised customers. IPPs also compete with utilities to supply captive customers through competitive tender. Utilities sell to captive customers, compete for liberalised customers.	IPPs compete with utilities through sales in spot market as well as through contracts.
Economic Regulation	MITI regulation of retail prices through rate-of-return regulation with a yardstick mechanism. Notification of MITI for optional rates and wheeling charges. Competition authority (FTC) limited to comment role.	MITI regulates network prices, terms of access, transmission plans, and retail prices for captive customers. Improved yardstick regulation. FTC's authority clarified by amendment of Anti-monopoly Act.	Increased use of regulatory incentives to reduce network costs. Regulation of generation based on comparison with market prices. FTC regulates anti-competitive practises for liberalised customers. FTC consulted on amendments to access terms.
Security of Supply/ Nuclear Power	Utilities have obligation to serve and plan for adequate supplies. Government policies support nuclear expansion and continued fuel diversification.	Utilities have obligation to serve and plan for adequate supplies for captive customers. Nuclear power development continues.	As in Step 1.
Renewable Energy	Utilities purchase renewable energy at special buyback rates. Government support for new energy through subsidies, low-interest loans and tax privileges.	Utilities continue to purchase renewable energy. Existing commitments continued through subsidies, low-interest loans and tax privileges.	As in Step 1.
Public Service Obligations	Obligation to serve all customers of utility (including, e.g., remote islands). "Postage stamp" pricing of electricity.	Captive customers served by utility at postage stamp prices. Utility sells ancillary services to liberalised customers.	As in Step 1.
Stranded Cost Recovery	Not applicable	Tax on electricity use or other mechanisms.	As in Step 1.

Further steps

Implementation of the measures proposed in the second step of reform should complete the process of liberalising retail supply and achieve functional separation of the competitive and monopoly activities. Subsequent evaluation of the performance of the electricity market would be needed to determine whether these measures have been effective in establishing competition in the electricity market in every utility service area throughout Japan. Among the performance indicators to evaluate are whether prices are approaching internationally comparable levels, whether independent generators experience discrimination, and whether there are difficulties in reaching environmental and energy security goals for the electricity sector. Depending on the outcome of such an evaluation, the Government should then determine whether further regulatory and structural measures might be necessary and practical in particular utility service areas including, for example:

- encouraging entry of new generating companies;
- expanding interconnections between regions to support greater trade;
- changing terms and conditions of access to networks;
- modifying economic regulation of the utilities to provide greater incentives to compete for customers;
- encouraging or requiring further vertical separation of network activities from competitive activities through strategies such as operational or ownership separation; and
- encouraging or requiring horizontal separation of the generating assets of utilities into a number of competing entities.

CONCLUSIONS

The 1995 amendments to the Electric Utilities Industry Law have begun a process of change in the Japanese electricity sector. The tendering for new capacity by independent power producers, which the amendments enabled, revealed significant scope for cost savings in generation. A revised regulatory process has put greater emphasis on improving efficiency at the utilities.

The decision to move forward with partial liberalisation of retail supply is an important and irreversible step for Japan to take towards its goal of international comparability in electricity prices. The first step of partial liberalisation may bring benefits to both liberalised and non-liberalised customers; it may bring the significant benefit of information about potential efficiency gains, and make clearer the way forward. The principles guiding the discussion of the first step in Japan appear to be soundly based. In particular, the recognition of the need for equal

conditions for competition between the utilities and new entrants, the need for fair and transparent rules on the use of power transmission lines, and the commitment to set a timetable for liberalisation highlight essential points of any successful market liberalisation in electricity. Furthermore, the decision that extra high voltage industrial and commercial customers be liberalised, representing 28% of total utilities' sales, is an important milestone.

However, this first step under consideration will need to be carefully monitored to assess whether partial liberalisation of retail supply meets all the energy policy goals of the Japanese Government. To establish the foundation for reducing Japan's electricity costs on a medium- to long-term basis, and to meet all of Japan's policy goals, further liberalisation will be needed. Further liberalisation will enable markets to become established and to expand, which will induce more efficient ways of organising the sector, and ways of using existing assets in the sector. It is important that access to the transmission grid and ancillary services be non-discriminatory and cost-reflective. Both the demand and the supply sides of the markets for electricity should be sufficiently unconcentrated, and those parts of the sector remaining under economic regulation should be subject to credible, transparent regulation. Each of these conditions is part of the foundation upon which an efficient electricity sector is built. A more robust foundation would require additional conditions.

RECOMMENDATIONS

The Government should adopt a comprehensive reform plan for the industry that lays out the timing and criteria for evaluating progress with reform of introducing effective competition for the electricity sector, taking into account its major policy goals (environmental protection, energy security and economic growth).

As part of this reform plan, the Government should define measurable indicators of these reforms so that progress towards their achievement can be monitored. The Government should monitor the progress of these reforms and, if there are problems with this progress, the Government can make a timely adjustment towards other policies.

Competition principles should be strengthened in the overall policy framework.

The following recommendations would apply particularly to the first step of reform:

Regulatory independence from day-to-day political pressures is essential to build confidence of all electricity market participants that government intervention in the electricity market will be neutral and transparent. Further, independence from the regulated companies, including but not limited to utilities, is needed to ensure transparent, fair, and reasonably predictable decisions. Therefore, the regulation of the electricity sector should be independent from policy-making functions and

electricity industry promotion functions, with transparent procedures and due process for the review of decisions. Transparency, expertise, independence and adequate legal powers are particularly important. Co-ordination with the Fair Trade Commission should be clearly defined.

Non-discriminatory tariffs and terms of access to the networks and system services are cornerstones of electricity reform. Therefore, the first step of reform should include the requirement for regulated terms and conditions of access to the network and provision of ancillary services. Separate accounts for natural monopoly activities and supply of electricity to captive customers are needed from the potentially competitive activities. Prices should reflect, to the extent possible, underlying costs to encourage efficient development and use of the networks.

Standard customer tariffs do not reflect the high cost of peak power. Cost-reflective pricing of energy would encourage those customers able to manage their load to use less energy on peak, thus reducing total electricity costs. Therefore, standard electricity tariffs for captive customers, and network/ancillary service tariffs for liberalised customers, should reflect costs by time of use. Implementation of the time-of-use tariffs should be phased in, beginning with liberalised customers and the larger (power) captive customers.

The current application of yardstick assessment to economic regulation provides only diffuse incentives for utilities to improve their efficiency. Therefore, the yardstick assessment scheme should be revised to provide a greater incentive for utilities to improve their efficiency by providing a less direct link between prices a utility can charge and the corresponding cost, and providing a more direct link with the cost-efficiency of other electric utilities, making suitable adjustments for utilities' unique physical situations.

Competition law needs to be enforced vigorously where collusive behaviour, abuse of dominant position, or anti-competitive mergers risk frustrating reform. The Anti-monopoly Act should be amended to clarify that it also applies to the electricity sector.

If after a reasonable period, such as by 2003, there continues to be evidence of discriminatory behaviour, and the market is not sufficiently competitive, despite accounting separation, further changes will be necessary.

The Government should expand the set of eligible customers. If possible, make all customers eligible.

If difficulties with accounting separation are found, and if measures to strengthen accounting separation have not eliminated these difficulties, then utilities should be required to functionally separate their regulated activities from unregulated activities and the regulatory regime may need to be strengthened. The Government should consider the full range of feasible separation options to promote competition in the industry.

Increased activity in the trading of electricity will increase the need and the opportunity for a short-term electricity market to deal with imbalances between generation and loads. Therefore, a short-term market for electricity sales should be created to optimise use of generating resources.

Following the second step in the regulatory reform in the electricity sector, consistent with its reform objectives, the Government of Japan should undertake a review of the operation of the competitive electricity market in each utility service area in Japan. Depending on the outcome of such an evaluation, the Government should consider what further practical regulatory and/or structural reforms should be introduced, consistent with Japan's overall energy policy goals and objectives. Among the options to be considered are:

- measures to encourage entry of new generating companies;
- the expansion of interconnections between regions in a way that supports greater competition as well as reliability of supply;
- modification of economic regulation applied to the utilities to provide them with greater incentives to operate and invest efficiently in monopoly activities of the sector, as well as to compete for customers in the competitive activities of the sector;
- measures to encourage the voluntary sale of utilities' generating capacity to multiple buyers; and
- the full range of feasible horizontal and vertical separation options to promote further competition in the industry.

8

OIL, GAS AND COAL

OIL

Industry Structure

Oil accounts for 56% of Japan's primary energy supply and is sourced largely from the Middle East. Security of oil supply continues to be the over-riding consideration in the design of oil policies. The Japan National Oil Corporation (JNOC) is a government organisation established to secure international oil supplies from fields involving Japanese companies. Its functions include supporting overseas and domestic oil exploration and development activities by providing equity and loans to Japanese oil companies, and by undertaking research and development of oil exploration and production technology. Other than JNOC activities, exploration, development and refining are managed by private companies, including foreign-owned corporations.

Exploration and Production Policies

Policy on exploration and development of oil and natural gas is based on the Future Development of Domestic Oil and Combustible Natural Gas (1995-1999), June 1994, which established a target for domestic production of 3.3 million kl for oil and natural gas by 2000.

There are currently 37 companies which have developed oil abroad and import it to Japan. In 1996, about 670 000 barrels[21] per day of crude oil imports (38.80 million kl or 14.7 % of Japan's total crude oil imports) were produced by Japanese companies operating overseas. Japanese policy is to increase the contribution from these sources to 1.2 million barrels per day by 2001. A number of assistance measures are in place. Although companies receiving government assistance are assumed to supply Japan, there is no formal obligation to do so.

Pre-Exploration Stage

The geological features of prospective but unexplored areas abroad are investigated by JNOC, and basic investigations of domestic oil and natural gas resources are carried out on a government commission basis.

Exploration Stage

Exploration investment and finance is provided by JNOC for up to 70% of exploration costs abroad, and 80% of exploration costs in the offshore areas

21. 1 barrel = 159 litres; 1 kilolitre = 6.289 barrels.

surrounding Japan (at an interest rate of 1.8% as of June 1998). If exploration is unsuccessful, the loan is exempt from repayment.

Development and Production Stage

Long-term low interest rate financing is provided by the Export-Import Bank of Japan (the loan rate covers up to 80% of the investment), or the Japan Development Bank (for up to 60 %). JNOC debt guarantees are also possible for up to 60% of loans, at a charge of 0.4% to 1.5% per year.

Tax System for Exploration and Development

A number of incentives are provided in the tax system. An Overseas Investment Reserve Fund for Losses allows writing off 100% of the investment and loans in the exploration stage and 30% in the development stage. A Depletion Allowance permits tax deductions for mining revenue used for exploration of new deposits within three years. An Offshore Oil Field/Gas Field Abandonment Reserve Fund offsets losses incurred in abandoned wells. Tax deductions or special repayment terms are possible on expenses incurred in the acquisition of overseas production oil field rights.

Refining Industry Policies

Following the recommendation of the Petroleum Council, distillation capacity has increased gradually each year from 4.6 million barrels per day in 1990 to about 5.3 million barrels per day at the end of March 1998. Conversion capacity, such as heavy oil cracking facilities, has also expanded. Imports of petroleum products by non-refinery companies have been permitted from March 1996 to improve supply efficiency of petroleum products. Further deregulation is planned to reduce the cost of supplying petroleum products.

Table 13
Oil Refineries – Utilisation and Capacity

Year end	*Number of Refineries*	*Utilisation Ratio (%)*	*Capacity (million barrels/day)*
1990	40	75.5	4.55
1991	40	79.1	4.74
1992	40	80.3	4.88
1993	40	80.2	5.05
1994	40	82.0	5.12
1995	40	79.7	5.27
1996	40	79.1	5.27

Source: Petroleum Association of Japan, *PAJ Annual Review 1997* (October 1997).

Distribution and Marketing Policies

Distribution of petroleum products is by direct sales to large consumers such as power and petrochemical companies (including naphtha, jet fuel and fuel oil) and sales through dealers and sub-dealers. The number of service stations has been stable since 1980 at around 59 000, although it has been gradually reduced recently. The number of dealers is high in proportion to the number of service stations and more than half of the dealers run one station. Average gasoline sales volume in service stations is about 80 kl per month, a very low level by international standards.

The business environment in the oil distribution industry changed after deregulation. The distribution market is now characterised by new entrants, including supermarkets, by an intensification of price competition and by diversification of service station business. From 1977 the Gasoline Retail Business Law had sought to promote sound development of dealers and to secure quality by measures including the registration of dealers, who were also required to hold a supply certificate issued by wholesale distributors, the restriction of new stations in designated areas where excessive competition was occurring, and the prohibition of off-specification gasoline and other quality controls. Until March 1990, MITI administrative guidance did not allow any increase in the number of service stations. When the restriction was lifted, the number of outlets grew to a peak in 1994.

In 1996, importation of petroleum products was liberalised and the Gasoline Retail Business Law replaced by the Law on the Quality Control of Gasoline and Other Fuels. While regulations remain to ensure quality control and for environmental protection under the new law, restrictions have been eased progressively and the Government has sought to make the pricing mechanism transparent, with the notion that petroleum product sales companies should be freed to make rational judgements on participating in the industry. Margins are very low and are understood not to cover variable costs in some outlets.

Oil Consumption

Electricity generation accounts for nearly one-quarter of oil consumption in Japan, transport 31.2% and industry 27.6%.

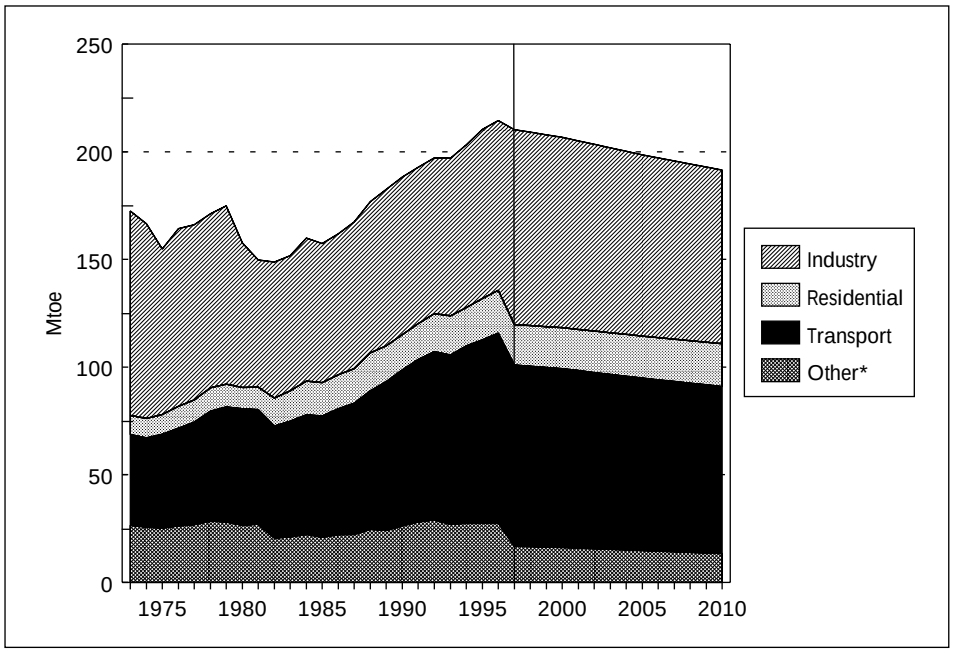
Oil's share of electricity generation in Japan fell from 73% in 1973 to 21% in 1996, under the influence of government policy. MITI has established long-term targets for oil-fired generation but large investments in oil-fired capacity have been preserved, with only a few plants converted to other fuels. Japan has few economic alternatives to oil for meeting seasonal demand and none for meeting peak demand other than pumped storage, which is often oil-fuelled. Hydro capacity is limited and coal and natural gas expensive, leaving oil as the least costly means of meeting peak summer demand, which is largely driven by air-conditioning. Nuclear capacity meets base load demand.

