INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

JAPAN

2008 Review

OECD

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The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-seven of the OECD thirty member countries. The basic aims of the IEA are:

- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations.
- To operate a permanent information system on the international oil market.
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- To promote international collaboration on energy technology.
- To assist in the integration of environmental and energy policies.

The IEA member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. Poland is expected to become a member in 2008. The European Commission also participates in the work of the IEA.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.
The European Commission takes part in the work of the OECD.

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EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

The second-largest economy in the IEA, Japan is a world leader in progressing energy and environmental policy. The country is actively engaged in the international policy-making process and is committed to guiding the world's economies along a sustainable and secure energy pathway. In the environment arena, Japan has led by example, committing to meeting its own climate change targets while urging global action for the long term. It has also shown leadership in the Asia-Pacific region, helping to drive technology transfer and collaboration with its neighbours – helping expand energy efficiency and, as a result, increasing energy security and reducing greenhouse gas emissions. With its 2008 presidency of the G8, Japan is resolved to continue to elevate the issues of climate change and energy efficiency.

There is much to praise in Japan's domestic energy policies. It has a well-developed and robust energy R&D programme, to which significant government resources continue to be devoted. In fact, its commitment to energy R&D spreads benefits beyond Japan. The country is also steadfast in its commitment to nuclear energy as a major component of its energy mix, extracting the significant benefits of this greenhouse gas-free generation source. Its nuclear industry is also prominent globally, supplying the international market with state-of-the-art technologies. Similarly, Japan's renewables industry, particularly solar photovoltaics, and its electronics industry supply the world with cutting-edge technologies that reduce global greenhouse gas emissions and increase global energy security. Turning to fossil fuels, the country is a pioneer in the industry with strong policies to ensure security of supply and a well-developed infrastructure that has laid the foundation for the global trade in liquefied natural gas. The country makes energy security through energy diversity a top priority. It also helps underpin a secure oil supply for IEA countries by holding much more than its required share of oil stocks. Finally, the IEA sees that enhanced competition can bring to Japan important benefits such as global competitiveness and security of supply. To that end, we are pleased to note the efforts the country is now making towards liberalising its gas and electricity markets.

One policy area that deserves particular notice is energy efficiency. The government puts tremendous effort into increasing energy efficiency in the country and has established some innovative policies, including the Top Runner programme for product efficiency. The programme drives domestic efficiency, but also spurs international gains given Japan's position as a major exporter of electronics and vehicles. Notably, it is designed to continue to place pressure to improve energy efficiency, and thus has a built-in mechanism to drive energy improvement over the long term without continued policy negotiation. In general, we commend the government for its strong leadership in energy efficiency and urge it to continue to refine and improve the programme. Japan's commitment to energy efficiency helps underpin global gains in energy efficiency.

Building on this strong progress, this report explores areas of energy and environmental policy where improvements can be made to ensure that Japan's policies fully balance the "3 Es" of sound energy policy – Energy security, Environmental sustainability and Economic efficiency. As in all countries, further progress can be made, and given the strong leadership Japan continues to show, the country is up to the task. In describing the challenges that Japan faces, three themes emerge – the need to complement existing voluntary measures and regulations with stronger policies in some areas; the need to enhance market signals and create the right incentives in the economy; and the need for more integration of its internal energy markets. Improvements in these areas have many benefits, most notably long-term, stable security of energy supply and the ability to cost-effectively reduce greenhouse gas emissions. At the same time, we urge the country to continue its strong leadership in the area of international collaboration and technology transfer.

CONTINUING INTERNATIONAL LEADERSHIP AND TECHNOLOGY COLLABORATION

Recently, Japan has been an active member of the Asia-Pacific Partnership on Clean Development and Climate (APP), in particular playing a leading role in the steel and cement sectors by taking a sectoral approach, which aims to identify the energy conservation and CO_2 reduction potential of each country. Japan is promoting the application of this approach as an effective tool for setting objective and fair targets. Japan also regards energy conservation as a means for simultaneously solving issues in relation to energy security, the strengthening of competitiveness of the national economy and climate change. The country has demonstrated leadership in the Asia-Pacific region, such as at the East Asia Summit and Asia-Pacific Economic Co-operation (APEC), by setting individual goals and formulating action plans voluntarily for improving energy efficiency. Moreover, Japan has been encouraging the transfer of know-how and technical knowledge in the field of energy efficiency. With its 2008 presidency of the G8, Japan is working to raise the profile of the issues of climate change and energy efficiency. It has already done so through the recent launch of the *Cool Earth Promotion Programme* at the World Economic Forum in Davos in January 2008. In this programme, Japan advocates that in order to reduce global greenhouse gas emissions by half by 2050, technological innovation is critical in coping with climate change.

With this perspective, the government will focus on R&D investment in the environmental and energy sectors, injecting about USD 30 billion into these sectors over the next five years. The government also states that it is necessary to establish a framework for accelerating technological development and sharing the resulting achievements through close partnership with the IEA and other relevant parties. The IEA encourages Japan to continue its international leadership on climate change as this can help foster important dialogue for the future. We also appreciate Japan's efforts to diffuse energy-saving technology in Asian countries, including China and India, by dispatching energy-saving experts, accepting trainees and supporting energy-saving projects. The country's good work to enhance technology transfer in the Asian region – thereby helping lower global energy demand – is a model for other countries and the IEA urges it to continue.

COMPLEMENTING EXISTING VOLUNTARY MEASURES

Japan's government has strong energy and environmental policies in place. Among these policies, there is strong emphasis on voluntary approaches, particularly with industry, as this is seen to allow greater flexibility and less government involvement. Many countries rely on voluntary agreements with industry and Japan's programme is notably comprehensive. In many cases, in fact, the voluntary approaches are voluntary in name only and the success rate has been very high – companies that commit to trying to meet the standard or requirement always do. This is the case with the Keidanren agreements with industry, where companies have an excellent record of fulfilling their goals. In general, however, there is room to complement the existing voluntary measures with other policies. This is true most notably in the housing sector, where the largely voluntary approach leaves room for efficiency improvements. Though some of the benefits of stronger building codes take longer to materialise owing to slow building stock turnover, the housing sector offers one of the largest opportunities for efficiency gains and greenhouse gas emissions reductions. Therefore we are pleased to see the recent efforts to specify energy efficiency standards that apply to a greater share of large buildings. Nevertheless, most other IEA countries have recognised the effectiveness of standards in improving energy efficiency in buildings and have made these standards mandatory.

Strengthened regulations could also benefit the gas and electricity sectors, where some of the rules in place may not be strict enough to achieve the necessary result, though they are in the process of being revised. In both the natural gas and electricity sectors, the incumbent utilities do not yet seem to have sufficient incentives to level the playing field for smooth energy trading. In the electricity sector, clearer requirements on third-party access would enhance competition. Moreover, there should be strong rules governing the balancing market and allocation of inter-regional transmission capacity.

In the nuclear sector, the clarity in the organisation of the safety regulator could be improved as such clarity is critical for public support of nuclear power. The IEA does not doubt the independence of the Nuclear and Industrial Safety Agency, but it is important that the public and investors are also convinced. In short, perception is important and more needs to be done to clarify and highlight this independence. In addition, the lack of irrefutable clarity on regulatory independence may lead regulators to be overly conservative as a means to counter the public's perception – ultimately undermining the economics of more efficient operation of nuclear facilities.

FURTHER ENHANCING MARKET SIGNALS AND INCENTIVES

Enhancing the existing policies and complementing the voluntary ones does not require imposing cumbersome regulations. Creating market signals throughout the economy is the clearest way of driving sustainable policy outcomes, but one that does not require imposing strict regulations. Particularly with respect to climate change goals, putting a value on greenhouse gas emissions in the economy will naturally drive consumer choices towards technologies and behaviours with lower emissions. Consumers need market signals to make the right choices. In some cases, standards and other policies can be the more appropriate way to drive energy policy. Sectoral approaches could also be a part of the overall policy mix. In addition, taxes, emissions trading schemes and other market-based policies could create the right signals and encourage the more efficient use of resources throughout the economy. Such signals are also necessary to help balance measures to reduce CO_2 emissions and ensure that reductions are undertaken in the parts of the economy where the costs of doing so are lowest. Thus we are pleased to see the voluntary trading scheme currently in place as well as discussion of a proposed carbon offset scheme aimed at reducing greenhouse gas emissions from small and medium-sized enterprises. Building on these efforts, the government should work to create a market signal for greenhouse gas emissions that spreads throughout the economy.

Turning back to the electricity sector, stronger market signals would also help enhance energy security. In its current state, the partial liberalisation of the sector risks undermining the regulatory certainty that companies require to make the large, capital-intensive investments in new electricity capacity, particularly nuclear capacity. Rather than trying to ensure that policy priorities are met in a partly regulated and partly competitive market, it can be more efficient, transparent and secure to ensure policy objectives through direct incentives, such as by reflecting the value of low-CO_2-emitting energy sources. The combination of stronger regulations and proper market incentives and price signals would also lead to better performance of the electricity capacity, including nuclear capacity, resulting in higher capacity factors overall. It would also create a framework for competition to develop, giving confidence to market participants to enter and invest in the market.

BETTER INTEGRATING INTERNAL ENERGY MARKETS

As discussed, enhanced competition in Japan's gas and electricity markets could help further improve energy security, which would be accomplished by greater physical and market integration throughout the country. Owing to the historical development of the electricity grid in Japan, the power sector has ten vertically integrated utilities covering all its geographic regions. The regions are integrated, but interconnections are generally weak and regulations do not sufficiently encourage inter-regional trade. In the gas sector, the country has grids centred near LNG import terminals. The trunk pipeline networks of these grids are not fully interconnected across the country.

In the electricity sector, the benefits of greater reliance on trade across regions are clear. Long-standing power system operations rely on trade to enhance system security; the larger a regional grid, the greater the options for managing system load by relying on this larger suite of resources to either increase or decrease total supply. Within an adequately regulated framework and with independent system operations, the right incentives would be in place to ensure efficient sharing of resources across jurisdictions. This would help enhance system security in Japan – which already has very high system reliability compared to world levels – in a more cost-effective manner. In the gas sector, there are clearly costs for greater interconnections across the rugged geography of Japan. Nevertheless, commendably, the government has put in place fiscal policies to encourage greater integration, enhancing competition. However, as currently structured, a more integrated system is more likely to materialise if incumbents are given the right incentives.

Better integration of the electricity network also affects renewables deployment. As in all countries, Japan faces the challenge of securing an electricity grid with greater amounts of intermittent renewables, particularly wind. Growing experience and new research from the international community suggests that grids are able to handle higher levels of renewable resources than previously thought. Nevertheless, greater integration can be more easily managed if there is a larger, more integrated grid with more liquid trade of electricity. This will be particularly important in Japan, where the country currently has relatively low levels of renewables deployment. Not only is it important to set more ambitious targets for renewables, taking into account the natural and geographic conditions in Japan, but it is also critical to continue to streamline and harmonise market rules on grid interconnections in general and on the connection of renewables to the grid while continuing to pay due attention to the effects of increased intermittent sources on the network.

KEY RECOMMENDATIONS

The government of Japan should:

- *Continue to take a leadership role in the global dialogue on energy and the environment, building on the success of Japan's domestic efforts to improve energy efficiency, such as through sectoral approaches, and to develop low-carbon energy technologies.*
- *Maintain the country's global prominence in energy technology development and transfer.*
- *Complement existing energy and environmental policies with stronger options, including sector-specific benchmarks, standards, regulations, taxes and trading schemes, and continue to strengthen regulations for gas and electricity markets.*
- *Enhance the role of market signals in the economy, in part by strengthening the value on greenhouse gas emissions, in order to further improve energy security and environmental sustainability.*
- *Continue to work to create more integrated gas and electricity markets, particularly in light of the benefits on security of supply and renewables deployment.*

PART I

POLICY ANALYSIS

Figure 1

Map of Japan

Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: IEA.

GENERAL ENERGY POLICY

As an island nation that relies on imports for a very large share of its total energy supply and nearly all of its fossil fuel imports, Japan ranks energy security at the top of its policy priorities. The country is a pioneer in the liquefied natural gas (LNG) trade, and the largest LNG importer in the world. It is also now actively pursuing upstream hydrocarbon and minerals investment. Japan makes extensive use of nuclear power, and is set to maintain the strong position of nuclear in the energy mix in the future. Japan also makes energy efficiency a top priority, helping achieve the twin goals of energy security and environmental protection. The country relies heavily on voluntary agreements with industry to achieve its climate and efficiency policy.

COUNTRY OVERVIEW

A mountainous island nation off the eastern coast of Russia, China and Korea, Japan's total land mass is slightly smaller than California and larger than Germany at just under 400 000 square kilometres (km^2). The country has almost 30 000 km^2 of coastline (see Figure 1). The climate is largely temperate, though summers can be hot and tropical, particularly in the south, and winters can be quite cold throughout the country. Arable land covers just under 13% of the total area.

With almost 130 million inhabitants, Japan has the fourth-highest population density in the OECD. The country has a nearly flat population growth rate, 0.06%, and the highest life expectancy in the world. Japan has many very large cities, besides Tokyo, which has a population of over 8.5 million. Twelve cities have more than a million inhabitants. Cities continue to draw inhabitants from rural areas, resulting in urban migration.

With a gross domestic product (GDP) of almost USD 4.4 trillion in 2006,[1] Japan's economy is the second-largest in the world and about one-third the size of the United States' economy. The economy is driven by its manufacturing sector – particularly electronics and vehicles – which makes up over a fifth of the total. The country also has some of the largest iron and steel works in the world, relying heavily on imports of raw materials given the very limited domestic endowment. Japan has a small agricultural sector and one of the largest fishing fleets in the world – catching about 5% of the world's fish.

1. On average in 2007, JPY 118 = USD 1 = EUR 0.73.

Japan – "Nippon" phonetically in Japanese – is a constitutional monarchy with a parliamentary government. While the symbol of the State and of the unity of the people is Emperor Akihito, the head of the government is the Prime Minister, who is the head of the Cabinet and names and dismisses the ministers of State. Prime Minister Yasuo Fukuda was appointed on 26 September 2007 by the Emperor, after being designated by the Diet. The Diet, or *Kokkai*, is the bicameral legislature, made up of the House of Councillors, or *Sangi-in*, and the House of Representatives, or *Shugi-in*. Members of each house are elected for six- and four-year terms, respectively. The Liberal Democratic Party (LDP), a conservative party, is in a majority coalition government with the New Komeito Party. The Prime Minister comes from the LDP. The long-ruling LDP lost control of the upper house, the House of Councillors, in the September 2007 election. The country is divided into 47 prefectures, or administrative and political regions.

SUPPLY-DEMAND BALANCE

SUPPLY

Japan's total primary energy supply (TPES) was nearly 530 million tonnes of oil equivalent (Mtoe) in 2006, a small decrease, 0.2%, from the previous year and a 0.2% increase from 2000 (see Table 1). Japan's fuel mix is reasonably well diversified, with four fuels making up most of the total. Oil supplies the largest share, at just under one-half of TPES, the seventh-highest share in the IEA and above the IEA average of 40% (2006 estimated data). Coal provides the next largest share, one-fifth. Nuclear and natural gas make up 15% each. In total, renewables make up 3.2% of TPES, excluding industrial and non-renewable municipal waste.

Coal makes up a similar share of TPES as it did in 1970, though it dipped a bit lower in the 1980s and 1990s. The share of oil in TPES has fallen from over 70% in 1970 to less than half in 2006. This decrease has been taken up primarily by natural gas and nuclear.

DEMAND

Total final consumption of energy (TFC) in Japan was 352 Mtoe in 2006, with almost 40% of all consumption in the industrial sector (including non-energy use). The next largest share of consumption, 26%, was in the transport sector. The residential sector used 14%, with the remainder (20%) in the commercial and other sectors.

Table 1

Supply-Demand Balance, 2006

Unit: Mtoe	*Total*	*Oil*	*Coal*	*Nuclear*	*Natural gas*	*Hydro*	*Biomass*[1]	*Other renewables*	*Electricity and heat*
Supply									
Production	**101.1**	0.7	0.0	79.1	3.2	7.4	7.12	3.6	0.0
Imports (net of exports)	**431.1**	244.9	112.0	0.0	74.2	0.0	0.0	0.0	0.0
Other	**–4.6**	–5.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0
Total primary energy supply	**527.6**	240.6	112.4	79.1	77.4	7.4	7.1	3.6	0.0
Share	***100%***	*46%*	*21%*	*15%*	*15%*	*1%*	*1%*	*1%*	*0%*
Demand									
Electricity and heat production[3]	**132.1**	22.5	61.3	79.1	48.9	7.4	4.4	2.8	–94.3
Industrial consumption[4]	**140.3**	71.9	30.4	0.0	7.7	0.0	2.6	0.0	27.6
Transportation	**91.1**	89.5	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Residential	**48.6**	14.7	0.0	0.0	9.2	0.0	0.0	0.6	24.1
Other final consumption[5]	**71.8**	25.0	0.6	0.0	14.3	0.0	0.0	0.2	31.7
Other	**43.6**	16.9	20.1	0.02	–2.7	0.0	0.02	0.0	9.4
Total consumption	**527.6**	240.6	112.4	79.1	77.4	7.4	7.1	3.6	0.0
Total final consumption	***351.8***	*201.1*	*31.1*	*0.0*	*31.2*	*0.0*	*2.7*	*0.8*	*84.9*

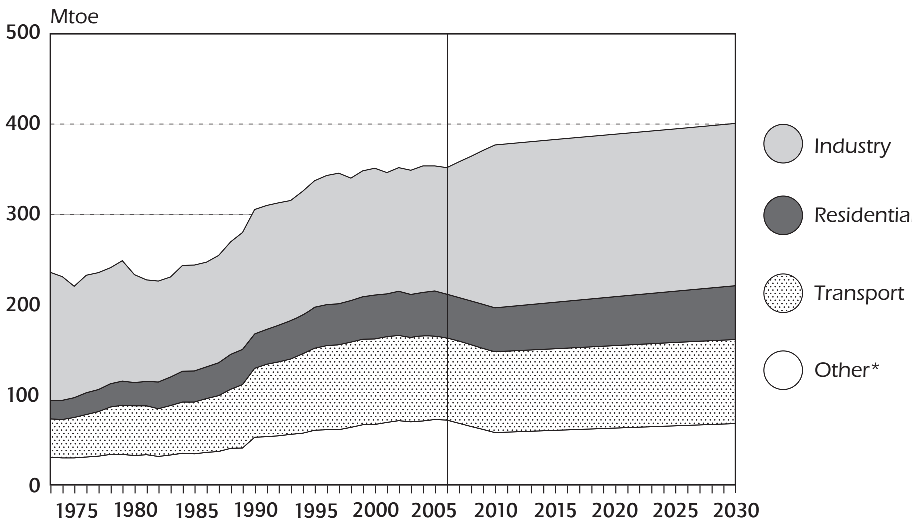
1. includes industrial and municipal waste. **2.** estimated. **3.** In this row, electricity and heat inputs are shown as positive numbers in the columns from oil to other renewables; electricity and heat output is shown in the last column as a negative number; and the total column represents the transformation losses. **4.** includes non-energy use. **5.** includes commercial/public services, agriculture/forestry, fishing and non-specified.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

The share of consumption in the industrial sector has declined dramatically from the high of nearly 70% in the late 1960s, though since 2001 it has been increasing slightly. The share of consumption in the transport sector reached a peak in 1998 and has decreased slightly since then. The shares in the remaining sectors have been largely flat in recent years, having increased somewhat through the 1990s (see Figure 2).

Figure 2

Total Final Consumption by Sector, 1973 to 2030



* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Note: Forecast data are to be revised by the Japanese government in 2008.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

ELECTRICITY GENERATION

In 2006, almost 1100 terawatt-hours (TWh) of electricity were generated in Japan, a 4% increase from 2000 and a 31% increase from 1990. As shown in Figure 23 in Chapter 6, the two largest and almost equal shares, nearly 28%, are supplied from nuclear and coal. The next largest share comes from natural gas, which provides almost a quarter of the total. Oil provides a very high share compared to other IEA countries, 11%. Hydro provides 8% of the total and biomass, 2%. Other renewables contribute a negligible share, though this segment has been growing rapidly in recent years.

ENERGY FORECASTS AND SCENARIOS

The government's first energy supply-demand outlook was established in 1967, and has been revised approximately every two to five years since then. The most recent outlook was completed in March 2005. In April 2007, the Demand-Supply Subcommittee commenced work on the fourteenth outlook, which is the final product of the Demand-Supply Subcommittee and is approved by the Advisory Committee for Natural Resources and Energy upon consultation with the Minister of Economy, Trade and Industry. The outlook includes forecasts for energy demand by sector, primary energy supply by fuel, electricity generation plant capacity by fuel, electricity generation by fuel and energy-derived CO_2 (carbon dioxide) emissions. Among others, two primary outlooks to 2010 are modelled, namely the case with existing countermeasures and the case with additional countermeasures. The second case assumes technological progress, increased environmental awareness, various outlooks for nuclear power and external changes in macroeconomic and social trends, among other things.

Since the most recent outlook was released in 2005, a number of changes have taken place in the international arena, including very high world oil market prices and growing interest in environmental issues. At the same time, the government has adopted new energy measures to respond to these additional resource and environmental pressures. The additional measures include policies under the May 2006 New National Energy Strategy and the Basic Energy Plan revision of March 2007, and are incorporated in the updated outlook.

The results from the countermeasures scenario are presented in Table 2, including both the low and high cases. "Low" and "high" refer to the minimum and maximum expected impact of the additional policies. Additional forecasts to 2020 and 2030 are presented in Table 3. These outlooks represent three cases: the technology frozen case, the continuous effort case and the maximum introduction case. Under the technology frozen case, new technology is not introduced after the base year of 2005, and the efficiency of equipment remains unchanged. Under the continuous effort case, efforts to improve the efficiency of equipment are to be continued along the current trajectory. Under the maximum introduction case, the energy-saving performance of equipment is expected to drastically improve through leading-edge technology at the commercial level deployed to the greatest extent possible, but in a reasonable manner (*e.g.* without legally forcing the purchase of this particular equipment).

The results of the previous reference case are the basis for the IEA's forecast data used in figures and tables throughout this report (including Annex B). IEA forecast data will be updated to reflect Japan's updated case with existing countermeasures and the continuous effort case when the data are submitted to the IEA by the Japanese government in 2008.

Table 2

Supply-Demand Outlook Scenarios, 1990 to 2010

	1990		*2005*		*2010*			
					Additional countermeasures scenario			
					Low case		*High case*	
Supply-demand balance Unit: million kilolitres (Mkl) crude oil equivalent		Share		Share		Share		Share
Total final consumption	359	100%	413	100%	395	100%	392	100%
Industry	181	50%	181	44%	173	44%	172	44%
Residential and commercial	95	26%	134	32%	128	32%	127	32%
Residential	*43*	*12%*	*56*	*14%*	*52*	*13%*	*51*	*13%*
Commercial	*52*	*15%*	*78*	*19%*	*76*	*19%*	*76*	*19%*
Transport	83	23%	98	24%	94	24%	93	24%
Domestic primary energy supply	508	100%	587	100%	568	100%	566	100%
Oil, etc.[1]	265	52%	255	43%	223	39%	218	39%
LPG	19	4%	18	3%	18	3%	19	3%
Coal	85	17%	123	21%	114	20%	113	20%
Natural gas	54	11%	88	15%	89	16%	89	16%
Nuclear	49	10%	69	12%	83	15%	83	15%

Table 2

Supply-Demand Outlook Scenarios, 1990 to 2010 *(continued)*

	1990		*2005*		*2010*			
					Additional countermeasures scenario			
					Low case		*High case*	
Hydro	22	4%	17	3%	19	3%	19	3%
Geothermal	0	0%	1	0%	1	0%	1	0%
New energy, etc.[2]	13	3%	16	3%	20	4%	24	4%
Electricity generation[3] Unit: TWh		Share		Share		Share		Share
Total	737.6		984.5		1 014.6		1013.1	
Hydro	88.1	12%	81.3	8%	95.4	9%	95.4	9%
Conventional	*78.8*	*11%*	*71.4*	*7%*	*78.0*	*8%*	*78.0*	*8%*
Pumped storage	*9.3*	*1%*	*9.9*	*1%*	*17.4*	*2%*	*17.4*	*2%*
Thermal	448.1	61%	597.3	61%	542.6	53%	541.1	53%
Coal	*71.9*	*10%*	*252.9*	*26%*	*222.3*	*22%*	*221.8*	*22%*
LNG	*163.9*	*22%*	*233.9*	*24%*	*252.0*	*25%*	*251.2*	*25%*
Oil, etc.[1]	*210.8*	*29%*	*107.2*	*11%*	*65.1*	*6%*	*65.0*	*6%*
Geothermal	*1.5*	*0%*	*3.2*	*0%*	*3.2*	*0%*	3.2	0%
Nuclear	201.4	27%	304.8	31%	366.4	36%	366.4	36%
New energy, etc.[1]			5.6	1%	10.2	1%	10.2	1%
Other[4]			–4.4			0%		0%

Table 2

Supply-Demand Outlook Scenarios, 1990 to 2010 *(continued)*

	1990	*2005*		*2010*			
				Additional countermeasures scenario			
				Low case		*High case*	
Energy-related CO_2 emissions Unit: Mt CO_2			Growth relative to 90FY		Growth relative to 90FY		Growth relative to 90FY
Total	1 059	1 201	13.4%	1 089	2.8%	1 076	1.6%
Industry	482	452	–6.1%	428	–11.3%	424	–12.1%
Residential and commercial	292	413	41.5%	351	20.5%	346	18.6%
Residential	*127*	*174*	*36.4%*	*141*	*10.9%*	*138*	*8.5%*
Commercial	*164*	*239*	*45.4%*	*210*	*27.9%*	*208*	*26.5%*
Transport	217	257	18.1%	243	11.9%	240	10.3%
Energy conversion sector	68	79	16.5%	66	–2.3%	66	–2.3%

Note: May not sum to total because of rounding. The share of primary energy supply from new energy is higher than that from electricity because the electricity data only include new energy produced and purchased by utilities, not self-generation by companies or households.

1. includes LPG, other gases and bituminous compounds other than oil.

2. includes the use of energy from top-pressure recovery turbines (TRT) in addition to new energy.

3. based on data for general electric utilities only.

4. refers to the unidentified power source categories in which those traded in the Japan Electric Power Exchange are included.

Source: *Outlook for Long-Term Energy Supply and Demand*, Demand-Supply Subcommittee, METI.