Table 14
Service Stations and Dealers

End of Financial Year	*Service Stations*	*Dealers*
1980	59 209	36 344
1985	59 082	34 693
1990	58 614	32 642
1991	58 825	32 413
1992	59 224	32 060
1993	59 733	31 766
1994	60 421	31 559
1995	59 990	30 465
1996	59 615	30 032
1997	58 263	29 239

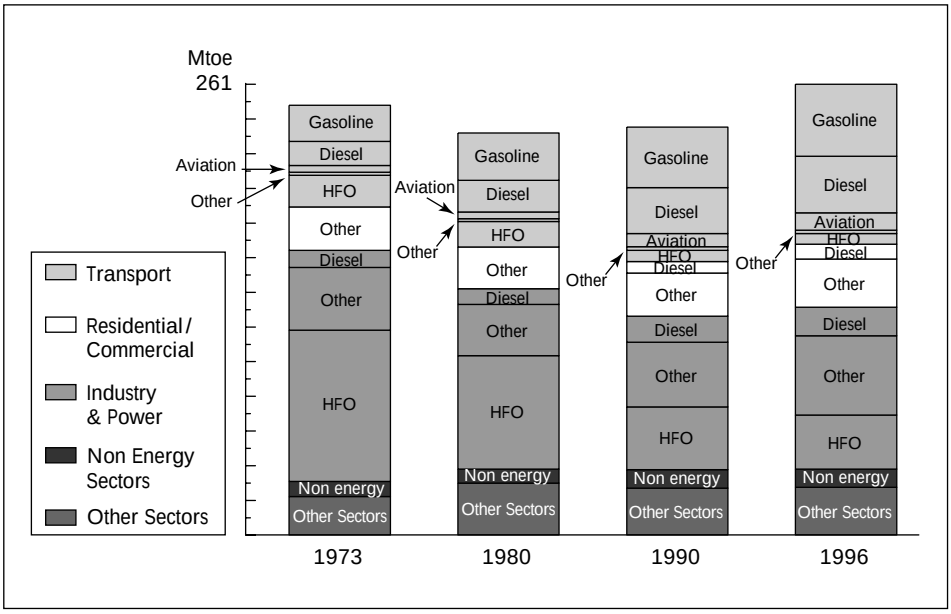
Source: MITI.

Figure 28
Final Consumption of Oil by Sector



* Includes commercial, public service and agricultural sectors.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

Figure 29
Oil Consumption by Sector



Note: HFO = Heavy Fuel Oil
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998.

Oil Taxation

A Customs Duty and a Petroleum Tax are levied on imported crude oil and petroleum products. When refined products are delivered in the domestic market, the following taxes are also paid:

- Gasoline — Gasoline Tax plus local Road Tax
- Gasoil (diesel)[22] — Gas Oil Transaction Tax
- Jet Fuel — Aircraft Fuel Tax
- LPG — Petroleum Gas Tax

Exemptions and reimbursements apply to fuel oil in agriculture and fishery use, to crude oil and naphtha used in the petrochemical industry, and to asphalt and

22. Gasoil is the name given to the middle distillate, mostly diesel. The oil product used for space heating in Japan is kerosene (as in the United Kingdom) whereas in most OECD countries light fuel oil (also referred to as gasoil) is used for such purposes.

petroleum coke produced domestically. Special depreciation allowances and exemptions or reductions of local taxes apply to anti-pollution facilities and sophisticated facilities such as cracking units. Gas used in automobiles, which accounts for 9% of gas use, is also subject to a Petroleum Gas Tax of ¥17.5/kg.

Revenues from oil-related taxes are mostly allocated to specific purposes:

- The Customs Duty was introduced as a temporary measure in 1960 to fund assistance to the coal industry against competition from oil.
- The Gasoline Tax was introduced as a temporary measure in 1954 to fund road construction.
- The Petroleum Tax was established in 1978 to fund oil policies such as oil stockpiling, and later extended to fund expenditures on alternative energy sources.

Expenditure on oil policy accounted for 9.4% of oil-related tax revenue in FY 1998.

Table 15
Customs Duty on Petroleum (¥/kl)

Product	*Base Rate*	*Applied Rate*	*End Use*
Crude Oil	0	63	Petrochemical industry
		215	Other
Fuel Oil A	600	215	Refining feedstock
		0	Agriculture and fisheries
		2 620	Other, low sulphur
		3 410	Other
Fuel Oil B	390	215	Refining feedstock
		2 400	Other, low sulphur
		3 410	Other
Aviation Gasoline	3 020	2 090	
Gasoline/naphtha	1 830	12	Petrochemicals, ammonia production
		750	Power generation
		1 400	Other, including motor gasoline
Kerosene	1 760	570	
Gas Oil (diesel)	1 640	1 270	
LPG	0	0	
Lubricant	9.6%	8.7%	Specific gravity 0.8494 and above
	4.6%	4.6%	Other

Source: MITI.

Table 16
Excise Tax on Petroleum

	Base Rate	*Applied Rate*
Petroleum Tax	Oil 2 040 ¥/kl, LNG 720 ¥/tonne, LPG 670 ¥/tonne	
Petroleum Gas Tax	17.5 ¥/kg	
Gasoline Tax (¥/kl)		
Gasoline Tax	24 300	48 600
Local Road Tax	4 400	5 200
Total	*28 700*	*53 800*
Gasoil Transaction Tax (¥/kl)	15 000	32 100
Aircraft Fuel Tax (¥/kl)	26 000	

Source: MITI.

Emergency Response Measures

Given a continuing high rate of dependence on oil from the Middle East, the lack of substitutes for oil in the transport sector, and the limited economic substitutes for peak electricity demand, Japan is highly vulnerable to oil supply disruptions. This situation is reflected in the high priority which the Government of Japan accords to oil emergency response measures. The Government has wide-ranging legal authority to implement emergency response measures and facilitate close co-operation with the industry.

Legal Authority and Emergency Organisation

The basic legal framework to secure adequate oil supply in an emergency consists of:

- The Petroleum Stockpiling Law.
- The Japan National Oil Corporation Law.
- The Petroleum Supply and Demand Optimisation Law.

The Petroleum Supply and Demand Optimisation Law provides for the following actions to secure adequate supply, subject to a Cabinet decision and proclamation to implement an emergency measure under the Law:

- MITI prescribes and issues the target for oil supply.
- Each oil refiner, importer or marketer prepares and reports to MITI its plan for oil production, import and sale.
- MITI, when necessary for the achievement of the oil supply target, instructs any reporting oil refiner or marketer to revise its plan for oil production or sale.

In the case of an oil supply disruption, the Agency of Natural Resources and Energy (ANRE, within MITI) would be responsible for the implementation and co-ordination of the domestic emergency response measures. Japan's National Emergency Sharing Organisation would be established in ANRE to comply with the IEA's International Energy Program.

Emergency Reserve and Stockpiling Policy

Japan maintains a high level of emergency oil stocks. The Government maintains its own emergency reserves under the Japan National Oil Corporation Law and imposes stockpiling obligations on the industry (primary distributors, refiners and importers), in accordance with the Petroleum Stockpiling Law. Government stocks are all crude oil and are held by JNOC.

The Government achieved its target of 50 million kl of government stocks in February 1998. Together with the private stocks, Japan's stock level stands at the level of 120 days of net imports on IEA definitions. The Government has an effective monitoring system to ensure that emergency reserves remain adequate in an emergency.

The Minister of International Trade and Industry is empowered to reduce stockholding obligations of private companies in accordance with the Petroleum Stockpiling Law, taking into account individual companies' oil availability as well as the general oil supply situation. During the Gulf War, the Government lowered stockholding obligations for compulsory stocks held by companies by four days' of consumption to meet Japan's commitment as part of the IEA Contingency Plan. Government stocks can be drawn down on the basis of an instruction by the Minister in accordance with the Japan National Oil Corporation Law.

Under the Petroleum Stockpiling Law, LPG stocks are held by private companies at present. In addition to this private sector stockpiling, the Government is planning to establish a national LPG stockpiling system with a target of building up a reserve volume of 1.5 million tonnes by fiscal year 2010 in view of the importance of securing a steady supply of LPG in a major oil disruption. There is no requirement to stockpile LNG.

Demand Restraint and Other Measures

The Petroleum Supply and Demand Optimisation Law and Electric Utilities Industry Law provide the Government with legal authority to implement compulsory demand restraint measures. The activation of these laws is likely in a severe crisis following energy conservation measures and moderate demand restraint measures.

In the event of a crisis, the Cabinet Committee for the Promotion of Comprehensive Energy Measures and the Committee for the Promotion of Energy and Resources Conservation Measures (Vice Ministerial level) would meet to decide on these measures.

The Government is empowered to take initiatives to introduce demand restraint measures aimed at persuading the public and industries to make greater efforts to conserve energy and provide them with necessary information on the emergency situation. Measures to be taken would be decided on an *ad hoc* basis and would reflect the nature of the specific crisis.

In the case of an emergency, the Minister has authority to make a recommendation to modify the supply plan or to issue a supply order to electric power companies in accordance with the Electric Utilities Industry Law. These actions would be taken to secure an adequate capacity for electric power supply and to shift the energy source to non-oil energy sources such as coal, natural gas and nuclear power.

GAS

Supply

Japan imports natural gas in the form of liquefied natural gas (LNG) from, in order of importance, Indonesia (about 40% of imports in 1996), Malaysia, Australia, Brunei, the United Arab Emirates (Abu Dhabi), the United States (Alaska) and Qatar. LNG imports began in 1969. Imports from Qatar commenced in January 1997 (2.4 Mt in 1997). Japan is now the largest LNG importer in the world, accounting for 62% of global LNG trade. Demand rose 4.1% in 1996-97, and was met by a corresponding rise in imports. During 1997, total imports of LNG were 48.35 Mt. Liquefied Petroleum Gas (LPG) is also used extensively in Japan.

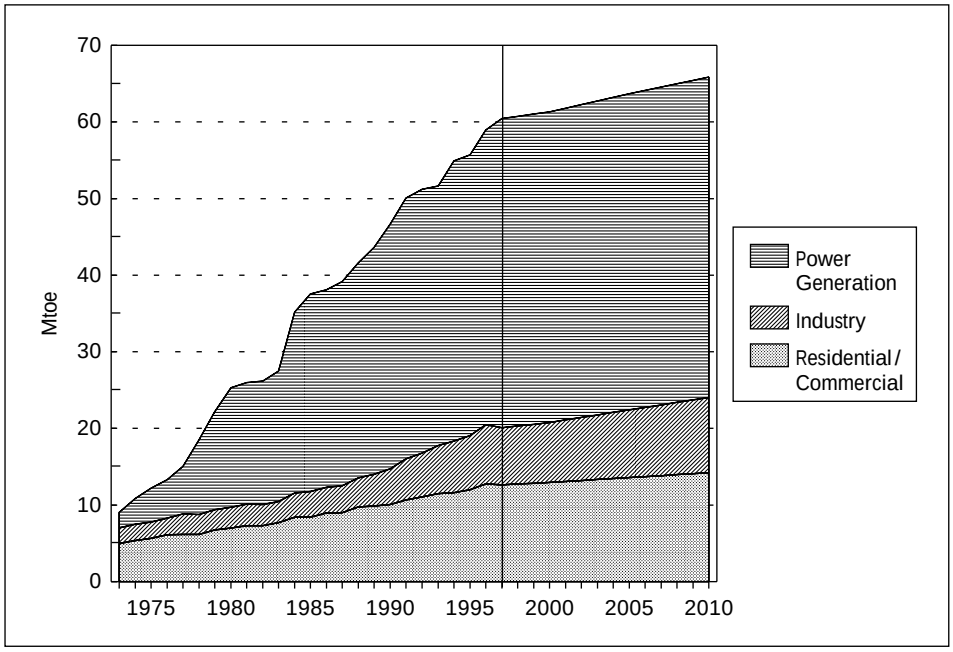
LNG is imported by the electric utilities, by a few large users such as Nippon Steel, and by the major gas companies for distribution to smaller distributors and gas consumers.

Compared to its gas demand, Japan currently has the smallest gas transmission network of any major gas using country (see map, Figure 31). This is because most gas is used in power plants and by consumers in the residential, industry and commercial sectors close to the major LNG import sites in Tokyo, Nagoya and Osaka, which have only limited pipeline networks.

The private sector has, with assistance from JNOC, carried out domestic and overseas natural gas exploration and development projects. In June 1994, the Japan National Oil Corporation Law was revised to make possible investment and debt guarantees for the development and liquefaction stages of natural gas.

Japan has small reserves of natural gas, meeting about 3% of total demand. Development on-shore and off-shore is encouraged by measures similar to those for oil. Assistance available from JNOC includes the liquefaction stage. Loans are also available for development and liquefaction of natural gas by the Export-Import Bank of Japan. Loans are available from the Japan Development Bank for the construction of LNG tankers.

Figure 30
Natural Gas Supply



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

Assistance is also made available at the receiving and supplying stages. Low interest loans by the Japan Development Bank and an optional special repayment system or tax deductions are extended for LNG receiving terminals and LNG carriers. Assistance is also available for promoting the introduction of natural gas by local town gas companies to replace manufactured gas.