Table 3

Supply-Demand Outlook Scenarios, 1990 to 2030

	1990		2005		2020						2030					
	Actual		*Actual*		*Technology frozen case*		*Continuous effort case*		*Maximum introduction case*		*Technology frozen case*		*Continuous effort case*		*Maximum introduction case*	
Total final consumption (Mkl, crude oil equivalent; percentage is total share)	**359**		**413**		**449**		**416**		**390**		**469**		**412**		**365**	
Industry	181	50%	181	44%	180	40%	180	43%	178	46%	179	38%	179	43%	176	48%
Residential	43	12%	56	14%	64	14%	58	14%	53	14%	70	15%	59	14%	48	13%
Commercial	52	15%	78	19%	105	23%	84	20%	76	19%	122	26%	89	21%	72	20%
Transport	83	23%	98	24%	100	22%	94	23%	83	21%	97	21%	86	21%	69	19%
Domestic primary energy supply (Mkl, crude oil equivalent)	**508**		**587**		**651**		**601**		**561**		**685**		**601**		**526**	
Oil	265	52%	255	43%	248	38%	232	39%	209	37%	245	36%	220	37%	183	35%
LPG	19	4%	18	3%	19	3%	18	3%	18	3%	19	3%	19	3%	18	3%
Coal	85	17%	123	21%	136	21%	121	20%	110	20%	146	21%	123	20%	95	18%
Natural gas	54	11%	88	15%	107	16%	87	14%	79	14%	129	19%	94	16%	73	14%
Nuclear	49	10%	69	12%	99	15%	99	17%	99	18%	99	15%	99	17%	99	19%
Hydro	22	4%	17	3%	19	3%	19	3%	19	3%	19	3%	19	3%	19	4%
Geothermal	0	0%	1	0%	1	0%	1	0%	1	0%	1	0%	1	0%	1	0%
New energy, etc. [1]	13	3%	16	3%	22	3%	22	4%	26	5%	26	4%	26	4%	38	7%

Table 3

Supply-Demand Outlook Scenarios, 1990 to 2030 *(continued)*

	1990	2005	2020			2030		
	Actual	*Actual*	*Technology frozen case*	*Continuous effort case*	*Maximum introduction case*	*Technology frozen case*	*Continuous effort case*	*Maximum introduction case*
Electricity generation[2] (TWh; percentage is share of total)	**737.6**	**984.5**	**1 271.5**	**1 106.6**	**1 005.0**	**1 424.5**	**1 156.9**	**890.8**
Hydro	88.1 12%	81.3 8%	89.6 7%	86.6 8%	84.6 8%	94.2 7%	92.4 8%	85.6 10%
Conventional	*78.8 11%*	*71.4 7%*	*78.1 6%*	*78.1 7%*	*78.1 8%*	*78.1 5%*	*78.1 7%*	*78.1 9%*
Pumped storage	*9.3 1%*	*9.9 1%*	*11.4 1%*	*8.5 1%*	*6.5 1%*	*16.1 1%*	*14.3 1%*	*7.5 1%*
Thermal	448.1 61%	597.3 61%	722.8 57%	560.9 51%	461.3 46%	861.7 60%	595.9 52%	336.6 38%
Coal	*71.9 10%*	*252.9 26%*	*306.4 24%*	*239.5 22%*	*200.6 20%*	*359.8 25%*	*254.3 22%*	*148.1 17%*
LNG	*163.9 22%*	*233.9 24%*	*340.9 27%*	*249.7 23%*	*201.3 20%*	*442.5 31%*	*282.4 24%*	*146.3 16%*
Oil, etc.[3]	*210.8 29%*	*107.2 11%*	*72.2 6%*	*68.3 6%*	*56.0 6%*	*56.1 4%*	*55.8 5%*	*38.9 4%*
Geothermal	*1.5 0%*	*3.2 0%*	*3.3 0%*	*3.3 0%*	*3.3 0%*	*3.3 0%*	*3.3 0%*	*3.3 0%*
Nuclear	201.4 27%	304.8 31%	437.4 34%	437.4 40%	437.4 44%	437.4 31%	437.4 38%	437.4 49%
New energy, etc.[1]		5.6 1%	21.7 2%	21.7 2%	21.7 2%	31.2 2%	31.2 3%	31.2 4%
Others[4]		−4.4 0%	0%	0%	0%	0%	0%	0%

Table 3

Supply-Demand Outlook Scenarios, 1990 to 2030 *(continued)*

	1990		2005		2020						2030					
	Actual		*Actual*		*Technology frozen case*		*Continuous effort case*		*Maximum introduction case*		*Technology frozen case*		*Continuous effort case*		*Maximum introduction case*	
Energy-related CO_2 emissions (Mt CO_2; percentage is growth rate relative to FY1990)	**1 059**		**1 201**	**13%**	**1 275**	**20%**	**1 144**	**8%**	**1 026**	**–3%**	**1 348**	**27%**	**1 132**	**7%**	**897**	**–15%**
Industry	482	452	–6%	441	–9%	433	–10%	410	–15%	442	–8%	431	–11%	383	–21%	
Residential	127	174	36%	179	40%	152	19%	130	2%	198	56%	153	20%	100	–21%	
Commercial	164	239	45%	303	85%	231	41%	198	21%	365	122%	248	51%	179	9%	
Transportation	217	257	18%	259	19%	243	12%	214	–1%	254	17%	223	3%	173	–20%	
Energy conversion	68	79	16%	93	37%	85	25%	73	8%	89	31%	77	13%	62	–9%	

Note: May not sum to total because of rounding.

1. includes the use of energy from top-pressure recovery turbines (TRT) in addition to new energy.
2. Installed capacities for FY1990, FY2005 and the amount of electricity generation for FY1990 are all based on data for general electric utilities.
3. includes LPG, other gases and bituminous compounds other than oil.
4. refers to the unidentified power source categories in which those traded in the Japan Electric Power Exchange are included.

Source: *Outlook for Long-Term Energy Supply and Demand*, Demand-Supply Subcommittee, METI.

GOVERNMENT, REGULATORY INSTITUTIONS AND OTHER ORGANISATIONS

Since the last in-depth review in 2003, energy policy institutions have remained largely the same, with the exception of the Japan National Oil Company, which was dissolved. At the same time, the Japan Oil, Gas and Metals National Corporation (JOGMEC) was established.

The Agency for Natural Resources and Energy (ANRE), which is part of the Ministry of the Economy, Trade and Industry (METI), is responsible for comprehensive energy policies to ensure strategic energy security, realise an efficient energy supply and promote energy policies in harmony with the environment. It is also responsible for measures to promote the development of the economy and industry, such as enhancing the vitality of the private sector and facilitating economic relations with other countries. The Nuclear and Industrial Safety Agency (NISA), which is a special agency attached to ANRE, is responsible for ensuring safety and security with regard to the use of nuclear and other energy sources as well as industrial safety in a comprehensive manner.

Other government departments involved in the energy sector include the Ministry of Education, Culture, Sports, Science and Technology, with responsibilities for fusion research and development, the Ministry of the Environment and the Ministry of Foreign Affairs.

The New Energy and Industrial Technology Development Organisation (NEDO), one of the largest research and development (R&D) institutions in Japan, implements R&D programmes concerning energy- and environment-related technologies as well as industrial technologies, and promotes the diffusion of such technologies.

JOGMEC provides the funds necessary for exploration of oil, natural gas and metal resources, promotes the development of such resources and undertakes operations needed for stockpiling oil and metal resources. It also helps to secure stable supplies of oil, natural gas and metal resources at low prices and provides loans necessary for measures to prevent and mitigate mining pollution. These activities aim to contribute to the protection of the population's health and preservation of a favourable living environment as well as a sound development of mining businesses.

The Energy Conservation Centre, Japan (ECCJ) is a public-interest corporation involved in programmes related to the provision of information and public enlightenment to promote energy conservation efforts as well as in programmes to promote efficient use of energy in the industrial and transport sectors and international programmes for energy conservation.

The New Energy Foundation (NEF) is a non-profit organisation that seeks to raise public awareness about new energy and ensure a sound development of new energy-related industries and regional economies. Its goal is to improve Japan's energy self-sufficiency and enhance the Japanese population's living standards, through activities such as conducting surveys and research related to the development and use of new energy sources and providing opinions and presenting proposals to relevant organisations.

The Petroleum Association of Japan, which has oil refiners and distributors as members, is an organisation whose purpose is to maintain stable oil supply and promote a sound development of Japan's oil industry.

The Federation of Electric Power Companies of Japan, made up of the ten regional general power utilities, was established in order to ensure smooth management of the electric utility business.

The Japan Gas Association, which counts city gas suppliers as members, seeks to promote a sound development of the city gas business and contribute to industrial and cultural development.

KEY ENERGY POLICIES

The Basic Act on Energy Policy, established in June 2002, sets the general guiding direction for Japan's future energy policy. It prioritises securing stable supply, environmental suitability and use of market mechanisms as the key tenets of overall energy policy. Since the last review in 2003, two new or revised policies form the framework for Japan's energy policies, the Basic Energy Plan and the New National Energy Strategy. These are discussed more fully in the following sections.

OVERVIEW OF KEY POLICIES

Basic Energy Plan

The Basic Energy Plan is based on the policy direction of the Basic Act on Energy Policy adopted in June 2002. It was formulated in October 2003 and revised in March 2007. The key points of the plan are to:

- Promote nuclear power generation, including the nuclear fuel cycle, and steadily expand the introduction of new sources of energy.
- Enhance strategic and comprehensive efforts to secure a stable supply of oil and other resources.
- Lead the formulation of an effective international framework for enhancing energy conservation measures and coping with climate change.

- Resolve energy and environmental constraints through enhancement of technological capability and the strategic use of this capability.

New National Energy Strategy

The New National Energy Strategy, formulated in May 2006, was based on the recognition of recent changes in the international energy supply-demand structure. The key pieces of this strategy aim to:

- Improve energy consumption efficiency in terms of GDP at least by an additional 30% by 2030.
- Reduce the proportion of oil in the total primary energy supply to 40% or less by 2030.
- Reduce the oil dependence of the transport sector to approximately 80% by 2030.
- Increase the proportion of nuclear energy in total power generation at 30-40% or higher in 2030 and thereafter.
- Further expand the ratio of exploration and development of oil resources by Japanese companies, to around 40% by 2030.

Energy efficiency and climate change policies

Under the Kyoto Protocol, Japan has committed to reducing its emissions by 6% from 1990 over the 2008 to 2012 period. The relevant plan guiding efforts to reduce GHG emissions is the Kyoto Protocol Target Achievement Plan, formulated in 2005 and undergoing revision in March 2008. The *Cool Earth 50* initiative, launched in May 2007, followed by the *Cool Earth Promotion Programme* in January 2008, will also guide the country's climate change policies, both during the first commitment period and post-2012 (see Box 1). While Japan relies on a mix of different policies, such as labelling and the Top Runner programme for appliances and vehicles, the country relies to a large extent on voluntary measures to reduce greenhouse gas emissions. Japan currently has a weak price signal for greenhouse gas emissions in the economy, though this is changing with the voluntary emissions trading scheme launched in 2005 and the discussion of plans for a voluntary domestic offset scheme aimed at reducing greenhouse gas emissions from small and medium-sized enterprises.

Science and technology policy

In addition to its general energy policy tenets, the country has established guiding science and technology policy principles. Under the government's Third Science and Technology Basic Plan, which is a five-year plan running from 2006 to 2010, energy has been tagged as an area to be promoted. In particular, a number of energy technologies have been targeted, including fuel cells, innovative manufacturing processes, fast breeder reactors (FBR), clean coal technologies, solar power and batteries.

POLICY EVALUATION

The government conducts *ex post* evaluation of energy and environmental policies. These reviews lay out the targets and objectives of the particular policy or measure, detail the achievements towards the target and describe any challenges or factors that contributed to meeting or not meeting the targets.

Recently the government renovated its evaluation system. METI now reviews all energy and environmental policies in a systematic manner, assessing them according to eight criteria:

- Ensuring the stable supply of oil, natural gas and coal.
- Intensive use of energy and diversification of energy sources.
- Implementation of energy conservation policies.
- Promotion of nuclear power and the creation of a more sophisticated electric power infrastructure.
- Ensuring the stable supply of mineral resources.
- Promotion of measures against global warming.
- Promotion of the recycling of natural resources.
- Strengthening environmental management and competitiveness.

The eight energy and environmental criteria are a subset of the 34 criteria used by METI.

METI conducts *ex ante* evaluation on these eight criteria and discloses the results of the analysis each year when it makes its budget request. From 2008, stemming from a national fiscal institutional reform, this review process will be better harmonised with the budget process in order to enhance efficiency. In addition, *ex post* evaluation is conducted once every three to five years, with the results disclosed to the public. The *ex post* evaluation seeks to verify the effectiveness and efficiency of the individual programmes and measures, determining whether the results conform with the objectives and targets specified at the time the programme was developed, with a view to making use of the findings in the implementation of new programmes and when drafting future policies. Furthermore, while cost-benefit evaluations take place with an effort to make these as quantitative as possible, it is not clear that the current evaluation process is part of a comparative cost-effectiveness analysis that looks across a wide spectrum of possible policies and measures.

For some specific programmes, such as budget and tax measures, and other regulations, advisory councils and other entities conduct quantitative analyses and evaluations. METI confers with these entities before making policy decisions concerning the approval and implementation of the proposed programmes.

INTERNATIONAL COLLABORATION AND LEADERSHIP

G8 PRESIDENCY

Japan holds the G8 presidency in 2008. Among other items, Japan is placing international efforts to fight climate change at the top of the G8 agenda. At the 2008 G8 Summit in Hokkaido, Japan, the main themes to be debated are the environment and climate change, development and Africa, the world economy and other issues such as nuclear non-proliferation.

Under the theme of environment, Japan is urging leaders to focus on concrete goals and means to address the imminent challenge of climate change. Japan will lead discussions based on its *Cool Earth* initiatives (*Cool Earth 50* and the *Cool Earth Promotion Programme*), with the aim of producing tangible outcomes for the promotion of the United Nations' process to create an effective framework to address climate change beyond 2012.

Japan will emphasise energy efficiency as one of the most effective measures for mitigating climate change. It improved its energy efficiency by over 30% over the past 30 years, as a result of improvements made after the oil crisis. With this experience, Japan will lead the international discussion to achieve compatibility among environmental protection, energy security and economic growth by harnessing energy conservation and other technologies.

ENERGY MINISTERS' MEETINGS

In June 2008, Japan hosted two meetings of energy ministers, namely, the second five-country energy ministers' meeting and the G8 energy ministerial meeting, which will contribute to the G8 Summit in Hokkaido. The first five-country energy ministers' meeting was hosted by China in December 2006 with the participation of the United States, India, Korea and Japan, where Japan volunteered to host the second five-country energy ministers' meeting.