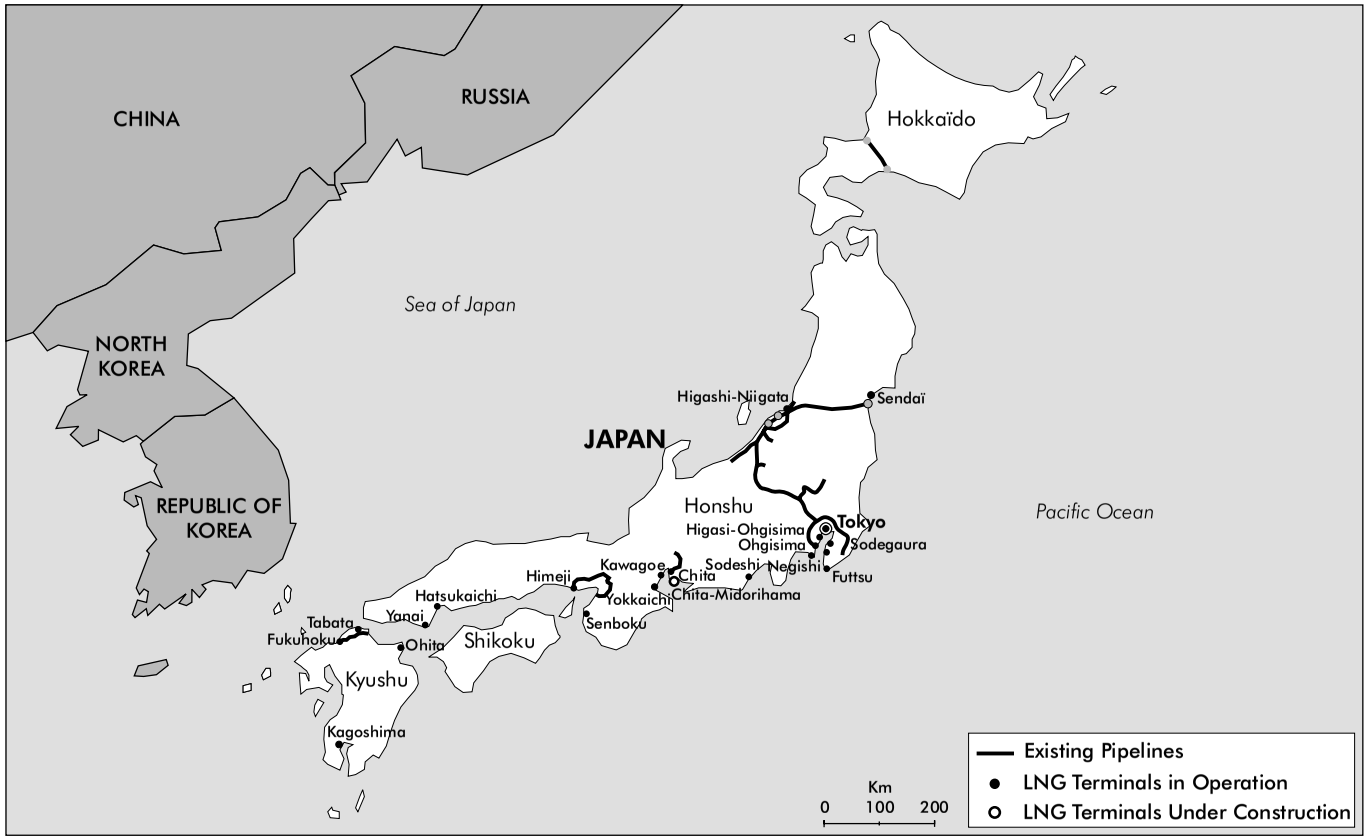
Industry Structure

The Japanese gas industry is fragmented into many vertically integrated regional companies (see Figure 32), most of which produce or import their own gas, rather than buying from a transmission company as is the case in Europe. Some smaller companies purchase gas from the larger gas companies. The gas companies have exclusive supply areas protected from competition by government regulation but are obliged to supply any consumer within the area. There are 245 regional companies, dominated by three: Tokyo Gas, Osaka Gas and Toho Gas (Nagoya area), which together account for over 75% of the market of the gas utilities. There are 14 large companies, 161 small and medium sized companies, and 70 public corporations.

Natural gas accounts for over 85% of all gas sold in Japan by the gas utilities and LPG for the remaining 15%. Government policy has the objective of encouraging the substitution of manufactured gas for city gas use by natural gas. The excise levels

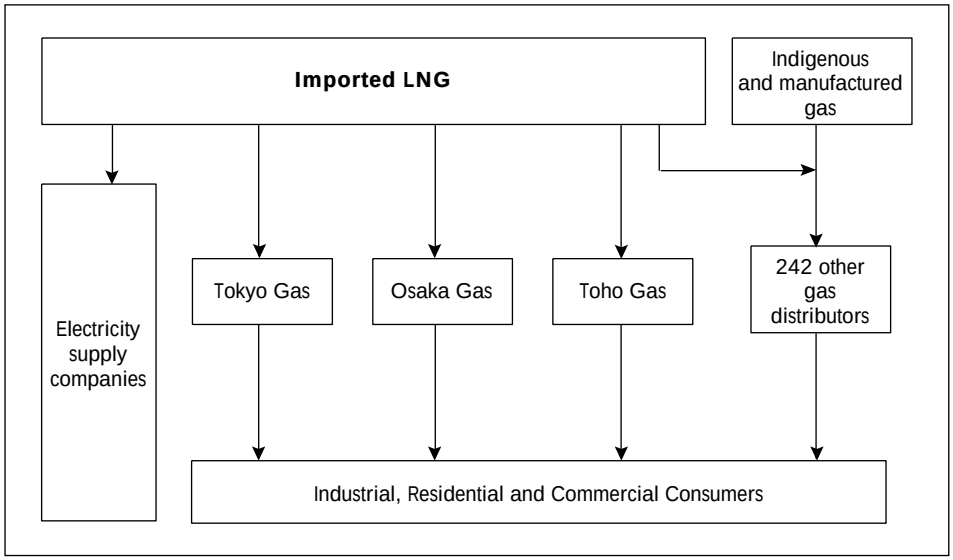
Figure 31

Natural Gas Transmission Network



Source: MITI.

Figure 32
Structure of the Gas Industry



are different between LNG and LPG (LNG is charged an excise tax of ¥720/tonne, while LPG is charged ¥670/tonne), although they are equal on a calorie basis.

The three largest companies supply LNG only, except for LPG used to increase the calorific value of gas (Tokyo Gas since 1988, Osaka Gas since 1990 and Toho Gas since 1993). Of the remaining 242 companies, 42 supply LNG only, 63 supply domestically produced natural gas, 16 supply LNG and domestically produced natural gas, and 121 supply LPG.

The area of grid-based supply by city gas companies covers about 5% of the national land area, and about 21% of the city areas, which is very small among the IEA countries. City gas is supplied to 24.82 million customers, equivalent to about 50% of the number of all households. City gas sales in 1997 were 20.3 billion cubic metres (bcm) at 11 000 kcal/m^3. Sales by the three largest companies were: Tokyo Gas - 7.2 bcm (35.7%), Osaka Gas - 6.5 bcm (32.1%),Toho Gas - 1.6 bcm (7.8 %). LPG is delivered to 25 million customers in containers throughout Japan. LPG consumption in FY 1997 was 19.3 million tonnes.

LNG Terminals

There are 22 LNG terminals, including regional terminals in Fukuoka, Hiroshima, Kagoshima, Sodeshi and Sendai. The regional terminals handle smaller tankers to meet gas demand in these areas. Twenty-six satellite terminals supply customers with gas trucked from the main terminals. Satellite terminals are, on average,

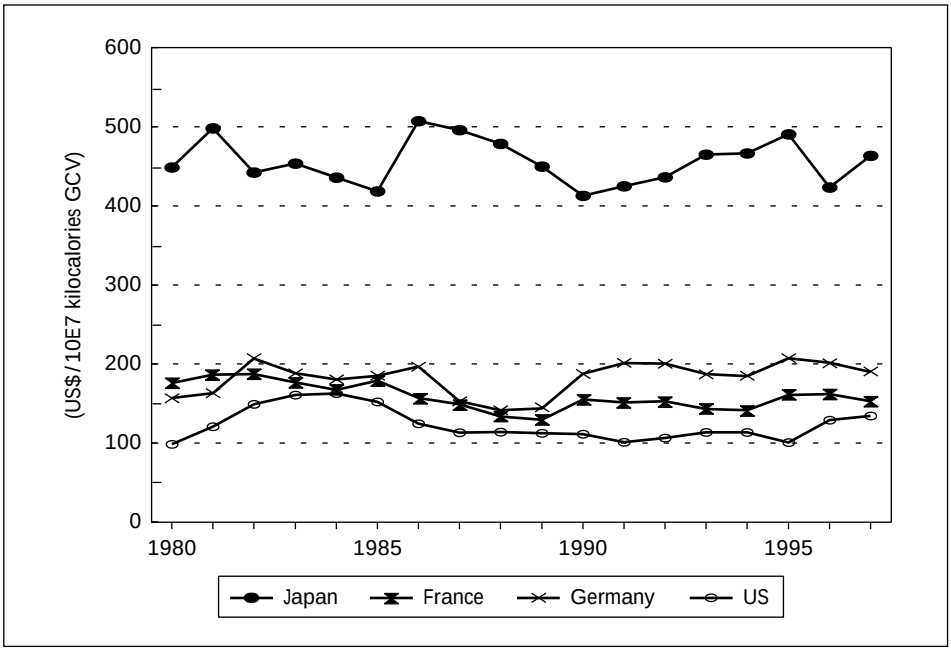
120 kms from the main terminals and their access to LNG is at much higher cost because of the high transport cost.

Most of the terminal capacity is in the Tokyo-Osaka-Nagoya area. Terminals are privately owned, in most cases by one of the regional electricity companies, either alone or with one of the three largest gas companies. Exceptions are the Tobata/Kitakyushu terminal, which is part-owned (25%) by Nippon Steel, also an independent power producer; the Higashi-Nigata terminal, which is part-owned by Hokkaido Tohoku Development Bank (25% share), Nigata Prefecture (16.7%) and oil companies and others (16.9%); and the Oita terminal, which is part-owned by Kyushu Oil (8%) and Oita Gas (2%).

LNG Contracts and Prices

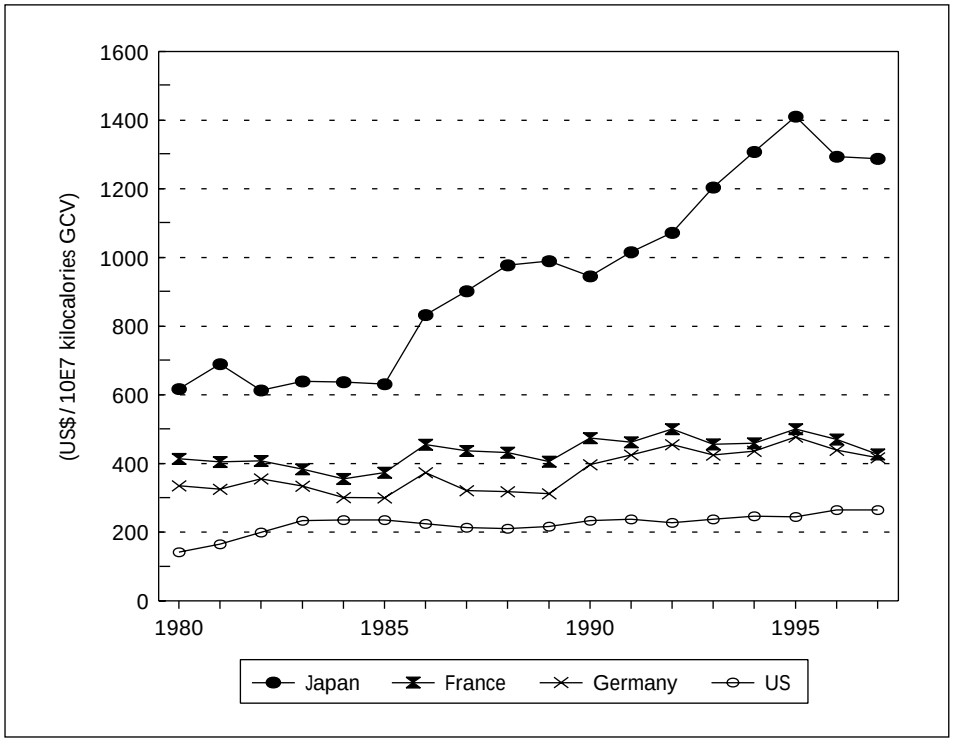
LNG projects are long-term in nature and most of Japan's import contracts run for around 20 years. Shorter contracts (one to ten years) have been signed with Indonesia, based mainly on excess production and for smaller volumes. The more recent contracts with Abu Dhabi and Qatar are long-term commitments. Contract prices are mostly linked to the prices of sweet regional crude oils imported by Japan but can also be partly linked to one of several crude oils exported by the LNG exporting country. As a result, LNG prices in Japan follow oil prices closely.

Figure 33
Gas Prices in the Industry Sector



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Figure 34
Gas Prices in the Household Sector



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

Pipeline Gas

There are three principal possibilities for pipeline gas supply to Japan:

- Sakhalin Projects I and II (with Japanese participants) are planned to commence gas production in 2005, at present with LNG in mind.
- The Kovyktinskoye Project will be the subject of a feasibility study (with Japanese participants), at present to supply China's coastal areas, Korea and Japan.
- The Trans-ASEAN Pipeline Project to link Asian pipeline networks, at present focused on Malaysia and Indonesia.

Network Development

The prospects of a national gas transmission system are unlikely. Main consumers are not prepared to develop pipeline gas supplies from Sakhalin because of the high risks and costs involved, including negotiating the route through fishing areas and

high construction costs in mountainous areas. The Government is prepared to consider the fiscal environment in which a pipeline might be developed privately, but is not otherwise prepared to promote the project. Until a national gas trunkline is in place, little consolidation of Japan's diverse gas sector is likely to occur.

A pipeline has been proposed to link Tokyo, Nagoya and Osaka and to supply towns along the route. The scheme would be expensive because of land costs but would give greater access to gasified LNG, provide flexibility and security, promote competition and possibly lower prices. In the longer term, a trunkline might be expected to run the length of Japan, with possible connections to Russia, China and Korea.

Gas Consumption

Gas is primarily used in power generation which accounts for about 70% of imports. The remaining imports are used as feedstock for distribution or in the steel industry. LNG is expensive to store, and using it to meet large seasonal variations in demand would be costly. Hence, LNG is used on a regular daily basis for meeting the daily demand for electricity production, whereas nuclear and coal are presently base load; and oil and pumped hydro meet the seasonal demand and the peak. City gas sales are close to base load and in symmetry with electricity production since gas demand for end-users peaks in winter because of heating demand, whereas gas demand for electricity production is higher in summer because of air-conditioning demand. Overall, the demand is base load with lower seasonality than for European or north American utilities. At present, about 40% of city gas demand is in the household sector and about 30% in industry. The demand for gas has been increasing, and the reduction in the gas price (relative to kerosene for household heating and to steam coal in industrial uses) should facilitate gas penetration.

Market Liberalisation

Large Scale Consumers

Regulations on entry and rate setting of gas supplies for large scale consumers, whose yearly contracts exceed more than two million cubic metres, were relaxed in June 1994 with the revision of the Gas Utility Industry Law. The revised law came into effect in March 1995. As a result, at the end of March 1998, 717 large scale consumers supplied by gas utilities (including five customers located outside the service area) were able to negotiate their price directly. There are also seven large scale consumers supplied by non-utilities. Large scale consumers can negotiate the conditions of supply, including the gas price. The utilities have benefited from a steady increase in the number of high load customers.

Gas Transportation

The guidelines for transportation services were identified in *Town Gas Utility Rate System*, July 1995, with respect to basic issues such as access conditions and tariffs.

The three largest companies have since published *Terms of Reference for Transportation*, which sets out their own operating rules. To date there is only one example of third party access. Shin Nippon Steel Company Co., Ltd. has started gas supplies to its Shinkougousaki factory (super waste power generation) in Kitakyushu City, using a pipeline owned by the Saibu Gas Co., Ltd.

Next Steps

The Society of the Study of Town Gas Utility Structure Reform (an unofficial study group led by the Director-General of the Public Utilities Department in MITI), which consists of academics and some representatives from industry, was established in May 1997 to discuss future reform of the gas utility industry. Issues under discussion include:

- Measures to offer a wider choice for large scale consumers.
  - Review the supply range for large scale consumers (currently two million cubic metres per year).
  - Improvements in the transportation service.
- Measures to offer a wider choice for general customers.
  - Improvements in the load adjustment contract system.
- Measures to offer general customers a wider choice of natural gas.
  - Support to local gas companies to change to natural gas from manufactured gas.
  - Promotion of gas air-conditioning.

In September 1998, the Society published a report which sorts the measures to be considered further for the short term and for the mid to long term. The supply range for large scale customers was regarded as a short-term issue. Further elaboration on the measures will take place at the Urban Heat Energy Subcommittee of the Advisory Committee for Energy.

COAL

Coal Trade

Japan is by far the world's largest importer of steam coal for power generation, paper pulp and cement production (64.1 Mt in 1997, of which 60% was for power generation) and of coking coal for steel making (65.3 Mt in 1997). Japan accounts for about 28% of total world coal imports. Sources of imported coal are very stable, in part reflecting the use of steam coal in base load electricity production and the historic premium paid to ensure security of supply (discussed further in the

Critique below). Following a very stable pattern established over the last 20 years, steam coal imports are primarily sourced from Australia (36.5 Mt in 1997), South Africa (2.8 Mt), and the United States (2.6 Mt). Steam coal imports from China have risen sharply (from 2.7 Mt in 1990 to 6.7 Mt in 1997), and from Indonesia (0.7 Mt in 1990 to 7.5 Mt in 1997). Coking coal imports follow a similar pattern, with stable supplies from Australia (33.1 Mt in 1997), Canada (16 Mt), the United States (5 Mt) and Russia (2.4 Mt), while imports from China (3.1 Mt in 1997) and Indonesia (2.8 Mt) have grown sharply[23].

Domestic Production

Japan maintains heavily subsidised domestic coal production, in part on security grounds and as a means of supporting the development of coal technology. Production has declined under competitive pressure from imported coal from about 55 Mt in the early 1960s to its present level of about 4 Mt (FY 1997). Mitsui Coal Mining Co. Ltd closed the Miike mine in Fukuoka Prefecture, southern Japan, at the end of March 1997. The mine was the largest in Japan and employed 1 329 people. Following the closure, only two underground mines remain, the Taiheiyo mine (Hokkaido) and the Ikeshima mine (Nagasaki). There are 11 open cast mines in operation. At the end of FY 1997, 2 903 people were employed in the coal mining industry.

This decade is regarded as the last stage of structural adjustment in the domestic coal mining industry in accordance with the New Coal Policy, which has been implemented since 1992. Domestic coal production is to be phased down, while diversification of the business and development of new activities for coal mining companies is promoted, to the point where the industry's role in the national economy and its burden are "balanced". Coal subsidies are planned to end in FY 2001. Figure 35 illustrates the effectiveness of policies to date in reducing the level of domestic production and the level of assistance per tonne of coal produced[24].

In the budget for FY 1998, the total allocation for coal policies was ¥99.05 billion (compared with ¥102.15 billion in 1997), derived from hypothecated taxes on petroleum products. Main expenditure items are currently:

- Structural adjustment measures ¥14.56 billion
- Land restoration ¥57.52 billion
- Employees leaving mines ¥13.16 billion
- Development of mining areas ¥10.29 billion

23. For Japan, the IEA classifies coal used in pulverised coal injection into blast furnaces (PCI coals) as coking coal, although its physical qualities are those of steam coal.
24. For the purposes of this illustration, subsidies are measured by the standard IEA Producer Subsidy Equivalent methodology, which calculates direct assistance to coal production.

Table 17

IEA Secretariat Estimates of Assistance to Japanese Coal Producers

(in billion ¥ or ¥ per tonne)

	Fiscal Years (1 April - 31 March)						
Assistance Category [a]	*1990/91*	*1991/92*	*1992/93*	*1993/94*	*1994/95*	*1995/96*	*1996/97*
I. ASSISTANCE INCLUDED IN PRODUCER SUBSIDY EQUIVALENT							
1. Direct aid to current production							
a) Grants for modernising coal pits	4.2	4.2	4.0	3.3	3.2	2.6	1.90
b) Grants for stabilising the coal industry	6.7	5.8	3.6	4.3	3.5	2.6	2.40
c) Grants to improve safety conditions	3.5	3.2	3.1	2.9	2.5	2.1	2.80
d) Grants for paying off interest on loans	2.6	2.0	1.1	0.7	0.5	0.3	0.20
Subtotal	**17.0**	**15.2**	**11.8**	**11.2**	**9.7**	**7.6**	**7.3**
2. Price support [b]							
e) On coal consumed by electricity producers and non-ferrous industries	101.4	96.0	84.6	90.4	83.6	74.5	69.80
f) On coal consumed by iron and steel and gas coke producers	7.6	0	0	0	0	0	0
Subtotal	**109.0**	**96.0**	**84.6**	**90.4**	**83.6**	**74.5**	**69.8**
Total PSE (billion ¥)	**126.0**	**111.2**	**96.4**	**101.6**	**93.3**	**82.1**	**77.1**
Total PSE (million US$)	**870.15**	**826.77**	**760.85**	**913.67**	**912.92**	**872.48**	**708.64**
Yen per tonne produced	**15 249**	**14 023**	**12 689**	**14 076**	**13 858**	**12 991**	**12 496**
US$ per tonne produced	**105**	**103**	**100**	**127**	**132**	**139**	**109**
¥ per tonne sold	11 582	12 306	11 734	13 776.0	13 776.0	13 221.0	12 598
Production (million tonnes)	8.263	8.052	7.597	7.218	6.933	6.261	6.48
US$/¥ exchange rate (OECD figures)	144.8	134.5	126.7	111.2	102.2	94.1	108.8

p Preliminary data, subject to revision.

[a] Definitions of categories are in Appendix D of *Coal Prospects and Policies in IEA Countries: 1987 Review*, IEA/OECD Paris, 1988.

[b] Includes benefits to coal producers arising from differences between prices in external markets and those established under domestic agreements.

Source: MITI; adapted and updated from *Energy Policies of IEA Countries: 1998 Review*, IEA/OECD Paris, 1998.

Table 17 (continued)

IEA Secretariat Estimates of Assistance to Japanese Coal Producers

(in billion ¥ or ¥ per tonne)

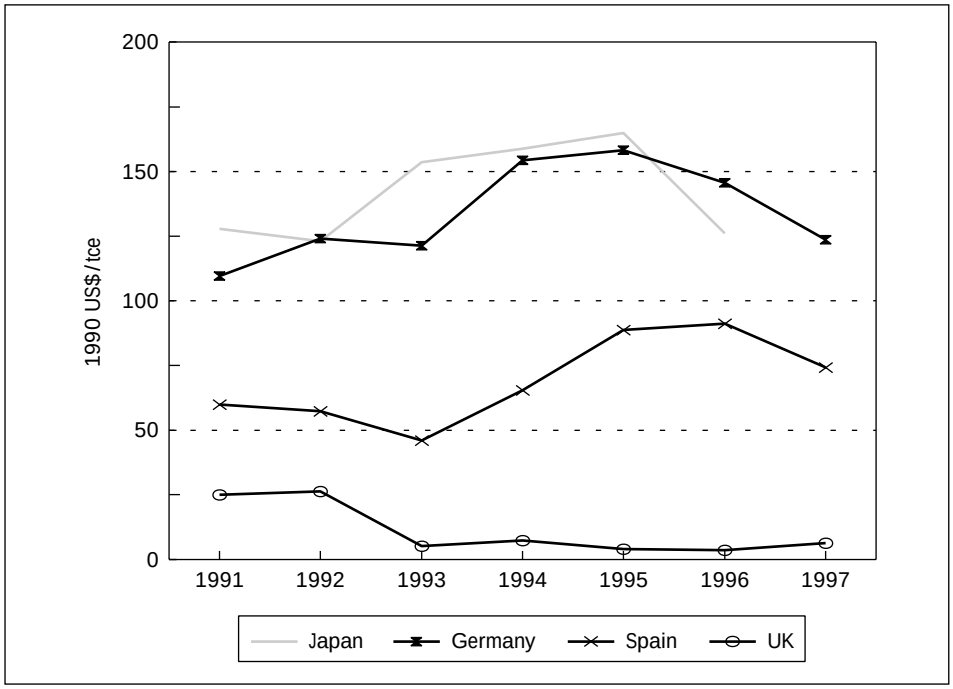
	Fiscal Years (1 April - 31 March)						
Assistance Category [a]	*1990/91*	*1991/92*	*1992/93*	*1993/94*	*1994/95*	*1995/96*	*1996/97*
II. ASSISTANCE NOT BENEFITING CURRENT PRODUCTION							
1. Regional economic development and aid for work training							
g) Regional economic development aid to coal mining districts	8.0	8.0	10.3	11.5	11.4	11.3	11.7
h) Worker retraining	17.4	15.6	14.3	13.4	13.4	13.8	13.20
2. i) Grants to offset the costs of closing collieries	2.8	0.0	3.7	0.0	2.5	4.3	0.0
3. j) Grants to help pay for past subsidence damage	39.1	31.4	33.0	35.5	45.1	49.0	45.6
4. k) Coal-related R&D	20.1	19.5	25.2	25.1	26.2	27.1	21.0
Total aid not benefiting current production (billion ¥)	**87.4**	**74.5**	**86.5**	**85.5**	**98.6**	**105.5**	**91.5**

p Preliminary data, subject to revision.

[a] Definitions of categories are in Appendix D of *Coal Prospects and Policies in IEA Countries: 1987 Review*, IEA/OECD Paris, 1988.

Source: MITI; adapted and updated from *Energy Policies of IEA Countries: 1998 Review*, IEA/OECD Paris, 1998.

Figure 35
Subsidies and the Domestic Production of Coal



Source: IEA.

Coal Consumption

Just over three-quarters (75.7% in 1996) of all steam coal imports are consumed in electricity generation, where coal consumption has been growing at 10.4% per year since 1978. Most of the remainder (20%) is used in industry, principally in cement making. The steel industry uses virtually all coking coal imports (of which 11.1% are steam coal quality used for pulverised coal injection into blast furnaces).

CRITIQUE

Oil

Oil Security

Oil remains a critically important energy source for Japan. The supply structure remains weak, since Japan's dependency on the Middle East is higher than that of other IEA countries. Securing oil is the most important issue in the context of energy security. Japan has, therefore, adopted measures, such as stockpiling, self development of crude oil abroad and co-operation with oil-producing countries.

Figure 36
Coal Consumption by Sector

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 1998 and country submission.

Alongside direct government involvement (principally through JNOC), Japan has started to introduce policies to ensure that the operation of the domestic market in petroleum products is comparable with international standards of performance. The intention is to reduce or abolish government interference in non-emergency periods.

Exploration by Japanese companies overseas is an important issue for Japan's stable oil supply, and some results have already been achieved. In 1967, 12.7% of imports (27 000 bpd) were sourced from "autonomous oil development", i.e., oil imports produced and imported by Japanese companies. By 1996, the share of imports from these sources had risen slightly to 14.7% (67 000 bpd). The level in 1996 was about one-half the target for the beginning of the next century of 1.2 million bpd, set in 1995. It should be noted that there is no legal obligation on the part of companies receiving assistance to supply Japan, although there is a firm expectation that this will occur. The effectiveness and efficiency of public assistance projects under JNOC have been questioned, and a review is to commence in autumn 1998.

Market Liberalisation

Deregulation of the retail petroleum market in Japan illustrates the economic and security benefits of liberalised markets, as well as the transition problems which may

need to be addressed. The immediate goals of government policy to bring final prices of major products into balance by improving the relationship of wholesale prices for gasoline, kerosene and gasoil to international market prices and to form fair and transparent prices, have been achieved through freeing up the market.

Domestic oil refining and marketing activities of the Japanese petroleum industry were deregulated in the period 1987 to 1992, based on the principle that the industry should be free to compete domestically except during emergencies, when government controls would apply. A second phase of deregulation followed from April 1996, with the aim of improving efficiency in the domestic petroleum industry. Among the aims was the improvement of the supply efficiency of petroleum products. Improving the operation of the market was recognised as a means of improving the security of energy supply.

During the second phase, imports of refined products were deregulated through the repeal of the Provisional Measures Law on the Importation of Specific Kinds of Petroleum Refined Products, and a number of measures were introduced designed to improve the efficiency of product distribution in Japan. The effects on the Japanese oil industry have been dramatic. Following liberalisation, 13 enterprises began importing kerosene, gasoil (diesel) and gasoline for the first time.

Petroleum distribution companies responded by amending the pricing structure for petroleum products, in particular the price of gasoline where retail margins were much higher than in other countries. The new pricing structure established retail margins in line with international levels for petroleum products. Assistance by oil companies to affiliated service stations was also abolished, so that regional margins were adjusted to reflect costs.

Supermarkets entered the gasoline market during 1996. Retail margins fell as a result. Profits of the oil companies fell sharply, by about 40% (before tax) in fiscal year 1996. Price competition benefited consumers by an estimated ¥874 billion per year, according to the Economic Planning Agency. Distribution began a rationalisation phase, reducing costs through the introduction of larger trucks, joint operation of distribution facilities (such as transport and terminals) and the swapping of products.

Further change appears inevitable. The number of service stations remains high, and there appear to be willing new entrants to retailing despite very low margins. The most likely means of improving margins will be to increase sales volumes and to reduce the cost of handling, which would require a reduction in the number of outlets, and measures such as self-service facilities. Experience in other countries suggests that a dramatic reduction in the number of retail outlets can be expected. Oil companies are also likely to seek to diversify their activities to counter falling profits, for example by transforming their outlets into convenience stores. Comparison with other countries suggests that a substantial number of the outlets could be closed during the next few years as a drastic move to increase throughput and reduce unit costs.

Taxation

Customs duty and excise taxes apply to petroleum. At present, imported petroleum products, other than LPG, pay customs duty as well as excise, but the base rate of customs duty on crude oil is set at zero. The applied rate of customs duty varies but the applied rate of duty on products is generally higher than on crude oil. The different levels of taxation on crude and oil products and the differences between taxes on oil products could be generally subsidising domestic refining and creating cross-subsidies leading to economic inefficiency. For LPG, the current structure of charges appears to favour imports, since no customs duty applies to LPG, but duties do apply to crude oil used in the manufacture of LPG in Japanese refineries. A solution would be to restructure taxes to ensure that imported products and products produced domestically from imported crude oil face the same level of government charges. This would also have the effect of creating a better balance between the use of heavy fuel oil and that of crude oil in power generation.

Japan wishes to ensure that domestic refining capacity is maintained to ensure that during emergency periods, stocks of crude oil can be readily converted to products. Security of supply considerations are therefore relevant to decisions which may affect the future of the refining industry. As with other areas of Japanese energy policy, it would be desirable to define the objective (for example, in this case, the minimum level of refining capacity required to ensure an appropriate product slate is available during emergencies) and then to develop cost-effective policies to achieve the goal.

Gas

Achieving the *3 Es* through Market Mechanisms

Natural gas is considered to be one of Japan's more important energy sources on energy diversity and security grounds, since dependency on the Middle East is smaller than that for oil, and on environmental grounds, because of lower greenhouse gas emissions than from coal-fired power[25]. Natural gas is principally LNG, the pipeline network is limited and consumption is largely for electricity generated at plants located near terminal facilities. Industrial use of gas is low compared with other industrialised countries because of its cost and the cost of pipeline development, which would be needed to support a rapid growth in consumption in the industrial or the commercial and residential sectors.

Given the high dependence on Middle East oil, natural gas might be considered as a means of meeting energy demand with an acceptable environmental outcome. To develop gas further would require overcoming two major barriers: developing the network and lowering the cost of supplying LNG.

25. Auto consumption of gas and losses in production, transport and liquefaction may reduce the environmental advantage.

Pipeline gas from Sakhalin, and the development of a gas network, appear to be logical developments for the future. Private investors are undertaking a feasibility study of pipeline gas and exchanging views with potential buyers. The major utilities would be the principal buyers of any pipeline gas, and they think it is necessary that pipeline gas be as competitive in price and as stable in supply as LNG if it is to be economic. The Government is making efforts to establish internationally harmonised safety standards on pipelines with a view to reducing the cost of pipeline gas.