Since China, India and Korea are all major players in the international energy market and since the United States and Japan are both members of the five-country energy ministers' meeting and G8 energy ministerial meeting, Japan decided to hold these two ministerial meetings back to back in Aomori, Japan. China, India and Korea were also invited to participate in the G8 energy ministerial meeting.

At these meetings, Japan focused on improving energy efficiency through setting individual goals and formulating action plans; using sector-based bottom-up approaches; introducing clean energy technologies such as nuclear, renewables and the clean use of coal; and promoting international co-operation to develop innovative technologies that are needed to attain the long-term goal of cutting global emissions by half from the current level by 2050. Energy security issues such as emergency preparedness and investment climate were also discussed.

Cool Earth 50

In May 2007, Japan launched its *Cool Earth 50* strategy, aimed at lowering global greenhouse gas emissions and encouraging international participation. At the World Economic Forum in Davos, Switzerland in January 2008, Japan presented its *Cool Earth Promotion Programme*, which focuses on how to implement the strategy (see Box 1).

Box 1

Overview of the *Cool Earth Promotion Programme*

The *Cool Earth Promotion Programme* was presented at the World Economic Forum in Davos, Switzerland in January 2008. It builds on *Cool Earth 50* and has three pillars, described below.

A post-Kyoto Protocol framework

- Japan calls on the United Nations to examine at the earliest possible time strategies and measures to bring about a greenhouse gas emissions peak in the next 10 to 20 years and a halving of emissions by 2050.
- Japan will, along with other major emitters, set a quantified national target for the greenhouse gas emissions reductions to be realised from this point forward.
- In setting this target, Japan will use a bottom-up approach by compiling on a sectoral basis energy efficiency as a scientific and transparent measurement and tallying up the reduction volume that would be achieved with the technology used in subsequent years.

- The base year should also be reviewed from the standpoint of equity.

International environment co-operation

- Until new innovative technologies become practically available, the world must make efforts to maximise the improvement in energy efficiency.
- Japan could take action to transfer high-quality environmental technology to a greater number of countries.
- Japan proposes to set a global target of a 30% improvement in energy efficiency by 2020.
- Japan will establish a new financial mechanism, the *Cool Earth Partnership*, on the scale of USD 10 billion.

Innovation

- In order to halve greenhouse gas emissions by 2050, it will be critical to have breakthroughs in technological innovation (*e.g.* innovative zero-emission coal-fired power generation, innovative solar power, advanced nuclear power, green information technology).
- Over the next five years, Japan will be investing approximately USD 30 billion in R&D in the environment and energy fields.
- Japan proposes the formulation of an international framework through which the world can collaborate closely with international agencies such as the International Energy Agency (IEA) to accelerate technology development and share the fruits of such efforts.
- Japan will undertake a fundamental rethinking of all its societal systems in order to shift Japan to a low-carbon society.

Source: Country submission.

ENCOURAGING ENERGY EFFICIENCY IMPROVEMENT AND TECHNOLOGY CO-OPERATION

Making use of its expertise and know-how on energy efficiency, Japan is playing a leading role in encouraging energy efficiency improvements throughout the Asia-Pacific region through various bilateral and multilateral forums. At the East Asia Summit (EAS) in January 2007, Japan proposed that all member countries should set individual goals and formulate action plans for improving energy efficiency; this proposal was included in the EAS Cebu Declaration. Japan also presented a package for receiving trainees and dispatching experts to support efforts by Asian countries to improve their energy efficiency. With a view to strengthening this momentum, Japan also proposed a peer review process on energy efficiency for the Asia-Pacific Economic Co-operation (APEC) forum, which was endorsed by APEC energy ministers in May 2007 and APEC leaders in September 2007. In August 2007, as a co-chair of the energy ministers' meeting of the EAS, Japan took a lead in working out an agreement to set energy efficiency goals and formulate action plans by 2009, followed by mutual monitoring, which was confirmed in November 2007. Japan's multilateral initiatives are backed by its bilateral co-operation programme in the field of energy efficiency with China, India and other countries. Box 2 provides an overview of Japan's international efforts in relation to the Asia-Pacific Partnership (APP), a multilateral forum.

As a key tool to realise a global vision of how to cut global greenhouse gas emissions by half, Japan is working to further innovative technology R&D development. A committee made up of executives from private companies along with the director of Japan's R&D institute was set up to identify key technologies, develop road-maps for their development and consider the direction to promote international technology co-operation further. The conclusions of this committee were published in the *Cool Earth – Innovative Energy Technology Plan* in March 2008.

Box 2

International Efficiency Efforts through Sectoral Approaches in the Asia-Pacific Partnership

Japan participates in the Asia-Pacific Partnership on Clean Development and Climate (APP), a co-operative framework operated by the seven major countries in the region that collectively account for more than half of the total global emissions (Japan, Australia, Canada, China, India, Korea and the United States). The partnership strives to reduce CO_2 emissions on a global scale within this framework.

The APP has established task forces for the eight sectors that cover about 60% of the partners' energy consumption and CO_2 emissions, namely aluminium, buildings and appliances, cement, cleaner fossil energy, coal mining, power generation and transmission, renewable energy and distributed generation, and steel. By taking a sectoral approach in which sector-based task forces independently gather ideas and take specific actions, the goal is to seek to implement effective reduction measures that are suited to the actual circumstances of individual sectors. To date, the task forces on steel and cement, both of which are chaired by Japan, have each held meetings on four occasions and already implemented a number of programmes.

Japan's efforts with the steel task force

- The steel task force conducted a survey on some representative technologies to identify diffusion rates, thereby evaluating the potential for CO_2 emissions reduction for each selected technology, and reached a consensus on the method of investigating energy consumption. The emissions reduction potential of all the partner countries except Canada was estimated at approximately 127 million tonnes of CO_2 (equivalent to approximately 10% of Japan's total emissions).
- As a first step for technical co-operation, a team of Japanese experts on saving energy visited three iron and steel plants in China in December 2007 and gave energy efficiency advice for each plant. Actions such as these by the APP's steel task force have been expanded to a global scale by the International Iron and Steel Institute (IISI).

Japan's efforts with the cement task force

- The cement task force is working on data collection using common boundaries, indicators and investigation methods. It has reached a consensus on the use of CO_2 intensity as one benchmark.
- As with the steel task force, the cement task force is also working to dispatch Japanese experts to cement plants of different countries in 2008.

Source: Country submission.

ENERGY TAXES AND SUBSIDIES

The structure and level of energy taxation have, with some exceptions, remained unaltered since the 2003 in-depth review. Table 4 provides details about some direct energy taxes.

TAXATION ON FOSSIL FUELS

Petroleum and coal tax

The petroleum tax was introduced in 1978 in the wake of the oil shock. Although the tax was initially imposed only on oil, its scope was expanded in 1984 to cover liquefied petroleum gas (LPG) and liquefied natural gas (LNG), and enlarged again in October 2003 to include coal. (On this occasion the tax was renamed to include coal.) Tax revenue (JPY 533 billion under the 2007 budget) is used to finance oil development and stockpiling as well as measures related to energy conservation and new energy. The tax rate stands at JPY 2 040 per thousand litres (kl) for oil, JPY 1 080 per tonne (t) for LNG or LPG and JPY 700 per t for coal.

Gasoline tax, gas oil delivery tax and liquefied petroleum gas tax

Taxes on gasoline, delivered gas oil and LPG for use in the fuel tanks of automobiles were introduced successively after World War II, in the late 1940s to the mid-1960s. Revenues from these taxes, which total approximately JPY 4 200 billion under the 2007 budget, are used to finance road construction. The tax rates have been raised in line with an increase in demand for road construction. The current rates are JYP 53 800 per kl for the gasoline tax, JPY 32 100 per kl for the gas oil delivery tax and JPY 9 800 per kl for the LPG tax.

Aviation fuel tax

The aviation fuel tax was introduced in 1972. Tax revenue, JPY 109.9 billion under the 2007 budget, is used to finance airport construction. The current tax rate stands at JPY 26 000 per kl.

TAXATION ON ELECTRICITY CONSUMPTION

Power source development tax

Established in 1974, the power source development tax aims at securing financial resources for promoting power source locations, R&D on nuclear power and other activities. Tax revenue is estimated at JPY 346 billion under the 2007 budget, and the current tax rate stands at JPY 0.375 per kilowatt-hour (kWh).

Table 4

Energy Taxes in Japan, 2007*

	Petroleum and coal tax	*Other specific indirect taxes*
Household sector		
Electricity		JPY 0.345/kWh
Natural gas	JPY 1 080/t	
LPG	JPY 1 080/t	
Kerosene	JPY 2.04/L	
Non-commercial use		
Unleaded gasoline	JPY 2.04/L	JPY 53.8/L**
Diesel	JPY 2.04/L	JPY 32.1/L***
Industry		
Electricity	JPY 0.345/kWh	
Natural gas	JPY 1 080/t	
All oil products	JPY 2.04/L	
Industry and commercial use		
LPG	JPY 1 080/t	
Diesel	JPY 2.04/L	JPY 32.1/L***
Industry, electricity generation and steam coal industry		
Coking coal	JPY 700/t	

* Taxes as indicated do not include the 5% consumption tax, which is applied to the post-tax price for all client groups. For diesel oil, the consumption tax is applied before the diesel oil delivery tax.

** gasoline tax of JPY 48.6 per L and a local road tax of JPY 5.2 per L.

*** diesel oil delivery tax.

Source: Country submission.

ENERGY SUBSIDIES

Existing energy subsidies are outlined in Table 5.

Table 5

Energy Subsidies as of 1 January 2008

Subsidy name	*Outline*	*Budget amount for FY2007 (thousand JPY)*
Natural gas exploration subsidy	To assist natural gas exploration by mining companies.	907 000
Subsidy for oil refining technology programmes in oil-producing countries	To assist joint research with oil-producing countries concerning oil refining technologies.	9 925 000
Oil prospecting subsidy	To assist geological surveys abroad.	1 811 561
Oil refining rationalisation subsidy	To assist the development of advanced oil refining technologies.	12 457 309
Oil product quality assurance subsidy	To assist analysis of test-purchased petroleum products and development of analysis techniques.	1 898 227
Subsidy for structural reform measures for petroleum product distribution	To assist business diversification and other structural reform measures by oil distributors.	12 442 348
Anti-large-scale oil disaster subsidy	To assist the construction and maintenance of oil fences and the transport thereof in emergencies.	800 000
Regional energy utilisation subsidy	To assist local governments' pioneering efforts to utilise non-fossil energy and promote the enlightenment and diffusion thereof.	4 465 000
Non-fossil fuel technology development subsidy	To assist the development of technologies for expanding utilisation of non-fossil energy.	2 258 300
Natural gas utilisation promotion subsidy	To help private firms convert coal-burning facilities to natural gas-burning ones.	6 005 000
Energy utilisation rationalisation subsidy	To assist installation of energy-efficient facilities.	82 814 319
International energy utilisation rationalisation subsidy	To conduct policy research to facilitate energy conservation efforts abroad, in Asia in particular, and assist diffusion of energy conservation technologies.	2 259 000
Energy conservation technology development subsidy	To assist development of energy-saving technologies.	16 630 056

Table 5

Energy Subsidies as of 1 January 2008 *(continued)*

Subsidy name	*Outline*	*Budget amount for FY2007 (thousand JPY)*
CO_2 emission reduction subsidy	To assist the installation of energy-efficient facilities with reduced CO_2 emissions.	14 097 500
Environmentally harmonised fuel utilisation subsidy	To assist the development of combustion technologies that reduce CO_2 emissions.	1 210 359
Power facilities promotion subsidy	To promote companies' moves into locations of power source development and create jobs in order to facilitate the construction and operation of power generation facilities.	16 294 611
Subsidy for promoting regional energy development and utilisation	To assist the installation of highly efficient water heaters by private firms.	13 295 000
Subsidy for promoting the development of power generation system technology	To assist the development of grid-stabilising equipment capable of recovering CO_2.	257 000
Uranium enriching technology development subsidy	To assist the development of uranium enriching technologies and a new type of centrifugal separator that enhances the production capacity.	2 091 000
Subsidy for technology development for a reactor whose core is fully loaded with MOX fuel	To assist technology development necessaryfor a reactor whose core is fully loaded with MOX fuel in order to help to expand utilisation of MOX fuel.	3 400 000
Nuclear power generation technology development subsidy	To assist the development of technologies for enhancing the safety and economy of nuclear power generation and the nuclear fuel cycle.	1 028 195

Source: Country submission.

CRITIQUE

Despite significant challenges, Japan has continued its efforts to improve and balance its energy policy, enhancing its commitment to the "3 Es" of sound energy policy – energy security, environmental sustainability and economic efficiency. In the area of energy security, the country is vigilant in its activities to ensure supply security, with a focus on international procurement of oil, natural gas and coal, expansion of nuclear power and general infrastructure development. In terms of environmental sustainability, Japan places a high priority on energy efficiency and the development of low-carbon energy technologies – a policy that also enhances its energy security. It is firmly engaged in its Kyoto commitment to reduce CO_2 emissions by 6% – though this will be very challenging to achieve, as discussed more fully in the next chapter. Japan is also taking a lead role in driving international action on climate change by spearheading the *Cool Earth 50* initiative, which it is linking to its 2008 presidency of the G8. In the international arena, the government is an active member of the Asia-Pacific Partnership on Clean Development and Climate (APP), promoting sectoral approaches in its leadership of the steel and cement task forces, which seek to identify energy efficiency and CO_2 emissions reduction potential for key sectors and enable objective, fair and equitable target setting. The government is also driving energy R&D collaboration and technology transfer in Asia and throughout the globe. In particular, the country is a world leader in R&D funding and energy technology, a position the IEA urges it to continue as this can help develop solutions to the world's energy and environment challenges, notably climate change. Japan is taking a leadership role in the Asia-Pacific region by encouraging countries to set energy efficiency goals and formulate action plans, as well as by transferring its know-how and expertise to them in the field of energy efficiency. The government has also prioritised making gains in competition in the energy sector, using competitive pressures to drive down prices of natural gas and electricity for Japanese customers. In short, the government's vigilance in improving energy policy is commendable – particularly its innovative energy efficiency policies – and we are pleased to see the enhanced activities since the last review in 2003. In light of the constant efforts the government is undertaking to ensure sound energy policy, we encourage continued policy efforts, particularly in areas where additional focus could be beneficial.