The more immediate options for developing gas involve lowering the cost of LNG and/or making it more attractive against oil through taxation to reflect its diversity and environmental values. According to the Japan Gas Association, construction costs of terminals have been reduced by about 25% and operating costs by about 50% since 1970. Cost reductions are attributed to technological developments such as doubling the size of terminal berths and LNG tank capacity, and to a five-fold increase in labour productivity. Over-riding considerations in reducing costs within the terminals are safety, reliability and security of supply.

It might be useful to define the cost of achieving security in order to determine if more cost-effective means might be devised. To date, the structure of the market has determined the approach to gas security in Japan. Underground storage, interruptible contracts and pipeline links, which are common in other regional markets, play no significant role in Japan. Reliance is placed on long-term contracts with stable suppliers, on measures to limit reliance on any particular facility and on the possibilities for substitution and sharing in the electricity generation system. These arrangements have worked well, and no security problems have been encountered. For the future, greater flexibility may be required in the approach to security. Gas is projected to play a greater role in energy supply and to come from more diverse sources under different contractual arrangements. More sellers and buyers may seek to participate in the market as demand grows. Moreover, as dependence on oil for power generation is reduced, gas may increasingly need to be used to meet summer electricity demand, with a corresponding need to match such an increase with a higher winter demand for heating purposes. These changes will occur at a time when both the gas and electricity markets are undergoing reform, when new markets for gas are possibly developing (in cogeneration or trigeneration, for example) and when new market players are seeking entry.

The operation of a free market may offer a means for both reducing costs through competitive pressure and for ensuring security since, unlike oil, sources of supply are diverse. A key consideration should be the complementarity between oil and gas in power generation. Dual-fired capacity permits switching between gas and oil products. Using fuel switching to balance demand, the high level of gas consumption in the power sector should allow gas to be allocated to electricity generation in priority to gas end-users without incurring serious risk to security. By exploiting this flexibility in the power sector, existing LNG storage (which is far more expensive than oil and oil products storage) could still be adequate at a higher level of terminal throughput without jeopardising security. Hence, the overall existing terminal capacity could be extended to increase LNG imports, at no or limited cost.

The ability of individual companies to operate flexibly is severely limited by the present organisation of the market within Japan. Since terminals are privately owned and dedicated solely to handling shipments of the owners, it is not possible for new players to enter directly into LNG procurement. Existing gas importers are also unable to take advantage of favourable market circumstances to buy gas for resale to other companies, since there are no pipeline links between the terminals. Large gas consumers, i.e., the power utilities, have been discouraged from entering the gas market to sell, for example, small quantities of gas surplus to their needs, but they are intending to enter the gas market in response to regulatory reform in the gas sector.

Third party access to the LNG terminals may be one way of introducing competition and lowering costs but would, of course, require consideration of the terms of access and/or compensation to the owners. In the future, third party access might encourage more flexible procurement. As the gas market develops, companies may face different demand profiles and may need to adjust supply according to their individual market needs. Development of individual relationships with key international suppliers could contribute to diversity of supply and allow Japanese companies to use their buying power to reduce prices.

Gas Pricing

Pricing for natural gas typically takes one of two forms: netback pricing, where the price is determined by the price of the competing fuel in the same use, or market-based pricing, where the price is determined by the marginal buyer and is the same for all uses, except for transport costs. A market price can only exist if any customer may resell its gas to another customer, and if gas can be transported at a fair and transparent cost.

Netback prices impede growth in demand, except for those consumers with no acceptable alternative fuel for technical or environmental reasons. Consumers will tend to be clustered near the terminals, as there would be little or no incentive to invest in a network when alternative fuels are available at lower supply cost. Gas penetration is likely to be limited as a result.

In other countries, combined heat and power production has been an important driver in encouraging the use of market-based pricing. In Japan, there would appear to be potential for trigeneration (combined heat and cold production and electricity generation) as a means of expanding the range of competitive electricity generators in the market. Trigeneration would also help to reduce the summer air-conditioning peak load by producing cold water at night. Gas air-conditioning is recognised in Japan as a means of coping with summer peak load, and market-based gas pricing could provide the appropriate mechanism to encourage its expansion.

Expanding gas consumption would assist Japan in achieving energy security, since sources of LNG are more diverse than for oil, and would assist in achieving environmental objectives, by supplementing the planned expanded role for nuclear. In these circumstances, competitive gas pricing would facilitate the development of the gas market (such as for Independent Power Producers and cogeneration).

Competition in the Gas Market

There is very little competition in the Japanese gas market. Grid-based gas companies are granted legal monopolies in their supply areas, and some LPG retailers have a very high degree of market power in their delivery areas. Initially, monopoly markets were considered necessary to encourage the development of gas in Japan. However, especially in city areas, where gas supply is established, competition should now be a realistic option to provide an incentive to reduce costs in the same way as it has been in other IEA countries in both the gas and electricity sectors.

An important step has been taken by allowing large consumers to negotiate prices and conditions on supply directly. The range of consumers included in this group could be enlarged. Consideration might also be given to removing the legal area monopolies for grid-based supply areas where the grid has already been developed. New entrants would be allowed into these areas, and third party access to the gas distribution network would be allowed on fair and transparent terms. Regulation would, of course, continue to be necessary to protect captive consumers.

Efforts should continue to be made to encourage the substitution of LNG for manufactured gas for city gas, wherever it is economic to do so. The market behaviour of LPG retailers should be closely monitored, and anti-competitive behaviour addressed.

Coal

Security of Supply

Japan has few natural energy resources and heavy dependence on imported coal has historically been an important issue. Forecasts of coal demand in Asia have led some commentators in the past to question the continuing security of supply of coal, and raised the possibility of a rising price trend being necessary to stimulate investment and to ensure supply. In Japan, where steam coal is used primarily for base load power generation, security of physical supplies of steam coal supply is essential. The question arises whether pressure to reduce fuel costs for electricity generation will conflict with Japan's energy security objective.

Traditionally, the price paid in Japan for coal is higher than elsewhere in Asia. Other Asian markets have historically followed the Japanese price in settling contracts but there are growing differentials, for example, sales to Korea have been settled independently of Japanese prices. The relatively high coal price paid historically in Japan reflects the value placed by Japanese buyers on securing upstream investment and not the negotiating strength of suppliers.

The Japanese coal market may be becoming more sensitive to movements in the spot market. Until 1995, prices in the Japanese market followed a fairly set pattern of relationships – the price for coking coal negotiated with Australian and

Canadian producers, in particular, became a benchmark for later negotiations on thermal coal. The future of the benchmark system is now in doubt. Negotiations appear to be freer because of pressure to contain costs of electricity production. Over time, the Asia-Pacific coal market may develop along lines seen in the European coal market, with the spot market becoming a more prominent point of reference for determining price. But it will still be distinguished from the European market by the demand for coal in base load power generation. This feature of the market should ensure continuing premiums for security of supply, but with closer reference to the spot market. This could, for example, take the form of long-term contracts at a price indexed to the spot market, plus a negotiated premium.

Both producers and some Japanese buyers have argued for the benchmark price system on grounds of security of supply. Producers argue that certainty is required to encourage investment at a level to secure supply. There could be some truth in this, insofar as coal mines are "lumpy" investments with a long lead time. Some increased volatility may have to be tolerated in a freer market, which might cause more intense price cycles. Nonetheless, security of coal supply has resulted more from the large number of existing and potential coal producers in a range of countries, than from the benchmark price. The security premium, if paid on the spot market, could possibly have secured supply at a lower cost (although, of course, not necessarily from the same suppliers which benefit from the benchmark price). In this way, a freer market could have achieved secure supply and led to a natural diversification of supply. The benchmark system, by supporting particular sellers and not being explicitly linked to security of supply, may have limited the ability of new entrants into the market by not providing adequately relevant price signals and hence may have weakened security.

Coking Coal

Interest in coal supply security from an energy policy viewpoint is focused on supply of steam coal for power generation. Security of supply of high quality coking coal is also of importance, since it is less plentiful than steam coal, there are fewer suppliers to the international market than for steam coal, and consistency of quality is more critical than for coal used in power generation.

The cost of premium hard coal in steel making has been one influence on the development of new steel making technologies. One of the more effective of these is the use of Pulverised Coal Injection (PCI), which has allowed coal of lower quality, and obtainable at steam coal prices, to be used in conventional blast furnaces. Since PCI reduces the quantity of coking coal required it is, in effect, a lower priced substitute for higher quality, and higher priced, coking coal.

In negotiations between the Japanese steel mills and Australian coking coal suppliers, a clear distinction has been drawn between the very highest quality coking coal and lower qualities where substitution could be possible. In other words, high quality coking coal may continue to attract a premium but the share of the market for these coals is shrinking.

Coal Subsidies

Competition in the electricity market is placing pressure on subsidies for Japanese coal production. In May 1997, recognising the pressure on utilities to lower electricity prices, the Japanese Government reduced the standard price utilities must pay for domestically produced coal by ¥1 000, to ¥17 000 per tonne, the exact price varying regionally depending on transportation costs. In May 1998, the Japanese Government further reduced domestic coal prices by ¥1 200, to ¥15 800 per tonne. Further reductions of over ¥1 800 will be made by FY 2001. Power utilities are obliged to pay a fixed price for domestic coal, currently about twice the level of imported prices. Following the abolition of the import quota system in 1992, utilities are no longer obliged to buy a certain share of domestic production as a condition to import coal.

The future of domestic production is currently under review. Government policies have been very effective in reducing the level of domestic production. In FY 1996, the level of assistance per tonne of coal produced fell slightly and is now at a level comparable with FY 1992. The decline is expected to continue in the period to FY 2001, when the "post 8th" policies end.

As in other IEA countries, the principal motive for coal subsidies appears to be to maintain regional employment. It is inconceivable that the current tonnage of domestic production could ever be unavailable on the international market at the price paid to domestic producers. By clarifying the objective of assistance as regional employment, the link with coal mining would be weakened and decision-makers could be presented with a wider range of probably more cost-effective options not involving mining, for assisting affected regions.

RECOMMENDATIONS

The Government of Japan should:

Oil

- ☐ In the course of the planned review of the role of the Japan National Oil Corporation (JNOC), seek to quantify the tangible energy security benefits arising from JNOC's activities to date and evaluate the cost-effectiveness of their achievement.

- ☐ Consistent with its policy of self-responsibility, permit further rationalisation of gasoline retailing, notwithstanding the drastic reduction in the number of service stations that appears likely in the immediate future.

- ☐ Review the structure of customs duty applying to petroleum products, to remove anomalies which may exist between products, and particularly with the higher tariff on heavy oil.

Gas

☐ Give consideration to the means by which competition might be introduced into LNG procurement as a means of reducing the cost of gas and enhancing security of supply.

☐ Review the basis on which prices are set in the gas market, to determine the extent to which monopolistic price-setting may be impeding the growth of gas consumption and the introduction of new technologies such as trigeneration of electricity, heat and cold.

☐ Ensure that large gas consumers are able to exchange gas freely and that the tariff on transport is set at a threshold low enough to encourage small-scale cogeneration and trigeneration; ensure that a protective tariff applies to gas transport for all captive users.

☐ Further encourage the introduction of competition in the gas market wherever the gas grid has already been developed, by expanding the range of consumers able to directly negotiate price and conditions of supply, and by monitoring prices and trade practices of LPG retailers with a view to preventing any anti-competitive activities.

☐ Encourage gas grid expansion wherever economical to do so.

Coal

☐ In reviewing the future of the domestic coal industry, and the role of coal generally, acknowledge the operation of the international coal market as a cost-effective means of contributing to Japan's energy security and encourage the development of pricing formulae in long-term contracts to provide the same level of security as the former benchmark pricing system.

☐ Clarify the objectives of assistance to the coal industry, particularly those objectives which could be achieved by measures other than continuing coal production.

☐ Continue efforts to achieve structural adjustment in the coal mining industry, and the abolition by FY 2001 of existing subsidies for domestic coal production.

9

ENERGY RESEARCH, DEVELOPMENT AND TECHNOLOGY

POLICY OBJECTIVES

The *Basic Plan for Research and Development on Energy* (1995), the Law Concerning the Promotion of the Use of New Energy (1997) and the Interim Report by the Industrial Technology Council (1998) contain the following policy objectives and priorities.

Directions for promoting research and development stated in the *Basic Plan for Research and Development on Energy* are as follows:

- Diversification of energy sources.
- Improvement of efficiency of energy supply and utilisation.
- Reduction of the environmental impact of energy use.
- Co-operation with, and contribution to, international activities.
- Promotion of basic and fundamental scientific technology.

Programmes in the *Basic Plan* fall into two broad groups:

- Long-term programmes, where an emphasis is placed on discovery of new technological possibilities and technological breakthroughs.
- Programmes for technologies already in full or partial practical application, where the emphasis will be placed on improvement of efficiency, cost reduction and technological sophistication.

The *Law Concerning the Promotion of the Use of New Energy* was enacted in 1997 to accelerate the introduction of energy sources and technologies that provide alternatives to oil but are not yet widely used for economic reasons. Other measures are taken to strengthen the development of new technologies, including increased funding for development of clean energy vehicles, photovoltaic energy systems and field tests of wind generation systems and measurement of the wind resource.

In June 1998, MITI's research and development policy was revised in the *Interim Report* by the Industrial Technology Council. The overall aim of the revision is to ensure that priority will be given to achieving Japan's greenhouse gas emissions commitments. Research and development and increased use of advanced technologies are important components of Japan's efforts to reduce greenhouse gas

emissions (along with investment in nuclear capacity, accelerated energy conservation measures, protection and enhancement of sinks and international co-operation). Based on the revised energy outlook, the committee recommended that new policies should:

- Divide important energy and environmental technologies into short- and long-term technologies; short-term technologies are those which are expected to be available for practical application by 2010, while long-term technologies are those which are not expected to be available for practical application until after 2010.

- Calculate the quantitative effects of short-term technologies in reducing greenhouse gas emissions, consistent with the Kyoto Protocol.

- Take all six greenhouse gases into account.

Table 18 shows examples of projects in the two categories.

ADMINISTRATION OF RESEARCH AND DEVELOPMENT

The Agency of Industrial Science and Technology (AIST) within MITI is responsible for energy research and development other than oil, electricity and nuclear, which are administered by the Agency of Natural Resources and Energy (ANRE), MITI. The Science and Technology Agency (STA) within the Prime Minister's Office also promotes energy and nuclear research and development.

The AIST oversees the 15 research institutes, where most of the government-funded research is undertaken. Industry representatives participate in the advisory committees for research and development activities. The New Energy and Industrial Technology Development Organisation (NEDO) is an implementing agency for promoting new technology, and co-ordinates activities in the public and private sectors. NEDO is largely financed by taxes on energy.

MAJOR RESEARCH PROGRAMMES AND PRIORITIES IN THE BASIC PLAN (1995)

Diversification of Energy Sources

Nuclear Energy

The principal priority of Japan's R&D programme for diversification is to support the policy objective of promoting nuclear power as a means of securing energy supply and achieving greenhouse gas emission targets. There are five general areas of activity.