Voluntary agreements are an important piece of Japan's climate policy. Japanese companies take their voluntary agreements seriously and are endeavouring to meet them first through domestic efforts and then, if necessary, through international credit purchases. While we find that these voluntary agreements can help Japan meet its Kyoto and domestic commitments, there are some improvements that can be made, as well as some other options to consider (discussed more fully in Chapter 3).

One of the advantages of voluntary agreements is that they allow industry to meet particular objectives in a flexible manner. Building on this desire to ensure as much flexibility as possible, other policy mechanisms should also be considered to complement the voluntary agreements. Greater reliance on market signals would enhance incentives for industry and other stakeholders to meet government policy objectives, allowing these to be better harmonised across sectors. To that end, the voluntary emissions trading scheme currently in place in which 150 companies are participating is a good first step. Furthermore, discussions in the government to implement a voluntary domestic offset scheme aimed at reducing greenhouse gas emissions from small and medium-sized enterprises are welcome. We encourage the development of these and other policies that would further the development of a market signal for emissions reductions. Finally, and perhaps most importantly, market signals drive the necessary investments in energy security.

While market signals are important in achieving policy goals, government policy makers also need to take decisions about implementing particular policies and measures. Government policy makers must estimate the costs of various policies when selecting from among a basket of options. For this reason, it is very positive that the government has an evaluation framework in place. Nevertheless, there seems to be scope for improvement. We are pleased to see that there is a systematic approach to conducting *ex ante* and *ex post* cost-benefit evaluations of energy and environmental policies, with most policies and measures undergoing *ex post* evaluation every three to five years. This is an important and commendable framework to have in place. Building on this, the framework should be expanded to ensure these *ex ante* evaluations are used in the policy selection process and that there is a systematic approach in place for *ex ante* and comparative evaluation of a suite of policy proposals before a policy is selected. Such a procedure would allow cost-effectiveness criteria to be given greater weight when selecting between various policies and measures across sectors and fuels. We encourage the government to make this a higher priority, as this will help set the framework for developing an integrated and cost-effective approach to addressing policy concerns, particularly with respect to climate change.

Sound energy supply-demand scenarios – and not only forecasts – are essential for good policy and market operation. Energy market participants rely on these scenarios to take long-term and capital-intensive infrastructure decisions. Policy makers use these scenarios to better understand which policies and measures are necessary to achieve certain energy goals. The Institute for Energy Economics, Japan has conducted long-term projection exercises with case studies based on different assumptions, which is a promising start. In addition, the government's supply-demand subcommittee is planning to update its current energy outlook in 2008, which is strongly encouraged and this should set the groundwork for a more transparent and regularly scheduled scenario-development process. As this modelling framework is enhanced, the relevant parameters, assumptions and methods should continue to be made transparent to all energy stakeholders. Not only do the underlying assumptions of the modelling framework need to be made transparent, but the results of the modelling must be made sufficiently clear and explicit as this will allow monitoring and tracking of progress towards energy and environmental policy goals.

It is also important that the modelling take into account both bottom-up and top-down approaches. Top-down models seek to estimate energy supply and demand at an aggregate, macroeconomic and broad sectoral level. These models balance out supply and demand with prices and ensure that there is an overall economic coherence to the results. In contrast, bottom-up models take advantage of disaggregated end-use data at a fine level of end-use granularity, such as lighting demand, for each sector. The individual pieces of such bottom-up models are combined to build up a picture of the overall economy. The purpose of combining both top-down and bottom-up modelling is to improve modelling accuracy. While this methodology might result in some inconsistency – the results of the bottom-up model may not add up to the results of the top-down model – the methodology can improve accuracy because it provides a sound basis for "triangulating" and querying modelling results. Overall, it is important that modelling efforts balance both approaches.

RECOMMENDATIONS

The government of Japan should:

- *Continue to take a leadership role in the global dialogue on energy and the environment, such as through sectoral approaches, building on the success of Japan's domestic efforts to improve energy efficiency and develop low-carbon energy technologies.*
- *Maintain the country's leading position in energy technology development and transfer.*
- *Continue to place greater emphasis on market signals that give incentives to sectors to achieve energy policy goals – including energy security, environmental sustainability and economic efficiency – in a flexible manner in order to:*
  - *Complement existing voluntary measures.*
  - *Drive private-sector investments to enhance energy security.*
  - *Lower the costs of achieving government policy goals.*
- *Raise the profile of* ex ante *and* ex post *analysis of energy and environment policies and measures, which will:*
  - *Promote cost-effectiveness to explicitly guide the process of selecting between different policy options within and across sectors.*

- *Help ensure an integrated approach to addressing climate change.*
- *Continue to enhance the evaluation and verification of the results of existing policies and measures.*

◗ *Build on the efforts under way to develop robust and timely energy supply-demand scenarios by:*

- *Ensuring that parameters, assumptions and methods are transparent to all energy stakeholders.*
- *Further developing modelling that is sufficiently explicit to allow monitoring and tracking of progress towards energy and environmental policy goals.*

SUSTAINABLE ENERGY POLICIES

Japan is a world leader in the field of sustainable energy policies. With respect to climate change, it has renewed its commitment to meeting its Kyoto target for greenhouse gas emissions, though this will be a difficult challenge. It is also elevating climate change to the top of the agenda with its presidency of the G8 in 2008. The country has begun implementing a voluntary emissions trading scheme and is evaluating the prospects for a voluntary domestic offset scheme aimed at reducing greenhouse gas emissions from small and medium-sized enterprises. Japan already places a high priority on energy efficiency, both for reasons of security of supply and climate change policy, and has relatively low energy intensity compared to other IEA countries. Energy efficiency and conservation policy is carried out as a public-private initiative, with the efforts of industry largely stemming from their voluntary action plan.

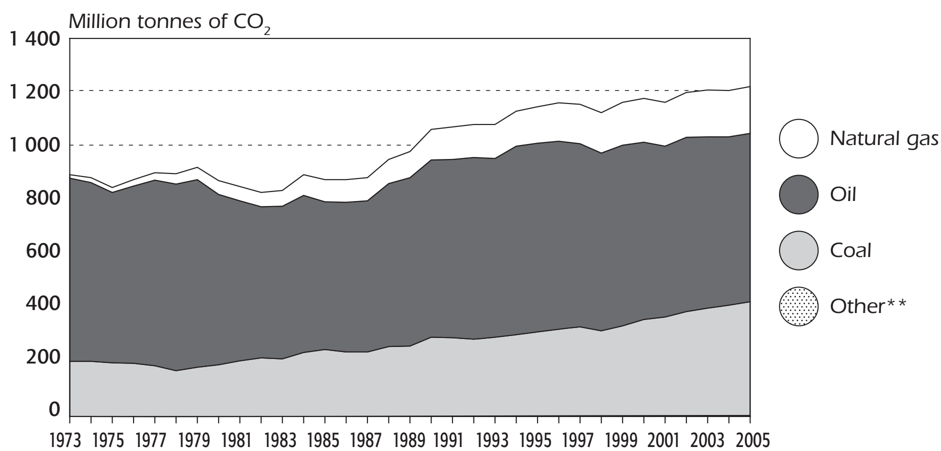
CLIMATE CHANGE

CARBON DIOXIDE EMISSIONS PROFILE

As detailed in Table 6 and Figure 3, Japan's total CO_2 emissions from fuel combustion have risen by 13% between 1990 and 2006. Nearly all of this

Figure 3

CO_2 Emissions by Fuel*, 1973 to 2005



* estimated by the IEA from energy data supplied by Japan and using the default methodology (the Sectoral Approach) and emission factors from the Revised 1996 IPCC Guidelines. ** includes industrial and municipal waste (negligible).

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2007.

Table 6

Energy-Related CO_2 Emissions by Fuel*, 1970 to 2030

Unit: Mt CO_2	*Oil*	*Coal*	*Natural gas*	*Biomass***	*Total*
1970	507.2	215.8	7.9	0.0	730.9
1980	638.6	190.8	51.2	0.0	880.7
1990	658.3	297.6	114.6	0.9	1 071.4
2000	656.0	368.5	164.8	3.0	1 192.4
2001	633.5	377.3	164.1	3.2	1 178.1
2002	643.7	397.8	169.1	3.5	1 214.1
2003	633.1	411.0	174.9	3.8	1 222.8
2004	623.0	421.1	174.4	3.8	1 222.4
2005	622.3	427.5	173.7	4.2	1 227.7
2006	586.8	431.4	190.0	4.5	1 212.7
2010	568.8	358.3	174.2	4.5	1 105.8
2030	577.3	375.2	234.1	4.5	1 191.2
Share in 2006	*48.4%*	*35.6%*	*15.7%*	*0.4%*	
Change (1990-2006)	*–10.9%*	*44.9%*	*65.8%*	*404.4%*	*13.2%*
Projected change (2006-2030)	*–1.6%*	*–13.0%*	*23.2%*	*0.0%*	*–1.8%*
Average annual growth rate (1990-2000)	*0.0%*	*2.2%*	*3.7%*	*12.9%*	*1.1%*
Average annual growth rate (2000-2006)	*–1.8%*	*2.7%*	*2.4%*	*7.0%*	*0.3%*
Average annual growth rate (2006-2030)	*–0.1%*	*–0.6%*	*0.9%*	*0.0%*	*–0.1%*

Note: Forecast data are to be revised by the Japanese government in 2008.

* estimated by the IEA from energy data supplied by Japan and using the default methodology (the Sectoral Approach) and emission factors from the Revised 1996 IPCC Guidelines. ** includes industrial and non-renewable municipal waste.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2007.

increase is accounted for by the rising use of coal and natural gas. Some small increases come from emissions from biomass. Declining oil consumption has led to a decrease in emissions from oil, almost 11% over the period. In total, Japan's 2006 energy-related emissions were 1 213 million tonnes of CO_2 (Mt CO_2). As a large share of TPES comes from nuclear, overall nuclear generation levels impact greenhouse gas emissions. In recent years, nuclear generation has been very variable, causing significant shifts in greenhouse gas emissions.

Kyoto target

As a party to the Kyoto Protocol, which the country ratified in June 2002, Japan has committed to reducing its greenhouse gas emissions by 6% below 1990 levels. According to the country's most recent national communication to the United Nations Framework Convention on Climate Change (UNFCCC), total greenhouse gas emissions (including the full basket of six gases) in 2003 were 1 339 Mt CO_2-eq, 8.3% above Japan's baseline emissions under the Kyoto Protocol. More recent estimates from the government show that emissions in 2005 were 7.8% higher than in the base year.

CLIMATE CHANGE POLICY

The relevant legislation guiding efforts to reduce greenhouse gas emissions is the Kyoto Protocol Target Achievement Plan, passed in 2005 and later amended. In May 2007, the government launched the *Cool Earth 50* initiative, which has proposed a global target to cut greenhouse gas emissions in half by 2050 and calls for a "global consensus" on the sharing of the goal. The *Cool Earth 50* initiative also includes a national plan, with a public awareness campaign, such as the "1 Person, 1 Day, 1 Kilogram" campaign, for Japan to meet its 6% Kyoto commitment. At the World Economic Forum in Davos in January 2008, within the framework of the *Cool Earth 50* initiative, Japan expressed its determination to set, along with other major emitters, a quantified national target and proposed a global goal of improving energy efficiency by 30% by 2020.

Institutional arrangements

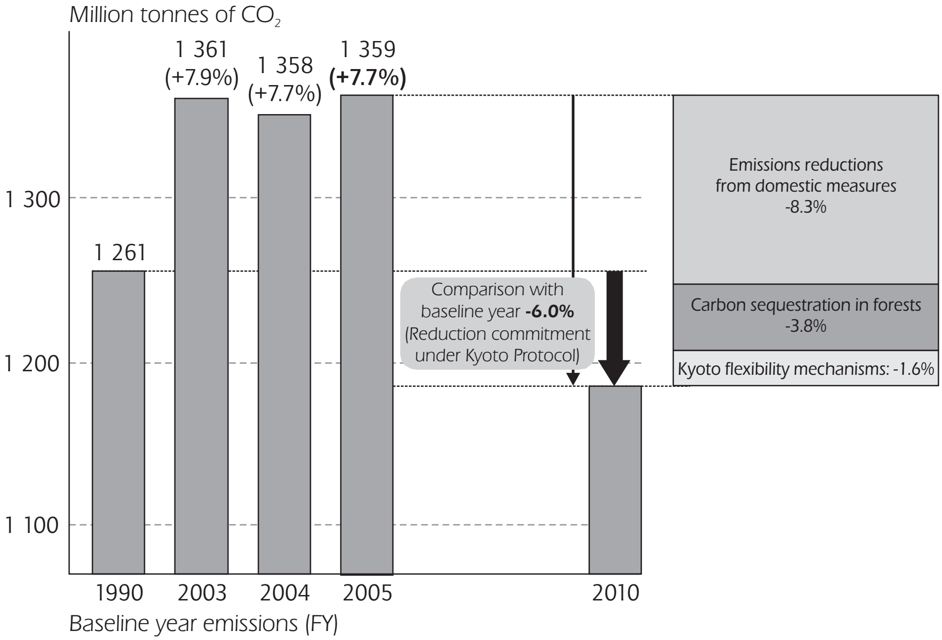
Japan has established the Global Warming Prevention Headquarters, of which the Prime Minister serves as chairman. The Chief Cabinet Secretary, the Minister of the Environment and the Minister of Economy, Trade and Industry serve as vice-chairmen, and all other state ministers serve as members, with all related ministries and agencies taking action against climate change in close co-operation with one another.