Table 18

Examples of Technologies to Reduce Greenhouse Gas Emissions

(Interim Report by the Industrial Technology Council, 1998)

	Short-term Technologies developed and disseminated by 2010	*Mid-term Technologies developed and disseminated 2010-2030*	*Long-term Technologies developed and disseminated after 2030*
Technologies for controlling energy-related carbon dioxide emissions			
New Energy	High efficiency power generation from waste. Low cost, high efficiency solar cells. Waste heat reclamation.	Power generation from completely ash-free coal.	Innovative hydrogen manufacture technology. Photovoltaic power generation in space. Conversion of methane hydrate resources.
Energy transportation and storage	Natural gas storage with absorbent material. Superconducting technology.	Ambient temperature latent heat storage.	
Advanced utilisation of energy	Advanced utilisation of supercritical fluids. Next generation high efficiency gas turbines. Ultra low power data terminal (using larger scale integrated circuits). Electric vehicles.	Hydrogen powered vehicles.	
Other technologies	Establishment of consecutive afforestation system.		Carbon dioxide sequestration and storage.
Technologies for controlling emissions of HFCs, PFCs and SF_6			
	Development of alternatives to HFCs. New cleaning technologies by alternative gases to SF_6 for chemical vapour deposition in electronic devices.	New etching process for electronic devices by using alternative gases to PFCs.	

Source: MITI.

Improving and Advancing Power Generation Systems by Employing Light Water Reactors (LWRs)

Research is directed to improving economic performance, safety and reliability. Measures to enhance the performance and safety of older plants is an important area of activity. Improving the performance of existing uranium enrichment technology is promoted in collaboration with industry. Research on next generation uranium enrichment technology is also a priority.

Technological Development of Nuclear Fuel Recycling

Japan considers uranium to be a finite energy resource and forecasts that supply will be severely limited by 2050. Nuclear fuel recycling is seen as a means of ensuring a stable future supply of energy and an effective approach to treating and disposing of radioactive wastes. Development of techniques for reprocessing uranium/plutonium mixed oxides (MOX) fuels, and the spent fuels of Advanced Thermal Reactors[26] and Fast Breeder Reactors (FBRs), is viewed as a necessary step to be taken before the commercial use of FBRs can be considered seriously. Other priorities are utilisation of MOX fuels in LWRs, the commercialisation of MOX fuel processing and handling of spent fuels.

The objective of the FBR programme in the June 1994 policy statement is to make sufficient progress with preliminary research to allow FBRs to be ready for practical use by around 2030. The December 1995 incident at the Monju FBR is generally acknowledged to have delayed the programme although the general intention to develop FBRs has been confirmed since the incident. The Atomic Energy Commission (AEC) established a "Special Committee on FBRs" at the end of January 1997, and its report accepted to continue R&D on FBRs as one of the best alternatives to the future use of fossil fuels. The AEC has supported the report of the special committee, and the carrying out of research and development based on this policy.

Back-End Measures

Research is proposed on disposal of radioactive wastes and decommissioning of reactors. A project for the disposal of high-level wastes is planned to establish an implementing entity by around 2000 and for the commissioning of a disposal facility in the 2030s or around 2045 at the latest. On-site tests of decommissioning techniques will be undertaken on actual commercial reactors.

Production of Nuclear Energy and Expansion of Nuclear-Related Fields

Basic studies are to be undertaken on reactor design, incorporating new features, such as passive safety systems in case of accidents affecting reactor cooling and

26. Advanced Thermal Reactors use heavy water as a moderator, light water as a coolant, and mixed (uranium/plutonium) oxides as a fuel. They are more efficient converters than LWRs but less efficient than FBRs. They have the advantage of avoiding the use of liquid sodium as a coolant. An Advanced Thermal Reactor began operation in Japan in 1979 but its operation was discontinued in 1995.

shut-down functions. Construction of a high temperature engineering test reactor is planned as a step towards development of a high temperature gas-cooled reactor. Research into nuclear heat utilisation, including the production of hydrogen, will be undertaken. Further research on marine reactors will be also undertaken, using results from the nuclear-powered ship "Mutsu".

Nuclear Fusion

Research priorities are in the areas of self-ignition and extended reaction times, and to establish the basic reactor engineering technology necessary to develop a prototype fusion reactor. The research will be based on the Tokamak fusion facility JT60[27]. Japan intends to participate in the International Thermonuclear Experimental Reactor (ITER), which aims to build an experimental reactor. Plasma performance and containment, reactor technologies and safety are also priority areas.

Natural Energy

Natural energy includes five areas of activity: solar, geothermal, wind, ocean, and biomass energy.

Solar Energy

Photovoltaic Power Generation:

Research priorities are to reduce the manufacturing cost and increase the conversion efficiency of thin polycrystal solar cells and thin film solar cells, to reduce the cost of system components such as modules and inverters, and to optimise power systems through means such as system control technology. A production target has been set for 2000 to achieve a production cost for solar cells of ¥ 100 to 200 per watt and power generation cost of ¥ 20 to 30 per kWh.

Solar Heat Application:

Research priorities are to reduce costs and popularise the use of active solar systems for hot water, space heating and cooling, and industrial uses, and to develop passive systems (insulation, for example) for buildings.

Sophistication of Solar Energy Utilisation:

Research priorities extend from basic material technology to applied research, with the aim of developing super high efficiency solar cells. Long range priorities include large scale utilisation technologies for solar energy, such as energy transmission satellites and extra-terrestrial power generation.

27. The Japan Atomic Energy Research Institute achieved the world's highest energy multiplication factor (1.25) in June 1998.

Geothermal Energy

Exploration, Drilling and Extraction Technology:

Drilling and extraction costs account for one-third of total geothermal energy development costs. The aim is to reduce the risk of exploiting geothermal energy by demonstration projects and feasibility studies.

Binary-Cycle Power Generation:

Binary-cycle technology uses hot water resources, unaccompanied by steam. Demonstration and reliability tests are being undertaken to develop the technology, including for applications exploiting medium and low temperature resources and in isolated locations.

Sophistication of Geothermal Energy Utilisation:

Elementary technologies are being developed for artificial reservoir creation and heat extraction to use hot-dry-rocks where steam and hot water are not naturally occurring. Long-term research is also being conducted into the extraction of thermal energy directly from the earth's magma.

Wind Energy

Priority areas for research are site selection, control technologies, system reliability and the establishment of large-scale wind power generation systems.

Ocean Energy

Research is directed to improving the economy and reliability of low density ocean energy, including wave power, thermal conversion utilising temperature differences between surface and deep-layer cold water, and energy from ocean currents and tides.

Biomass Energy

The intention is to develop biomass energy systems which do not result in net increases in carbon dioxide. Research is being conducted into the production of liquid and gaseous fuels, such as alcohol and methane, from forest and agricultural biomass.

Fossil Energy

Fossil energy includes two areas of activity: coal, and natural gas and petroenergy.

Coal

Research priorities include coal liquefaction, gasification and fluidised bed combustion technology. For coal liquefaction, the aim is to raise the yield of middle

and light fractions from various kinds of bituminous coal. For gasification, the aim is to develop a practical power generation system by early next century. Hydrogen-producing technology is also to be developed for use as a chemical raw material, for use in fuel cells, and as a high calorie gas substituting for natural gas. Pressurised fluidised bed combustion technology is being developed. Sophisticated exploration and production technologies are also to be developed.

Natural Gas and Petroenergy

Research priorities include identification of gas deposits and extraction, including the exploitation of methane hydrate. Storage technologies for natural gas and petroleum, extraction technologies for oil shale and oil sand, and refining technologies for heavy oils from these sources are also priority areas. Increasing the use of Japan's limited domestic petroleum resources is also an aim of research in this category.

Improvement of Efficiency of Energy Supply and Utilisation

Fundamental Technologies

Fundamental technologies include five areas of activity: energy conversion, energy transportation, utilisation of energy, storage of energy and effective utilisation of energy which would normally not be used.

Energy Conversion

Priorities are next generation fuel cells, ceramic gas turbines and superconducting power generation, the latter to improve system stability in, for example, transmission to remote areas.

Energy Transportation

Priorities include reducing transmission losses and improving network reliability, including for gas, in anticipation of future gas network development in Japan.

Utilisation of Energy

Priorities include direct smelting, high-efficiency electric cars, natural gas and methanol vehicles, and improvements in energy efficiency in all sectors.

Storage of Energy

Research is primarily directed at electricity load levelling, by highly efficient batteries. The research goal is to develop batteries with an energy conversion efficiency of 90%, service life of 3 500 cycles and weight-energy density four to five times higher than currently available lead batteries.

Effective Utilisation of Unused Energy

Innovative technologies are to be developed to use heat from wastes and to utilise heat differentials in river water, sewage and ground water, etc.

Social Systems Based on Efficient Use of Energy

Priority areas in this category include social research to better understand ways in which more efficient energy use can be achieved, cogeneration, recycling and other uses of low density or dispersed energy sources, hydrogen energy systems including for transport, and integration of low density energy sources (such as wave and solar energy) to improve reliability and utilisation.

Reduction of Environmental Impact of Energy Use

This category includes four areas of activity: recovery and fixation of carbon dioxide, reducing emissions of nitrogen oxides and sulphur oxides, assessment of localised environmental impacts, and global environmental impacts.

Recovery and Fixation of Carbon Dioxide

Recovery technologies, such as absorbents and separation membranes, and fixation technologies using organisms and artificial photosynthesis are being promoted.

Reducing Emission of Nitrogen Oxides and Sulphur Oxides

In the power generation sector, the aim is to develop ultra-low sulphur fuels and electron beam-based desulphurisation and denitrification technologies for combustion exhaust gases. In transport, the aim is to develop natural gas vehicles, hybrid vehicles and methanol vehicles, as well as technologies to reduce engine emissions.

Assessment of Environmental Impacts

Priorities here include life-cycle assessments and risk assessment methods, the latter considering risks to humans and ecosystems.

Global Environmental Impacts

Wide-ranging environmental impacts, such as acid rain, and prediction systems for carbon dioxide and other gases are being studied.

Co-operation with, and Contribution to, International Activities

In this category, Japan aims to work co-operatively with developing countries on low-maintenance, low-management energy systems suitable for particular regions

and locations. International research is promoted, particularly in the nuclear field, on global environmental issues and in areas where Japan has developed a technological lead.

Promotion of Basic and Fundamental Scientific Technology

In this category, Japan places priority on breakthrough research on, for example, high-temperature heat resistant materials for use in combined cycle power plants, new critical materials for fusion reactors, materials for solar cell production and superconductive materials. Basic research is promoted on plasma and nuclear physics, laser technology and microwave energy transport. System control for plant management and the analysis and assessment of energy consumption are also priorities in this area.

KEY RESEARCH AND DEVELOPMENT PRIORITIES IN THE BASIC PLAN (1995)

In the Basic Plan, a group of projects are highlighted, which are expected to be of practical use towards 2010. The priority areas are the subject of special attention for funding, short-term evaluation on technical and cost criteria, reliability and safety.

Table 19
Key Research and Development Priorities
(The Basic Plan for Research and Development on Energy, 1995)

Classification	*Projects*
1. Diversification of energy sources	
Nuclear energy	Power generation systems using light water reactors. Nuclear fuel recycling. Backend measures.
Natural energy	Photovoltaic power generation. Exploitation, drilling and extraction of geothermal energy. Binary-cycle power generation.
2. Improving efficiency of energy supply and utilisation	
Fundamental technologies	Next generation fuel cells. Ceramic gas turbines. Dispersed type batteries. Application of superconductivity in power generation.
Social systems for high efficiency energy utilisation	Social systems for comprehensive energy supply and utilisation. Systems for effective utilisation of unused energy.

Source: MITI.

NEW SUNSHINE PROGRAM

The New Sunshine Program, which began in 1993, is administered by the Agency of Industrial Science and Technology in MITI. It brings together three earlier R&D programmes:

- The Sunshine Project (1974), to develop new energy technologies.
- The Moonlight Project (1978), to develop energy conservation technologies.
- The Research and Development Project on Environmental Technology (1989).

The objective of the new programme is to develop innovative energy technology to contribute to environmentally sustainable growth. In 1996, MITI decided that the plan of activities under the New Sunshine Program should not exceed five years. It was also decided that faster dissemination of the outcomes of research and development should be implemented.

Technology research and development under the programme includes fuel cells, power generation technology, superconductive technology for electric power, ceramic gas turbine technology, broad area energy utilisation network system technology (the Eco-Energy City project) and simple chemistry. The Immediately Effective and Innovative Environmental Technology Development Program is part of the New Sunshine Program. Coal research and development conducted under the New Sunshine Program includes projects focused on technology development for converting coal to coke, on using coal gas for fuel cell power production, on pressurised fluidised bed fuel technology, on coal liquefaction and on desulphurisation technology for high-sulphur coal. The budget of the New Sunshine Program is ¥57 771 million (1998), an increase of 2.6% from 1997.

GOVERNMENT EXPENDITURE

The government allocation for energy research and development expenditure in FY 1998 decreased by 5.1% compared with the previous year. In real terms, government energy research and development budgets were flat from 1989 to 1995 and decreased steadily in nominal terms from ¥459 billion in 1996 to an estimated ¥415 billion in 1998. From 1998, the research and development budget is expected to be equal to or less than the budget of the previous year. Expenditure on nuclear and fossil research and development has decreased while expenditure on energy conservation research and development has increased. The budget for energy conservation research and development in FY 1996 was ¥34 billion, a 12.3% increase from the previous year. After dipping slightly in 1997, it is estimated to increase to almost ¥38 billion in 1998. Expenditure on nuclear research and development is projected to decrease from 76% to 73% of the government energy research and development budget from 1996 to 1998, while expenditure on energy conservation research and development is projected to increase from 7% to 9%.

Table 20
Government Energy Research and Development Expenditure
(million ¥)

	1996	*1997*	*1998 (est.)*	*% of 1998 Total*
Conservation	**34 035**	**33 220**	**37 673**	**9.1**
Fossil Fuels	**41 636**	**38 381**	**36 363**	**8.8**
Oil and Gas	16 341	15 892	14 474	
Coal	25 295	22 489	21 889	
Renewables	**13 253**	**13 194**	**13 781**	**3.3**
Solar	8 103	8 174	8 311	
Wind	607	555	477	
Ocean	147	187	1 141	
Biomass	593	586	580	
Geothermal	3 803	3 692	3 272	
Nuclear	**346 989**	**329 026**	**305 935**	**73.5**
Nuclear Fission	306 938	291 571	274 753	
Nuclear Fusion	40 051	37 455	30 182	
Power and Storage Technologies	**8 763**	**9 040**	**8 431**	**2**
Energy Systems Analysis	**1 563**	**1 800**	**1 774**	**0.4**
Other	**12 743**	**12 900**	**12 186**	**2.9**
TOTAL	**459 096**	**437 681**	**415 369**	

Source: MITI.

MAJOR NON-GOVERNMENT ENERGY RESEARCH AND DEVELOPMENT PROGRAMMES

The Federation of Electric Power Companies and the Central Electric Power Council plan research and development for the electricity sector on behalf of all the companies. Plans are published annually. The 1997 plan placed priority on developing technologies in the following areas:

- Reduction of costs to improve competitiveness, including reduction of construction, maintenance and distribution costs, and load levelling technologies.

- Nuclear power, including technologies to evaluate and extend plant life, safety and maintenance, aseismic design, new siting methods, use of mixed oxide fuels,

safety of sodium cooling systems in fast breeder reactors, and treatment and disposal of radioactive wastes.

- Coal utilisation, including coal gasification, and pressurised fluidised bed combustion.

- Recovery and disposal of carbon dioxide, and matching renewable sources of energy to local power needs.

- Fuel cells, long distance power transmission, information and communications technologies, and superconducting technologies.