Policies and objectives

To meet its overall 6% Kyoto target, the government aims for a 0.6% reduction in domestic greenhouse gas emissions compared with the base year and for a forest sink of 13 million tonnes of carbon (MtC, or 47.7 Mt CO_2, equivalent to an emissions reduction of 3.8%) during the first commitment period of 2008 to 2012 under the Kyoto Protocol. The government intends to achieve the target of a 6% reduction compared with the base-year gross emissions by realising an additional reduction of 1.6% with the use of the Kyoto mechanisms. How these actions would affect total emissions is outlined in Figure 4. (For more detailed descriptions of policies and measures, see the next section on energy efficiency or Chapter 7 on renewables.)

Figure 4

Overview of Kyoto Emissions Targets and Measures to Achieve the Target



Source: Country submission.

Domestic measures

The Kyoto Protocol Target Achievement Plan includes about 60 policies and measures, which are described in Table 7. Most of these policies and measures are related to improved energy efficiency, further details of which are provided in the next section of this chapter. In the commercial sector, the primary means of achieving emissions reductions is through voluntary agreements with industry. There are also some smaller programmes to promote energy-efficient equipment. In the transport sector, the biggest source of emissions reductions is from the Top Runner programme to improve the fuel economy of vehicles. Other important policies to reduce CO_2 emissions include improvements to the energy performance of buildings, efficiency improvements in equipment, reductions in the CO_2 intensity of the power sector, promotion of renewables and promotion of carbon uptake through forest sinks.

Table 7

Policies and Measures in the Kyoto Protocol Target Achievement Plan

Unit: Mt CO_2		*Specific measures*	*Estimated value of reduction*	*Additional measures*
Energy-derived CO_2	Industrial sector	**Voluntary action plan**	42.40	
		Thorough management of energy under Law Concerning the Rational Use of Energy	1.70	1.66
		Energy conservation by collaboration among multiple companies	3.20	3.15
		Promotion of introduction of high-performance industrial furnaces	2.00	0.94
		Dissemination of high-performance boilers	1.30	
		Promotion of introduction of next-generation coke ovens	0.40	0.35
		Dissemination of fuel-efficient machines in the construction and engineering work sectors	0.20	0.17
	Transport sector	Promotion of use of public transportation means	3.80	
		Greening of vehicle transportation businesses through promotion of dissemination of eco-driving practice	1.30	
		Support of introduction of idling-stop vehicles	0.60	0.63
		Adjustment of demand for vehicle traffic	0.30	
		Promotion of intelligent transportation system (ITS)	2.60	
		Promotion of intelligent transportation system (ITS) (centralised control traffic signals)	1.00	
		Reduction in works on roads	0.50	
		Improved maintenance of traffic safety facilities	0.50	
		Promotion of traffic alternatives by using information communications such as telework	3.40	
		Integrated measures for greening of marine transportation	1.40	
		Modal shift to rail freight transportation	0.90	
		Improvement of efficiency of truck transportation	7.60	
		Reduction in distance of land transportation of international freight	2.70	
		Improvement of fuel efficiency of vehicles under the Top Runner standard	**21.00**	**0.20**
		Promotion of dissemination of vehicles powered by clean energy	3.00	1.18
		Reduction in the top speed of large trucks on expressways	0.80	
		Introduction of sulphur-free fuels and vehicles powered by sulphur-free fuel	1.20	1.16
		Improvement of energy consumption efficiency of railroad	0.40	
		Improvement of energy consumption efficiency of aviation	1.90	

Table 7

Policies and Measures in the Kyoto Protocol Target Achievement Plan *(continued)*

Unit: Mt CO_2		*Specific measures*	*Estimated value of reduction*	*Additional measures*
Energy-derived CO_2	Commercial and household sectors	Thorough management of energy under Law Concerning the Rational Use of Energy	3.00	3.02
		Improvement of energy-saving performance of buildings	**25.50**	**1.57**
		Dissemination of high-efficiency air-conditioners for business use	0.60	0.59
		Dissemination of energy-saving refrigerators and freezers for business use	0.60	0.63
		Improvement of energy efficiency of residences	8.50	0.78
		Business and home energy management systems (BEMS/HEMS)	**11.20**	
		Improvement of efficiency of equipment under the Top Runner standard	**29.00**	**7.07**
		Promotion of renewal purchases of energy-saving equipment	5.60	5.60
		Energy information provided by energy suppliers	4.20	4.18
		Dissemination of high-efficiency water heaters	3.40	1.86
		Dissemination of high-efficiency lighting, such as light-emitting diode (LED) lighting	3.40	
		Reduction in stand-by power consumption	1.50	
	Energy conversion sector	Promotion of wider use of biomass (creation of biomass-based town)	1.00	
		Reduction in CO_2 emission intensity in the electric power sector through promotion of nuclear energy, etc.	**17.00**	**17.04**
		Promotion of measures for new energy	**46.90**	**6.61**
		Natural gas co-generation (*i.e.* CHP)	**11.40**	**0.27**
		Fuel cells	3.00	
Non-energy-derived CO_2		Expansion of use of blended cement	1.11	
		Measures for reduction in CO_2 emissions derived from incineration of wastes	5.50	
CH_4, N_2O		Reduction in the amount of final disposal of wastes	0.50	
		Installation of N2O decomposer in the production process of adipic acid	8.74	
		Sophistication of combustion at sewage sludge incineration facilities	1.30	
		Sophistication of combustion at general industrial waste incineration facilities	0.20	
Three fluorinated gases		**Promotion of well-planned efforts of the industrial community, and promotion of development and use of alternative materials**	**43.60**	

Table 7

Policies and Measures in the Kyoto Protocol Target Achievement Plan *(continued)*

Unit: Mt CO_2	*Specific measures*	*Estimated value of reduction*	*Additional measures*
Measures for forest sinks	**Promotion of measures for sinks through promotion of measures for forests and forestry**	**47.67**	
	Promotion of urban greening, etc.	0.28	
Kyoto mechanisms	Development of credit acquisition system by government	20.00*	
Total			74.16

Notes: Bold type denotes key policies and measures. These data will be updated in 2008 to reflect the new Kyoto Protocol Target Achievement Plan that was revised in March 2008.
* difference from reduction targets (-6%) and domestic measures (emissions reduction, carbon sinks).

Source: Country submission.

Emissions trading

Domestic trading

Since 2005, the Ministry of the Environment has been implementing a domestic emissions trading scheme based on voluntary participation. Thus far, 150 companies have participated in this system. In addition, METI is currently considering implementing a voluntary domestic offset scheme aimed at reducing greenhouse gas emissions from small and medium-sized enterprises (SMEs), calling it a domestic clean development mechanism (CDM) scheme. This domestic offset scheme is for SMEs that have made little progress on activities to reduce CO_2 emissions. Under the programme proposal, large Japanese businesses can buy carbon credits from SMEs that undertake activities to enhance their efficiency and lower their emissions. These offsets can be used as domestic credits for the large companies to use to meet their targets under their voluntary action plans. In exchange, the large companies provide SMEs with financial and technical support for the projects. The government is currently working out the details of whether subsidies would be given to SMEs to encourage the activities and, if so, at what level. It is also working out the details about the emissions reduction certification scheme and its consistency with international standards.

International purchases

Purchases of emission credits from the international market can be used to offset domestic emissions above the Kyoto target. The Kyoto Protocol provides for several so-called flexibility mechanisms to assist Annex I parties (developed countries) in meeting their Kyoto emissions targets in the most cost-effective manner possible. These three flexibility mechanisms are described below.

- Under joint implementation (JI), a project-based mechanism, Annex I parties may fund emissions-reducing or offsetting projects in other Annex I parties and then apply the resulting emissions reduction units (ERUs) towards meeting their own Kyoto target.
- Under the clean development mechanism (CDM), also a project-based flexibility mechanism, Annex I parties may fund emissions-reducing or offsetting projects in non-Annex I parties (typically developing countries) and then apply the resulting certified emissions reductions (CERs) towards its own Kyoto target.
- In addition to the above two project-based mechanisms, Annex I parties may engage in emissions trading, whereby an Annex I party purchases emission units from another Annex I party (or an authorised legal entity from within that party) and applies these units towards meeting its own target. Generally speaking, these units are assigned amount units (AAUs), though some other forms of emission units may also be traded. In the case of AAUs, they do not arise from particular projects; rather, if an AAU is sold to another country, the sale increases the total emissions reduction the selling country must achieve by an equal amount.

The government has already begun to procure emission credits from the international market. The New Energy and Industrial Technology Development Organisation (NEDO) is the key government agency managing credit purchases, and also manages the NEDO Credit Acquisition Programme. So far, NEDO has purchased 11.673 Mt CO_2 through the programme.

In addition, Japan Carbon Finance, which is financed and managed by private businesses and other non-government entities, purchases credits from reduction projects implementers and resells them to the Japan GHG Reduction Fund, which then distributes them to investors. Through this scheme, Japan Carbon Finance has purchased 9.96 Mt CO_2.

Table 8 outlines completed and expected international greenhouse gas credit purchases.

Table 8

Summary of International Greenhouse Gas Credit Purchases

Unit: Mt CO_2	*Purchases (contracted)*	*Total target of purchases*
NEDO (government)	11.67*	100.00
Japan Carbon Finance	9.96*	USD 141.5**
Federation of Electric Power Companies of Japan	120.00	-
Japan Iron and Steel Federation	44.00	-

* data disclosed by NEDO. ** upper limit of available funds for credit purchases.

Source: Country submission.

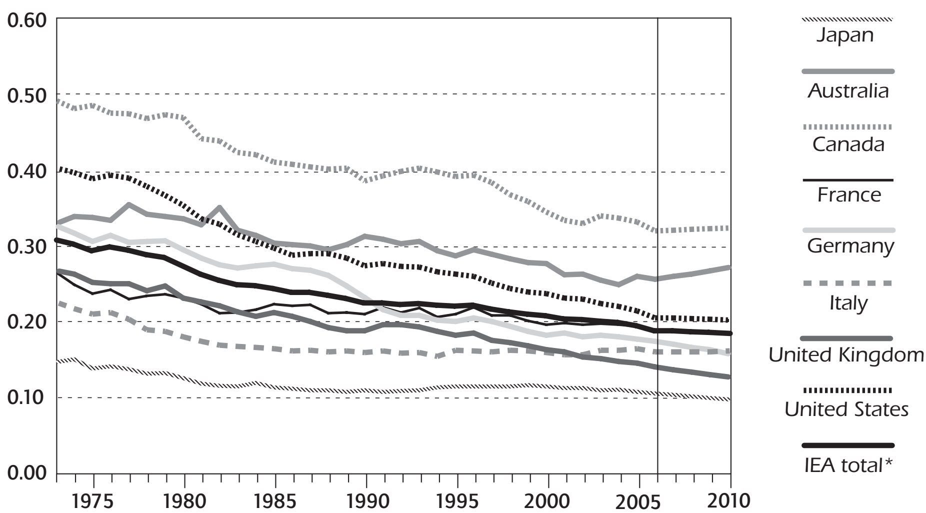
TRENDS IN ENERGY EFFICIENCY

Japan continues to pursue energy efficiency improvements as a cornerstone of its energy policy. As a result, as shown in Figure 5, Japan's energy intensity in terms of TPES per unit of GDP is the lowest among IEA countries when market exchange rates are used. It is one of the lowest when measured in terms of purchasing power parity (see Figure 6). Since the oil shocks of the 1970s, the economy has achieved an energy intensity improvement of around 30%. However, since the mid-1980s, this improvement has levelled off somewhat (in both market exchange rate and purchasing power parity terms). The government is now aiming for an improvement of at least another 30% in terms of final energy consumption per unit of GDP by 2030 compared with 2003.

Figure 5

Energy Intensity in Japan and in Other Selected IEA Countries, 1973 to 2010

(toe per thousand USD of GDP at 2000 exchange rates)



Note: Japanese forecast data are to be revised by the Japanese government in 2008.

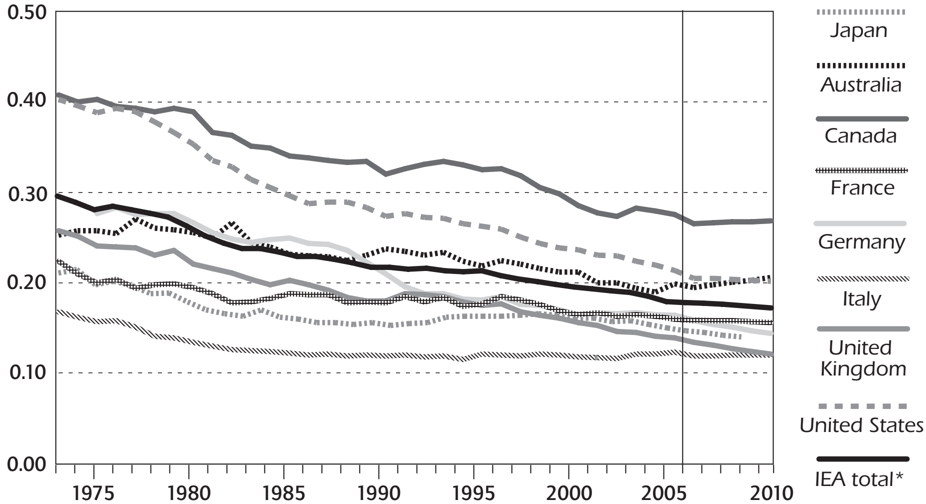
* excluding Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

Sources: *Energy Balances of IEA Countries*, IEA/OECD Paris, 2007; *National Accounts of OECD Countries*, OECD Paris, 2007 and country submissions.

Figure 6

Energy Intensity in Japan and in Other Selected IEA Countries, 1973 to 2010

(toe per thousand USD of GDP at 2000 prices and purchasing power parities)



Note: Japanese forecast data are to be revised by the Japanese government in 2008.

* excluding Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

Sources: *Energy Balances of IEA Countries*, IEA/OECD Paris, 2007; *National Accounts of OECD Countries*, OECD Paris, 2007 and country submissions.

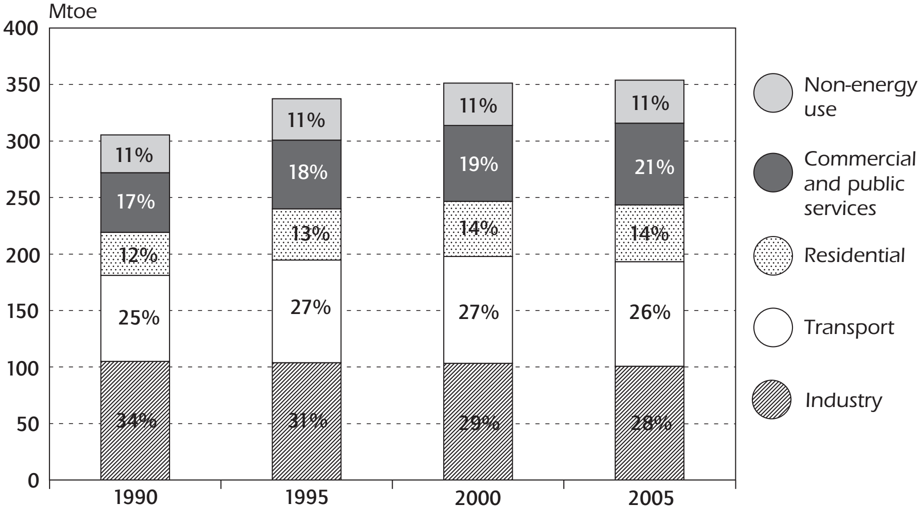
Japan and other IEA countries have experienced increasing TPES per capita since 1990. However, Japan's TPES per capita grew by 15% between 1990 and 2005, from 3.59 to 4.14 tonnes of oil equivalent (toe) per capita, in contrast to the IEA average increase of 9% to 5.14 toe per capita over the same period.

A sector-by-sector analysis reveals changes in the proportions of energy use in each sector (see Figure 7). Since 1990, Japan's energy use in the industrial sector as a proportion of the total has declined. In 1990, industry consumed around 100 Mtoe, about 34% of TFC. By 2005 this had reduced steadily to 28% of TFC. This is the result of several factors, including energy efficiency changes in major industrial sectors, shifts in the mix of production and changing production levels (see Figure 8). During the period between 1973 and 2005, energy efficiency (in terms of energy consumption per unit of production) improved by 20% in the steel industry, 52% in the paper-making industry, 24% in the cement industry and 29% in the chemical industry. As a result, the energy efficiency of Japan's major industrial sectors is one of the highest among IEA countries.

From 1990 to 1995, energy consumption in the transport sector followed the trends of most other IEA countries with an increase in energy consumption.

Figure 7

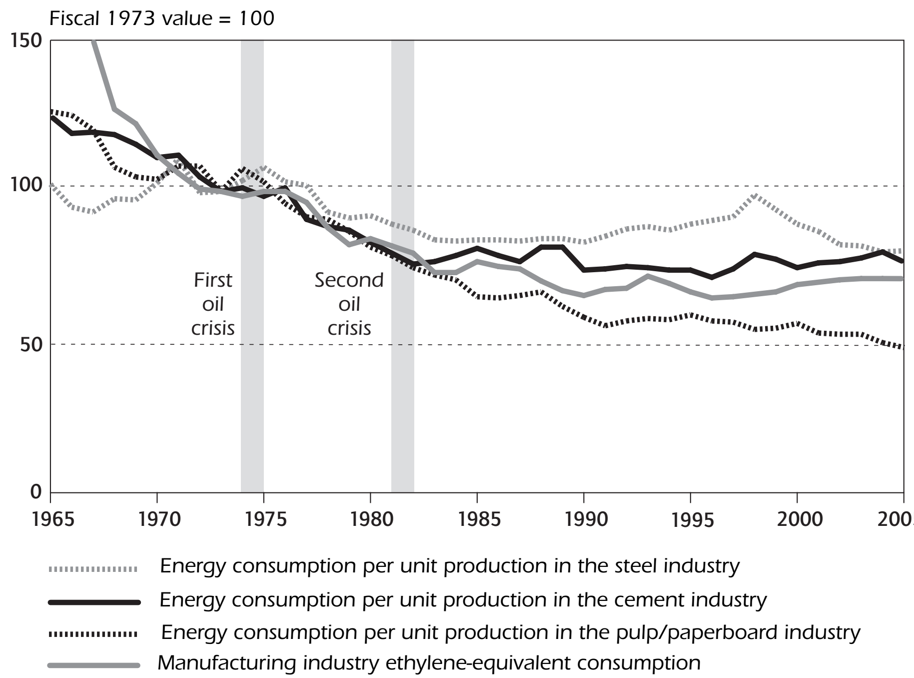
Japan's Energy Use by Sector, 1990 to 2005



Source: *Energy Balances of IEA Countries*, IEA/OECD Paris, 2007.

Figure 8

Changes in Energy Consumption per Unit Production in Selected Industries, 1965 to 2005



Source: *Energy Balances of IEA Countries*, IEA/OECD Paris, 2007.

However, since 1995 energy consumption in transport has remained relatively stable, and even recorded a reduction between 2000 and 2005 from 95 Mtoe to 93 Mtoe. This appears to be the result of changes in vehicle size – the average weight of gasoline-powered passenger cars has remained relatively stable since 1997 – and improvements in the energy efficiency of both freight and passenger vehicles. For passenger vehicles, there has been a consistent improvement in the average fuel economy from 12 km per litre in 1995 to 15 km per litre in 2004, combined with a recent reduction in annual driving distance per vehicle and a reduction in total driving distance for the vehicle fleet.

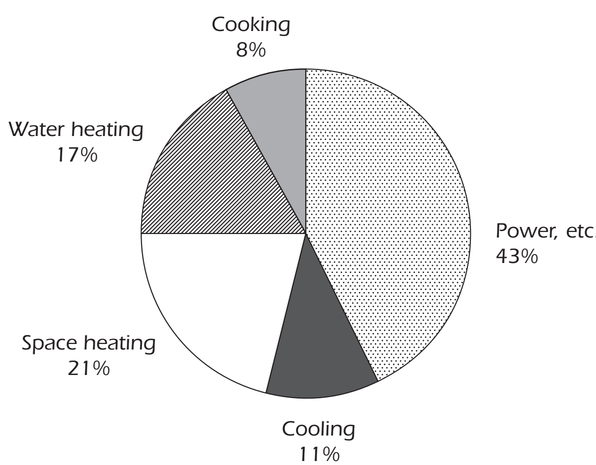
Similar recent achievements have been made in freight vehicle fuel efficiency. Freight energy efficiency increased from a peak of just over 16 000 kilojoules (kJ) per tonne-km in 2002 to 15 647 kJ per tonne-km in 2005.

In contrast, it is notable that final energy consumption in the commercial sector has experienced a mostly steady increase from 45 Mtoe in 1990 to 62 Mtoe in 2005. As a consequence, Japan's commercial and public services sector consumed around 20% of TFC in 2005 (see Figure 9). Nearly half of Japan's commercial sector energy consumption is used for heating (both space and water) and cooling. The next major energy load is for appliances and lighting.

Japan's energy use in the residential sector has shown a similar growth trend to that of the commercial sector. In 1990 the residential sector consumed 38 Mtoe. By 2005 this had increased to 55 Mtoe (18% of TFC). The increasing trend in household energy use is in part due to the increasing penetration of electrical appliances (see Figure 10). For example, in 1970, air-conditioners

Figure 9

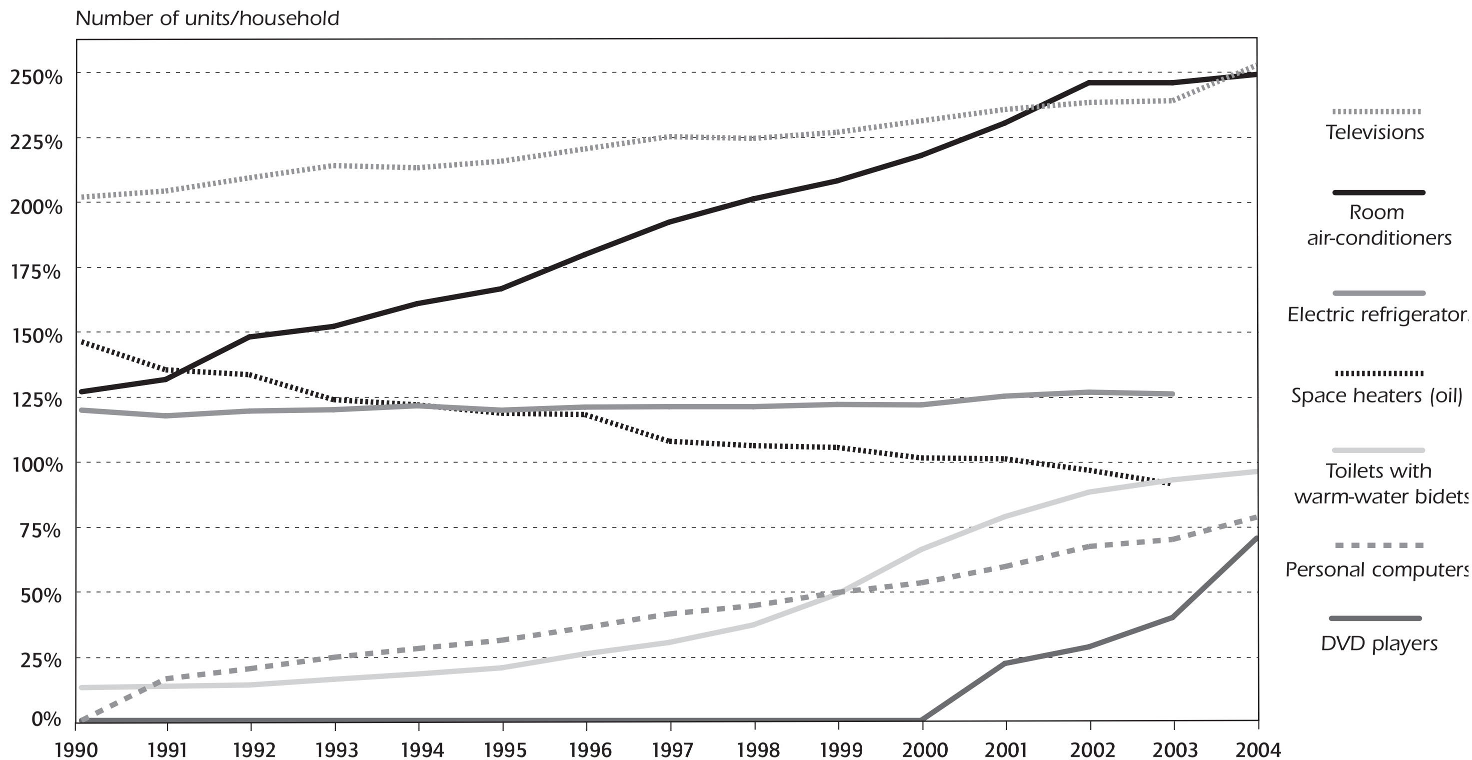
Commercial Sector Energy End Use, 2005



Source: *2007 EDMC Handbook of Energy & Economic Statistics in Japan*, ECCJ.

Figure 10

Diffusion Rate and Electricity Consumption of Home Appliances



Source: METI and ECCJ, "Energy Conservation Policy and Measures in Japan", p. 15.

were only in 8.8 out of every 100 households. By 2005, this had increased steadily to 255.3 air-conditioners per 100 households. Similar trends were seen in personal computers, DVD players, toilets with warm water bidets, televisions and microwave ovens.

Japan has a lower energy use per household than other countries. In 2001, Japan's energy use per household was 41 gigajoules (GJ), compared to 74 GJ in France and Germany and 97 GJ in the United States. Nevertheless, the fairly consistent increase in energy use in the residential and commercial sectors has led to these two sectors being the focus of an increasing amount of policy attention about energy efficiency in Japan.

Japan produces a *Long-Term Energy Demand-Supply Outlook* approximately every three years. In 2008, the government's demand-supply subcommittee is planning to update its 2005 energy outlook. This outlook projects energy use and supply through to 2030. The reference scenario, as with the outlook released in 2005, estimates that total final energy consumption will increase from 413 million kilolitres (kl) of crude oil equivalent to 425 million kl in 2030. The key contributor to this increase is energy use in the residential and commercial sectors. Energy use in the reference scenario for the transport sector is projected to remain constant through to 2030.

POLICIES AND MEASURES

Japan has continued its focus on energy efficiency policy advancement and implementation since the previous review. Examples of developments since 2003 include revising the standards and expanding the scope of the Top Runner programme (such as implementing standards for heavy-duty vehicles), starting the implementation of the labelling system for energy efficiency of home appliances, and extending the Act on the Rational Use of Energy to include large transport companies and consigners, and large residential buildings.

Policy framework and objectives

The cornerstones of Japan's energy efficiency policy include the Basic Act on Energy Policy 2002, the Basic Energy Plan and the New National Energy Strategy.