In FY 1997, the Japanese electricity industry, as reported by the Central Electric Power Council, spent slightly more than ¥200 billion on research and development. About a third of this amount went to nuclear energy research and development and another third went to electricity transmission and storage. About 6% went to environmental topics, 5% to both fossil generation technologies and end-use technologies, and 3% to renewable generation technologies. The remaining 15% was allocated to "other", which includes distribution. The Federation of Electric Power Companies notes that research and development efforts within the electric power industry are becoming increasingly focused on near-term research and development projects to reduce costs and that companies are working to reduce research and development expenditures as much as possible, two trends also seen in other IEA Member countries as electricity markets become more competitive.

In February 1998, the Agency of Natural Resources and Energy within MITI formed an Electricity Research and Development Review Committee with the electric power industry, academics and industry experts. The main themes of its current work are to review how to develop a framework for the industry that will allow for increasing competition and falling electricity prices while, at the same time, addressing environmental issues. It will identify appropriate task sharing between the Government and the private sector and develop a technology benchmarking method, with the goal of promoting long-term technology research and development under more competitive electricity market conditions.

The Japan National Oil Corporation conducts technology development, mainly on oil exploration and production, the education and training of technical experts in and out of Japan, technology and information services, and international joint research and development. Priorities include:

- Technology development: enhanced oil recovery; advanced seismic imaging technology; production technology for fields in severe corrosive environments, abnormal high-pressure zone, and other difficult production environments.

- Information services: designing and creating an oil mine database.

- Education and training: offering training and education programmes to domestic and foreign experts on oil development and production technologies.

- International joint research and development: conducting joint research and development with oil producing countries and delivering research results internationally.

CRITIQUE

Government expenditure on energy research and development in Japan is easily the highest among IEA Member countries (US$ 4.7 billion in 1995 US dollars, compared with US expenditure of US$ 2.9 billion in 1995). As a proportion of GDP, Japan spends more than twice as much as any other IEA country.

The pattern of Japan's expenditure is broadly consistent with its emerging energy policy priorities. While the proportion spent on nuclear research attracted attention in the last IEA review, the added importance of achieving the nuclear production target as a key measure for achieving its greenhouse gas emissions target would suggest that continuing strong emphasis on this category is appropriate. Particular effort should be made to ensure that the level of activity in nuclear research, and its results, receive wide publicity as part of an open dialogue with the general public on nuclear issues. Some reduction in the nuclear research and development budget may be necessary, however, to accommodate increases in research and development efforts for non-nuclear projects, which are also directed to meeting Japan's greenhouse gas emissions target.

The internal consistency of Japan's expenditure might be questioned, when categories of expenditure are compared with the priorities determined in the 1995 Basic Plan for Energy Research and Development. The share of research and development expenditure allocated to the non-nuclear priorities (photovoltaics, geothermal, power and storage technologies) is very low. In total, the key non-nuclear priorities attract less than 5% of the total research and development budget. The allocation to wind energy, which is regarded as a near-viable option in many IEA countries, is also very low. Japan considers that wind energy is not a reliable source of energy for the time being because suitable sites are limited by accessibility, transmission distances, and grid integration problems. These arguments could equally be considered sound reasons for conducting research, to see if the problems could be overcome.

More importantly, the proportion of the budget allocated in 1998 to energy conservation research and development is only 9% of the total research and development budget. Given the importance of energy conservation to achieving Japan's greenhouse gas emissions target, attention might be given to raising the allocation. This now appears likely to occur in the light of the Interim Report of the Industrial Council, which drew attention to the need to reorient policies towards achieving Japan's greenhouse gas commitments.

Achieving Japan's ambitious energy efficiency goals will require a combination of technology development and lifestyle changes, which would appear to suggest that an innovative research programme would be justified. Such a programme might include

sociological and economic projects as well as technology development, since the success of the energy conservation policy will depend in large measure on the voluntary efforts of the Japanese people. Thus, for example, the motivation of individuals to be more efficient in their use of energy and the rationale for their choice of cars and air-conditioning might be fruitful areas of research to determine if the historic nexus between economic growth and energy consumption might be broken in the future.

In Chapter 5, it is commented that Japan considers that pricing may have only a limited role as a means of moderating electricity demand. The issue is particularly important for the economic efficiency of the electricity industry and its environmental performance. Research on the effectiveness of pricing as an energy policy instrument could be considered, including, for example, analysis of trials conducted by the utilities to test the effectiveness of pricing in moderating peaks in electricity demand.

Electricity companies are facing the prospect of competition in the electricity market and may be expected to reduce their research and development budgets as a cost-cutting measure. Companies have expressed concern that MITI support for advanced coal-fired power technology will be withdrawn as a competitive market develops. Nevertheless, the companies at present recognise the competitive advantage of short-term research and development and are funding projects aimed at reducing construction and maintenance costs of new and existing plants, and distribution and transmission costs. Extending the life of existing nuclear plant and lowering the cost of new plant, will have an important bearing on the success of Japan's nuclear production target (see Chapter 6). The industry considers that the nuclear fuel cycle, if extended to a plutonium and breeder phase, will require continuing government support.

Japan has endeavoured to divide its priorities between short-term projects, where results might be expected to have practical results by 2010, and projects with a longer time frame. Such a division is necessarily a matter for judgement but, in Japan's case, appears soundly based. On the other hand, the criteria for deciding which projects are to be supported appear to rest on technical grounds. Projects in the shorter-term category, in particular, should take into account the potential commercial prospects of new technologies. Here, the views of industry should be an important consideration in project selection. The Electricity R&D Review Committee provides an existing framework that could be used both to solicit industry views on project selection and to identify ways to achieve the Government's goal of encouraging a mix of shorter-term and longer-term R&D in industry.

RECOMMENDATIONS

The Government of Japan should:

- ☐ Review the share of research and development funding given to developing wind power, in the light of its economic and technical performance in other IEA

countries, and with a view to responding to the difficulties encountered in its application in Japan.

- ☐ Review the share of research and development funding for energy conservation, in view of the importance of energy conservation to achieving Japan's greenhouse targets; and give consideration to socio-economic research on consumer motivation and the effectiveness of pricing as an instrument of energy policy.

- ☐ Ensure that industry views are considered in reaching decisions on funding for particular projects, within the Government's overall research and development strategy, so that long-term commercial potential is a criterion for project selection for projects expected to be implemented by 2010, in particular.

- ☐ Continue to pursue a mix of shorter-term and long-term research and development and to encourage industry to do the same; and consider sharing the results of the Electricity Research and Development Review Committee's deliberations on this subject with other IEA Member countries.

A

ANNEX

Outline Of The *ACTION PROGRAMME FOR ECONOMIC STRUCTURE REFORM*

(Decision of the Cabinet, May 1997)

CREATION OF A BUSINESS ENVIRONMENT IN LINE WITH INTERNATIONAL STANDARDS

1. Revision of the High Cost Structure

Drastic Deregulation

It was decided to undertake increased efforts regarding the physical distribution, energy and information communication, which are the fundamental industrial services, in order to provide by 2001 international standard services in terms of costs and other performance features. Japan will, with respect to the financial field, promote revision of the financial system, including drastic deregulation, with the target that Japan's financial markets will become international markets, which can compete by 2001 with New York and London.

2. Major Items

Physical Distribution

The necessary measures are to be taken, in order to abolish, in principle, supply and demand regulations within the target period 1999 to 2001.

Energy

Electric Power

The foundation will be realised for decreasing over the medium to long term Japan's cost of electric power through improvements in the load factor.

- Improvement of the load factor (the ratio between average electric power compared to maximum electric power generation, which determines the operating ratio of the electric utility industry's assets, including power generation and power transmission), is a core measure in decreasing Japan's cost of electricity. 1% of load factor is roughly equivalent to 1% electric power cost (about ¥150 billion).

- Study of concrete measures (promoting diffusion of the regenerative air-conditioning system, gas air-conditioners, and so on) by the Government, the electric utility industry, manufacturers and customers (in 1997). Decision on the load factor revision target (in 1997).

■ Increased use of IPP (Independent Power Plants)

Investigation into the potential supply capacity of IPPs (in the fall of 1997). Request to the electric utility companies for setting a target for long-term tender invitation (at the end of 1997).

■ Accelerated efforts for efficient management by the electric utility industry, such as by raising efficiency in the supply of materials and electric machinery.

The supply side system of Japan's electric utility industry will be overhauled, in order to accelerate further introduction of the principle of competition, in reference to the actual reform situation of the regulatory framework, which has been implemented in other countries. The core measures are as outlined hereunder.

■ In the field of power generation : Systems study, in order to facilitate both the power source development plan of the power companies and that of the independant power produces, so that they can compete with each other on equal terms (within a year's time).

■ Study of the formation of electric power distribution facilities (in the transmission and distribution department) in 1997.

Another revision of tariffs is expected in 2000, in addition to the revision of the power tariffs in 1998.

Oil

Deregulation and a revision of the system, which will enable substantial reductions in supply costs, will be implemented by the target year 2001. This will be done taking into full account the security of oil supply and promoting further the introduction of the market principle, such as building up closer co-operation with the international market.

■ Monitoring changes in the oil market in the wake of abolishing, after the fall of 1997, the *Provisional Measures Law on the Importation of Specific Kinds of Petroleum Refined Products*:

i) Establishment of a competitive environment in the petroleum refinery industry, under the premise that competition prevails in the international market.
ii) Improvements in practicality and efficiency in stockpiling.
iii) Establishment of an environment which secures stable supply of crude oil and improves economic efficiency.
iv) Discussion of the problems in the Petroleum Council, such as emergency measures.

Gas

■ Regulations concerning supply, including the supply area, will be subject to discussions regarding town gas, taking into consideration the arrangements for

competitive conditions among businesses as was in the past study, will be implemented within a year's time to provide choices among ordinary gas companies and other competing energy companies.

General Direction of the follow-up to the *Action Programme for Economic Structure Reform*
(Decision of the Cabinet, 24 December 1997)

The Government of Japan adopted the *Structural Economic Adjustment Programme* in December 1997 in order to promote decisive and prompt fundamental economic reform. Also, the *Action Program for Structural Economic Adjustment* adopted in Cabinet meetings in May 1998 with a view to provide, under the instruction of Prime Minister Hashimoto, as follow-up concrete guidelines for steady policy implementation.

The Government of Japan implemented follow-up measures, which included additional new policies, the steady promotion of the *Action Plan* and front-loading of the plan to the extent possible, in order to deepen the content of the structural economic reforms and in order to accelerate the process itself. Newly added policies under which concrete measures were adopted under these follow-up measures are identified below.

CREATION OF A BUSINESS ENVIRONMENT IN LINE WITH WORLD STANDARDS

1. Revision of the High Cost Structure

Fundamental Deregulation

A decision was adopted to aim at providing by 2001, services, the standard of which including cost levels, compares with the rest of the world with respect to the physical distribution of energy as well as information communication, which are basic elements of industrial activities.

2. Main Issues

Physical Distribution and Transportation

As regards market entry regulations, the *Supply and Demand Coordination Law* will be abolished within the target time frame of 1999 to 2001. Along with this, the necessary measures about environmental and conditional arrangements will be adopted.

Energy

Electric Power

Improvements in the load factor and in the establishment of distribution facilities are to be realised, while competition in the power generating industry will be

increased in order to establish the medium- to long-term foundation for decreasing Japan's electric power costs.

- After the adoption of a definite plan by May 1998, necessary measures will be adopted, including the revision of laws as to the system concerning the framework of electric power supply and the demand system itself.

- An environment enhancing the diffusion of regenerative air-conditioning systems and gas air-conditioners will be established, and the realisation of the electricity tariff system and technological development, such as load factor control technology, will be promoted. This will be done with the target of reducing electric power by 2010 by a maximum of about 17 million kW. This target will be reflected gradually in the power supply and demand plan after next year.

- A neutral organisation will be put in charge of *ex post* evaluation for securing equal level competition among participants in such cases in which power companies evaluate bids, while being bidders themselves. This will be done, in principle, keeping in mind the concept of competition in the field of the power generating industry, for all newly developed thermal power sources, except those already decided. However, a new bidding system will be introduced and implemented, in principle, starting in 1999, under which divided accounting should be applied with respect to successful bidding for thermal power sources. As regards electric power distribution facilities, the electric utility industry will be asked for cost reductions through rationalisation and enhanced efficiency of facility plants as well as the supply system itself, the system's configuration and maintenance. At the same time, the Government of Japan will, in order to reduce costs, arrange gradually the environment through the rationalisation of prior-to-use inspections and other means.

- A further revision of tariffs is expected by 2000 in addition to the realisation of tariff reductions in November 1998 (total reduction by ten power companies amounts to ¥520 billion), in order to rechannel benefits into society which have been gained through efficient management efforts.

Oil

Deregulation measures and a revision of the system itself, which will enable substantial supply cost reductions, will be implemented by 2001. This will be done taking into full consideration the securing of oil supply, and the promotion of further introduction of the market principle, such as building up closer co-operation with the international markets.

Oil supply will be secured within the framework of a changed domestic and international environment, while a drastic overhaul of supply and demand regulations, such as the permission system for oil refining facilities and emergency measures (conclusions on which will be reached by July 1998), will be implemented.

- The system, under which a gasoline source certification is required when registering a newly built oil depot, will be abolished by January 1998.

- Necessary measures will be adopted at the earliest possible time in 1998 with regard to relaxing the obligation to attend at the time of stocktaking of oil depots, under the condition of securing safety.

Gas

- As for town gas, discussions will be held on the regulations concerning large supply, including supply areas, and the promotion of a competitive environment among businesses. As for providing choices among ordinary gas companies and other competing energy companies, discussion will be held towards adoption of the necessary measures.

- The biggest three town gas companies are expected, through accelerating efficient management, to revise tariffs by the end of 2001 at the latest.

B

ANNEX

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	1996	1997P	2000	2005	2010
TOTAL PRODUCTION		**29.5**	**75.6**	**102.5**	**107.5**	**118.0**	**138.4**	**163.7**
Coal[1]		17.9	4.6	3.6	2.9	2.9	2.9	2.9
Oil		0.8	0.6	0.8	0.7	0.7	0.7	0.7
Gas		2.3	1.8	2.0	2.0	2.0	2.0	2.0
Comb. Renewables & Wastes[2]		–	6.7	7.1	7.1	8.0	9.7	11.9
Nuclear		2.5	52.7	78.8	83.6	91.8	107.2	125.1
Hydro		5.7	7.7	6.9	7.6	7.9	8.5	9.0
Geothermal		0.2	1.5	3.4	3.5	4.6	7.3	11.5
Solar / Wind / Other[3]		–	–	0.0	0.0	0.0	0.1	0.5
TOTAL NET IMPORTS[4]		**300.7**	**364.2**	**411.4**	**406.7**	**398.7**	**386.2**	**376.2**
Coal[1]	Exports	0.4	1.0	1.6	1.8	1.8	1.7	1.7
	Imports	41.3	70.0	83.1	85.0	83.8	80.6	77.6
	Net Imports	40.9	69.0	81.5	83.2	82.1	78.9	75.9
Oil	Exports	2.9	3.8	8.1	15.5	15.2	14.8	14.5
	Imports	276.7	262.6	288.0	290.6	281.0	267.0	255.0
	Bunkers	16.8	5.1	4.2	5.0	5.0	5.0	5.0
	Net Imports	257.0	253.6	275.7	270.1	260.7	247.2	235.5
Gas	Exports	–	–	–	–	–	–	–
	Imports	2.8	41.7	54.3	53.4	55.8	60.1	64.8
	Net Imports	2.8	41.7	54.3	53.4	55.8	60.1	64.8
Electricity	Exports	–	–	–	–	–	–	–
	Imports	–	–	–	–	–	–	–
	Net Imports	–	–	–	–	–	–	–
TOTAL STOCK CHANGES		**–6.6**	**–1.0**	**–3.5**	**–1.9**	**–**	**–**	**–**
TOTAL SUPPLY (TPES)		**323.6**	**438.8**	**510.4**	**512.3**	**516.6**	**524.6**	**539.9**
Coal[1]		57.9	74.0	84.6	86.8	85.0	81.8	78.9
Oil		252.2	252.9	273.5	268.3	261.5	247.9	236.2
Gas		5.1	43.3	56.1	55.4	57.9	62.2	66.8
Comb. Renewables & Wastes[2]		–	6.7	7.1	7.1	8.0	9.7	11.9
Nuclear		2.5	52.7	78.8	83.6	91.8	107.2	125.1
Hydro		5.7	7.7	6.9	7.6	7.9	8.5	9.0
Geothermal		0.2	1.5	3.4	3.5	4.6	7.3	11.5
Solar / Wind / Other[3]		–	–	0.0	0.0	0.0	0.1	0.5
Electricity Trade[5]		–	–	–	–	–	–	–
Shares (%)								
Coal		*17.9*	*16.9*	*16.6*	*16.9*	*16.5*	*15.6*	*14.6*
Oil		*77.9*	*57.6*	*53.6*	*52.4*	*50.6*	*47.3*	*43.8*
Gas		*1.6*	*9.9*	*11.0*	*10.8*	*11.2*	*11.9*	*12.4*
Comb. Renewables & Wastes		*–*	*1.5*	*1.4*	*1.4*	*1.5*	*1.9*	*2.2*
Nuclear		*0.8*	*12.0*	*15.4*	*16.3*	*17.8*	*20.4*	*23.2*
Hydro		*1.8*	*1.8*	*1.4*	*1.5*	*1.5*	*1.6*	*1.7*
Geothermal		*0.1*	*0.3*	*0.7*	*0.7*	*0.9*	*1.4*	*2.1*
Solar / Wind / Other		*–*	*–*	*–*	*–*	*–*	*–*	*0.1*
Electricity Trade		*–*	*–*	*–*	*–*	*–*	*–*	*–*

0 is negligible, – is nil, .. is not available.

Please note: Data for 1997 are provisional. Data for 2000 and 2005 are IEA Secretariat estimates. In 2010, data for combustible renewables and wastes, electricity generated, production and imports of coal, oil and gas, and bunkers are IEA Secretariat estimates.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	1996	1997P	2000	2005	2010
TFC	**235.3**	**294.5**	**337.1**	**334.9**	**335.3**	**336.9**	**340.6**
Coal[1]	20.2	22.5	21.4	22.2	21.8	21.5	21.2
Oil	172.4	188.3	214.5	210.3	206.7	198.6	191.4
Gas	7.0	14.7	20.5	20.1	20.8	23.9	27.6
Comb. Renewables & Wastes[2]	–	3.7	3.4	3.4	4.0	5.4	7.1
Geothermal	–	–	0.2	0.3	0.3	0.5	0.7
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	35.7	65.1	76.6	78.2	81.1	86.3	91.7
Heat	0.0	0.2	0.4	0.4	0.5	0.7	0.9
Shares (%)							
Coal	*8.6*	*7.6*	*6.4*	*6.6*	*6.5*	*6.4*	*6.2*
Oil	*73.3*	*63.9*	*63.6*	*62.8*	*61.6*	*59.0*	*56.2*
Gas	*3.0*	*5.0*	*6.1*	*6.0*	*6.2*	*7.1*	*8.1*
Comb. Renewables & Wastes	–	*1.3*	*1.0*	*1.0*	*1.2*	*1.6*	*2.1*
Geothermal	–	–	*0.1*	*0.1*	*0.1*	*0.1*	*0.2*
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	*15.2*	*22.1*	*22.7*	*23.4*	*24.2*	*25.6*	*26.9*
Heat	–	*0.1*	*0.1*	*0.1*	*0.2*	*0.2*	*0.3*
TOTAL INDUSTRY[6]	**140.2**	**134.5**	**144.1**	**157.4**	**156.8**	**156.1**	**155.9**
Coal[1]	18.2	21.7	20.4	21.2	20.7	20.4	19.9
Oil	94.9	73.3	78.9	90.5	88.4	84.2	80.6
Gas	2.1	4.6	7.7	7.4	7.8	8.8	9.8
Comb. Renewables & Wastes[2]	–	2.5	2.2	2.2	2.4	2.6	2.9
Geothermal	–	–	0.1	0.1	0.1	0.2	0.4
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	25.1	32.4	34.8	36.0	37.4	39.8	42.4
Heat	–	–	–	–	–	–	–
Shares (%)							
Coal	*13.0*	*16.2*	*14.1*	*13.5*	*13.2*	*13.0*	*12.7*
Oil	*67.7*	*54.4*	*54.7*	*57.5*	*56.4*	*54.0*	*51.7*
Gas	*1.5*	*3.4*	*5.4*	*4.7*	*5.0*	*5.7*	*6.3*
Comb. Renewables & Wastes	–	*1.8*	*1.5*	*1.4*	*1.5*	*1.7*	*1.8*
Geothermal	–	–	*0.1*	*0.1*	*0.1*	*0.2*	*0.3*
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	*17.9*	*24.1*	*24.2*	*22.8*	*23.8*	*25.5*	*27.2*
Heat	–	–	–	–	–	–	–
TRANSPORT[7]	**43.4**	**74.3**	**90.0**	**86.0**	**85.0**	**83.6**	**83.2**
TOTAL OTHER SECTORS[8]	**51.6**	**85.7**	**102.9**	**91.4**	**93.5**	**97.1**	**101.5**
Coal[1]	1.8	0.8	1.1	1.0	1.1	1.2	1.3
Oil	35.4	42.5	47.4	35.6	35.2	34.2	33.3
Gas	5.0	10.1	12.7	12.6	12.9	13.6	14.2
Comb. Renewables & Wastes[2]	–	1.2	1.2	1.2	1.7	2.8	4.2
Geothermal	–	–	0.1	0.1	0.2	0.2	0.3
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	9.5	30.9	39.9	40.4	41.9	44.5	47.2
Heat	0.0	0.2	0.4	0.4	0.5	0.7	0.9
Shares (%)							
Coal	*3.4*	*0.9*	*1.1*	*1.1*	*1.2*	*1.2*	*1.3*
Oil	*68.6*	*49.6*	*46.1*	*39.0*	*37.7*	*35.3*	*32.9*
Gas	*9.6*	*11.8*	*12.4*	*13.8*	*13.8*	*14.0*	*14.0*
Comb. Renewables & Wastes	–	*1.4*	*1.2*	*1.3*	*1.8*	*2.8*	*4.1*
Geothermal	–	–	*0.1*	*0.2*	*0.2*	*0.2*	*0.3*
Solar / Wind / Other	–	–	–	–	–	–	–
Electricity	*18.4*	*36.1*	*38.8*	*44.2*	*44.8*	*45.8*	*46.6*
Heat	*0.1*	*0.2*	*0.4*	*0.4*	*0.6*	*0.7*	*0.9*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	1996	1997P	2000	2005	2010
ELECTRICITY GENERATION[9]							
INPUT (Mtoe)	**90.5**	**170.6**	**210.4**	**214.9**	**221.1**	**233.8**	**252.0**
OUTPUT (Mtoe)	**40.0**	**73.2**	**86.3**	**88.3**	**90.6**	**95.5**	**101.5**
(TWh gross)	465.4	850.8	1003.2	1027.1	1053.0	1110.0	1180.0
Output Shares (%)							
Coal	*8.0*	*14.7*	*18.2*	*17.7*	*17.2*	*16.2*	*15.2*
Oil	*73.2*	*30.1*	*21.0*	*20.5*	*18.3*	*14.4*	*11.2*
Gas	*2.3*	*19.4*	*20.2*	*19.7*	*19.8*	*20.5*	*20.2*
Comb. Renewables & Wastes	*–*	*1.3*	*2.0*	*2.0*	*2.1*	*2.2*	*2.3*
Nuclear	*2.1*	*23.8*	*30.1*	*31.2*	*33.4*	*37.0*	*40.7*
Hydro	*14.3*	*10.5*	*8.0*	*8.6*	*8.7*	*8.9*	*8.9*
Geothermal	*0.1*	*0.2*	*0.4*	*0.4*	*0.5*	*0.7*	*1.1*
Solar/Wind/Other	*–*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.5*
TOTAL LOSSES	**94.5**	**143.2**	**174.2**	**178.9**	**181.4**	**187.7**	**199.3**
of which:							
Electricity and Heat Generation[10]	50.5	97.2	123.7	127.0	130.0	137.2	149.5
Other Transformation	25.1	23.3	24.6	27.6	27.4	27.1	27.1
Own Use and Losses[11]	19.0	22.7	26.0	24.4	24.0	23.3	22.6
Statistical Differences	**–6.2**	**1.2**	**–0.9**	**–1.5**	**–**	**–**	**–**

INDICATORS

	1973	1990	1996	1997P	2000	2005	2010
GDP (billion 1990 US$)	1590.43	2970.09	3315.66	3332.00	3640.97	4159.77	4706.39
Population (millions)	108.66	123.54	125.86	126.25	127.40	128.89	130.40
TPES/GDP[12]	0.20	0.15	0.15	0.15	0.14	0.13	0.11
Energy Production/TPES	0.09	0.17	0.20	0.21	0.23	0.26	0.30
Per Capita TPES[13]	2.98	3.55	4.05	4.06	4.06	4.07	4.14
Oil Supply/GDP[12]	0.16	0.09	0.08	0.08	0.07	0.06	0.05
TFC/GDP[12]	0.15	0.10	0.10	0.10	0.09	0.08	0.07
Per Capita TFC[13]	2.17	2.38	2.68	2.65	2.63	2.61	2.61
Energy-related CO_2 Emissions (Mt CO_2)[14]	910.2	1061.8	1177.7	..	1147.8	1109.8	1078.4
CO_2 Emissions from Bunkers (Mt CO_2)	53.5	16.3	13.5	..	16.1	16.1	16.1

GROWTH RATES (% per year)

	73–79	79–90	90–96	96–97	97–00	00–05	05–10
TPES	1.5	2.0	2.5	0.4	0.3	0.3	0.6
Coal	–2.0	3.4	2.3	2.5	–0.7	–0.8	–0.7
Oil	0.4	–0.2	1.3	–1.9	–0.8	–1.1	–1.0
Gas	24.2	8.0	4.4	–1.1	1.5	1.4	1.5
Comb. Renewables & Wastes	–	–	0.8	0.1	4.1	4.1	4.1
Nuclear	39.1	10.1	6.9	6.2	3.1	3.1	3.1
Hydro	3.2	0.9	–1.7	10.0	1.3	1.3	1.3
Geothermal	22.3	6.2	14.6	3.1	9.6	9.6	9.6
Solar/Wind/Other	–	–	–	33.3	44.2	46.1	45.2
TFC	0.9	1.6	2.3	–0.7	0.0	0.1	0.2
Electricity Consumption	3.9	3.4	2.8	2.1	1.2	1.2	1.2
Energy Production	4.9	6.1	5.2	4.9	3.1	3.2	3.4
Net Oil Imports	0.5	–0.4	1.4	–2.0	–1.2	–1.1	–1.0
GDP	3.5	3.9	1.9	0.5	3.0	2.7	2.5
Growth in the TPES/GDP Ratio	–1.9	–1.9	0.7	–0.1	–2.6	–2.3	–1.9
Growth in the TFC/GDP Ratio	–2.5	–2.2	0.4	–1.1	–2.9	–2.5	–2.2

Please note: Rounding may cause totals to differ from the sum of the elements.

Footnotes to Energy Balances and Key Statistical Data

1 Includes lignite and peat.

2 Comprises solid biomass and animal products, gas/liquids from biomass, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

3 Other includes tide, wave and ambient heat used in heat pumps.

4 Total net imports include combustible renewables and waste.

5 Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.

6 Includes non-energy use.

7 Includes less than 1% non-oil fuels.

8 Includes residential, commercial, public service and agricultural sectors.

9 Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.

10 Losses arising in the production of electricity and heat at public utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 33% for nuclear, 10% for geothermal and 100% for hydro.

11 Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.

12 Toe per thousand US dollars at 1990 prices and exchange rates.

13 Toe per person.

14 "Energy-related CO_2 emissions" specifically means CO_2 from the combustion of the fossil fuel components of TPES (i.e. coal and coal products, peat, crude oil and derived products and natural gas), while CO_2 emissions from the remaining components of TPES (i.e. electricity from hydro, other renewables and nuclear) are zero. Emissions from the combustion of biomass-derived fuels are not included, in accordance with the IPCC greenhouse gas inventory methodology. TPES, by definition, excludes international marine bunkers. INC-IX decided in February 1994 that emissions from international marine and aviation bunkers should not be included in national totals but should be reported separately, as far as possible. CO_2 emissions from bunkers are those quantities of fuels delivered for international *marine* bunkers and the emissions arising from their use. Data for deliveries of fuel to international *aviation* bunkers are not generally available to the IEA and, as a result, these emissions have not been deducted from the national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 1996 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

C

ANNEX

INTERNATIONAL ENERGY AGENCY
"SHARED GOALS"

The Member countries* of the International Energy Agency (IEA) seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

1 Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2 Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3 The environmentally sustainable provision and use of energy is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.

4 More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA Members wish to retain and improve the nuclear option for the

* Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5 Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6 Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-Member countries, should be encouraged.

7 Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8 Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9 Co-operation among all energy market participants helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

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ANNEX

GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention and abbreviated subsequently, this glossary provides a quick and central reference for many of the abbreviations used.

bcm	billion cubic metres.
b/d	barrels per day.
cal	calorie.
CHP	combined production of heat and power; sometimes, when referring to industrial CHP, the term "cogeneration" is used.
EU	The European Union, whose members are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.
GDP	gross domestic product.
GJ	gigajoule, or 1 joule $\times 10^9$.
GW	gigawatt, or 1 watt $\times 10^9$.
kl	kilolitre (1 kilolitre = 6.289 barrels).
LNG	liquefied natural gas.
LPG	liquefied petroleum gas; refers to propane, butane and their isomers, which are gases at atmospheric pressure and normal temperature.
mcm	million cubic metres.
Mt	million tonnes.
Mtoe	million tonnes of oil equivalent; see toe.
MW	megawatt of electricity, or 1 Watt $\times 10^6$.
MWh	megawatt-hour = one megawatt $\times$ one hour, or one watt $\times$ one hour $\times 10^6$.
NEA	the Nuclear Energy Agency of the OECD.
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, i.e. estimates the differences in price levels between different countries.
TFC	total final consumption of energy; the difference between TPES and TFC consists of net energy losses in the production of electricity and synthetic gas, refinery use and other energy sector uses and losses.

toe	tonne of oil equivalent, defined as 10^7 kcal.
TPES	total primary energy supply.
TW	terawatt, or 1 watt $\times 10^{12}$.
TWh	terawatt $\times$ one hour, or one watt $\times$ one hour $\times 10^{12}$.
UNFCCC	United Nations Framework Convention on Climate Change.