The Basic Act on Energy Policy, formulated in June 2002, sets the general direction for Japan's future energy policy. It specifically identifies securing stable supply, environmental suitability and utilisation of market mechanisms as key policy directions. This law also requires the government to "formulate a basic plan on energy supply and demand in order to promote measures on energy supply and demand on a long-term, comprehensive and systematic basis".

The Basic Energy Plan clarifies the direction of policies concerning future energy supply and demand as required in the Basic Act on Energy Policy. In March 2007, the Basic Energy Plan was revised on the basis of the New National Energy Strategy. A key point of the revised Energy Plan relating to energy efficiency is the increased attention paid to energy efficiency measures in the commercial/residential and transport sectors.

The New National Energy Strategy is a strategy for energy security that was formulated in May 2006 to reflect recent changes in the domestic and international energy situation. Improving energy efficiency is a key plank of this strategy. Key points of the strategy aim to:

- Improve the efficiency of energy consumption at least by an additional 30% by 2030.
- Reduce Japan's dependence on oil in the total primary energy supply to 40% or less by 2030.
- Reduce oil dependence in the transport sector to around 80% by 2030.
- Increase the proportion of nuclear energy in Japan's total power generation at 30-40% or more in 2030 and thereafter.
- Further expand the ratio of exploration and development of oil resources by Japanese companies, to around 40% by 2030.

Japan has also adopted the "Front Runner Plan" for energy conservation. This plan sets forth specific measures for achieving its goal of improving energy consumption efficiency by at least 30% by 2030 compared with 2003. The plan is based on the recognition that in addition to short-term energy conservation measures adopted with the first commitment period of the Kyoto Protocol, medium- and long-term measures are also important.

The 1979 Act on the Rational Use of Energy is a key piece of legislation underpinning many energy efficiency programmes. The law has been revised several times to reflect changes in priorities. It was revised in June 1998 to make progress towards the Kyoto Protocol, at which time the Top Runner programme was introduced (see below). Then, in June 2002 it was revised to reinforce the energy conservation measures for household, commercial and other sectors. The 2002 amendment took effect in April 2003, making it mandatory for the owners of large office buildings to submit reports to the relevant ministry with regard to energy efficiency measures that they implemented during the process of constructing or renovating buildings.

In 2005, the Act on the Rational Use of Energy was again revised. This revision was the result of discussions in December 2003 by the Energy Efficiency and Conservation Subcommittee of the Advisory Committee for Natural Resources and Energy on future energy-saving measures for the industrial, transport and commercial sectors. The subcommittee produced an interim report in July 2004 outlining a list of possible future energy-saving measures. In November 2004 and March 2005, the subcommittee discussed the radical strengthening of the Act on the Rational Use of Energy, and revised it in August 2005; the revised law took effect in April 2006. This version expands the scope of regulation to include the transport sector and large residential buildings, and requires the energy supply and electrical product retail sectors to provide information that encourages consumers to conserve energy.

Institutional responsibilities for energy efficiency have not changed since the last IEA review. METI's Agency for Natural Resources and Energy (ANRE) continues to be responsible for energy-sector matters. It leads national efforts to promote energy conservation measures, in co-operation with the Ministry of Land, Infrastructure and Transport (MLIT) and other ministries that are responsible for the relevant sectors. While the central government thus promotes energy conservation measures for the country as a whole, local governments are taking steps to implement their own energy conservation efforts.

Energy efficiency budget

The fiscal year (FY[2]) 2007 budget for METI and the Ministry of the Environment (MOE) for energy conservation was JPY 161.9 billion. This is a 2% decrease from the previous year's budget of JPY 164.9 billion. An extract of some items in Japan's energy efficiency budget is outlined in Table 9.

Table 9

Extract of Japan's Energy Efficiency Budget

Unit: thousand JPY	*2006 budget*	*2007 budget*
Subsidy for support of project operators for rational energy use	24 150 000	26 926 000
Subsidy for promotion of introduction of high-efficiency energy systems for residences and buildings	13 419 826	12 175 700
Subsidy for promotion of introduction of high-efficiency water heaters	12 000 000	12 000 000
Subsidy for strategic technology development for rational energy use	6 200 000	8 000 000
Subsidy for promotion of introduction of energy-saving measures	371 178	372 000
Subsidy for information provision on introduction of energy-saving equipment	1 850 000	1 663 271

Source: Country submission.

2. Japan's fiscal year runs from 1 April to 31 March. For example, FY2006 runs from 1 April 2006 to 31 March 2007.

Fiscal policies

The government has adopted a range of tax and subsidy schemes to promote energy efficiency across sectors.

In the transport sector, the government has adopted taxation measures, such as the introduction of the greening automobile tax for fuel-efficient and low-emission vehicles and a reduction of the automobile acquisition tax for fuel-efficient and low-pollution vehicles. In order to accelerate development and sales of these vehicles, the preferential taxation has been regularly revised to focus on more fuel-efficient and lower-emission vehicles and to cover compressed natural gas (CNG) cars, electric cars and hybrid cars, among others. It appears that this tax incentive has helped Japan achieve its fuel efficiency target of 15 km per litre (L) for cars running on gasoline ahead of schedule.

In the industrial sector, Japan has implemented a tax system for energy supply/demand structure reform and investment promotion for the industrial and commercial sectors. This system allows individuals and corporations to claim a tax credit or a special depreciation upon introduction of eligible equipment.[3]

In addition, sectors can also access a range of subsidy programmes for promoting energy-efficient technologies such as those outlined in Table 10.

Table 10

Subsidy Programmes and Budgets for Promoting Energy-Efficient Technologies

Subsidy name	*Outline*	*Budget amount for 2007 (thousand JPY)*
Energy utilisation rationalisation subsidy	To assist installation of energy-efficient facilities	82 814 319
Energy conservation technology development subsidy	To assist development of energy-saving technologies	16 630 056
CO_2 emissions reduction subsidy	To assist the installation of energy-efficient facilities with reduced CO_2 emissions	14 097 500
Environmentally harmonised fuel utilisation subsidy	To assist the development of combustion technologies that reduce CO_2 emissions	1 210 359
Subsidy for promoting regional energy development and utilisation	To assist the installation of highly efficient water heaters by private firms	13 295 000

Source: Country submission.

3. The tax credit is equivalent to 7% of relevant equipment acquisition costs to be deducted from the corporate tax amount and the special depreciation covers 30% of the equipment acquisition cost in the initial year.

Subsidies for housing and buildings are also available under the Project for Promoting the Introduction of High-Efficiency Housing/Building Energy Systems. This project provides subsidies for business operators and households introducing energy-efficient systems for their new buildings or extensions. Eligible technologies include:

- Combined use of multiple energy-efficient appliances for the construction of energy-efficient buildings (commercial sector).
- High-efficiency air-conditioners (commercial sector).
- Combined use of multiple energy-efficient appliances for the construction of energy-efficient houses (household sector).
- High-efficiency water heaters (household sector).

Energy efficiency standards, the Top Runner programme and labelling

Japan has a long tradition of promoting energy efficiency in appliances and equipment. For example, energy efficiency requirements were first introduced for refrigerators, room air-conditioners and automobiles in 1979 under the Act on the Rational Use of Energy.

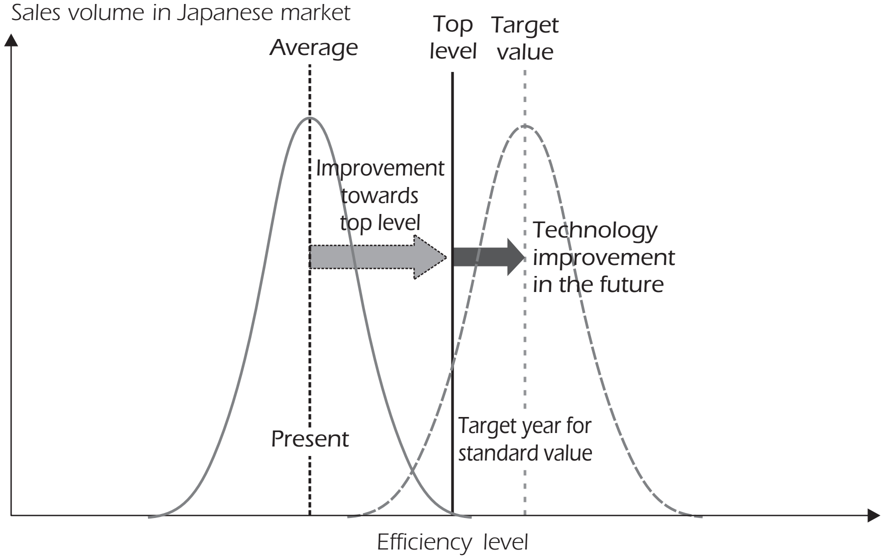
The centrepiece of Japan's efficiency programme is the ambitious Top Runner programme, implemented as part of the 1998 amendment of the Act on the Rational Use of Energy to make progress towards the Kyoto climate change targets. Under the programme, energy efficiency performance targets for categories of machinery and equipment, including vehicles both domestically manufactured and imported, are set by taking as the basis the level of the most energy-efficient products on the market at the time of the value-setting process.

Each type of equipment is divided into several subgroups, where appropriate, and the energy efficiency target is established for each subgroup. Development is not evaluated for each product, but for each group. Manufacturers of a product category covered by the programme are deemed to have met the future energy efficiency performance standard if the sales-weighted average energy efficiency performance of their products meets or exceeds the target level in the target year (see Figure 11). METI can disclose the names of unsuccessful companies, as well as issue recommendations, orders and fines if targets are not reached. To date, METI has not undertaken any legal enforcement actions.

The Top Runner programme has consistently extended its coverage of products. In April 2007, large trucks and buses, liquid crystal display (LCD) and plasma display panel television sets, rice cookers with thermos functions, microwave ovens and DVD recorders were added to the list of items covered by the programme. Furthermore, the government has put in force new standards for air-conditioners for home use and refrigerators in September 2006. For automobiles, a new fuel efficiency standard was

Figure 11

Schematic of Process for Setting and Evaluating Top Runner Standard



Source: Country submission.

established in July 2007 with a view to improving fuel efficiency by 23.5% by 2015 compared with 2004. The programme currently covers 21 items and the estimated energy savings achieved by the most recently achieved targets are shown in Table 11.

According to results provided by METI, Top Runner targets have been consistently met or exceeded (see Table 12).

As a related issue, it is important to note that standards programmes in general, and Top Runner is no exception, are not appropriate for addressing issues related to the energy efficiency of systems (that is, assemblies of components) and, thus, other policy mechanisms are required to access energy efficiency potentials in this domain.

Whereas the Top Runner programme targets manufacturers and importers, appliance energy efficiency levels are made visible to customers through the provision of relevant information. It is compulsory for manufacturers and importers of designated appliances to provide information on the energy efficiency of their products. It is up to manufacturers' discretion whether they complement this information with the use of labels or not. In addition, the amended Act on the Rational Use of Energy made it necessary for retailers to make efforts to provide information concerning energy conservation features of products. Consequently, in October 2006 Japan launched a unified energy conservation labelling programme that requires efforts to indicate comparative

Table 11

Target Year and Effects of Top Runner Programme

Category	*Equipment*	*Target fiscal year*	*Expected energy conservation effects as of the previous fiscal year of the target*
1	Gasoline and diesel passenger vehicles	FY2015	Approx. 23.5% compared to FY2004
	Minicoaches	FY2015	Approx. 7.2% compared to FY2004
	LPG passenger vehicles	FY2010	Approx. 11.4% compared to FY2001
	Trailer buses	FY2015	Approx. 12.1% compared to FY2002
2	Air-conditioners	FY2010	Approx. 22.4% compared to FY2004
3	Fluorescent lights	FY2005	Approx. 16.6% compared to FY1997
4	LCD and plasma televisions	FY2010	Approx. 15.0% compared to FY2005
5	Video-cassette recorders	FY2003	Approx. 58.7% compared to FY1997
6	Copy machines	FY2006	Approx. 30% compared to FY1997
7	Computers	FY2007	Approx. 83% compared to FY2007
8	Magnetic disk units	FY2007	Approx. 71.0% compared to FY2001
9	Small freight cars	FY2015	Approx. 12.6% compared to FY2004
	Large freight cars	FY2015	Approx. 12.2% compared to FY2002
10 11	Electric refrigerators and freezers	FY2010 FY2010	Approx. 21% compared to FY2005
12	Space heaters	FY2006	Approx. 1.4% compared to FY2000 for gas space heaters; approx. 3.8% for oil space heaters
13	Gas cooking appliances	FY2006	Approx. 13.9% compared to FY2000
14	Gas water heaters	FY2006	Approx. 4.1% compared to FY2000
15	Oil water heaters	FY2006	Approx. 3.5% compared to FY2000
16	Electric toilet seats	FY2012	Approx. 9.7% compared to FY2006
17	Vending machines (also introducing a paper pack and cup system)	FY2012	Approx. 33.9% compared to FY2006
18	Transformers	FY2006: oil-filled transformers FY2007: mold transformers	Approx. 30.3% compared to FY1999
19	Microwave ovens	FY2008	Approx. 8.5% compared to FY2004
20	Electric rice cookers	FY2008	Approx. 11.1% compared to FY2003
21	DVD recorders	FY2010	Approx. 20.5% compared to FY2006

Source: Country submission.

assessments of product energy efficiency for air-conditioners, refrigerators and televisions, and estimated annual electricity costs as shown in Figure 12. Table 13 outlines which types of labels and other information can be provided for retailers of particular classes of products.

Table 12

Results of Top Runner Programme in Selected Categories

Product category	*Improvement period*	*Target energy efficiency improvement*	*Actual energy efficiency improvement*
Televisions	1997-2003	16.4%	25.7%
Video-cassette recorders	1997-2003	58.7%	73.6%
Air-conditioners	1997-2004	66.1%	67.8%
Electric refrigerators	1998-2004	30.5%	55.2%
Electric freezers	1998-2004	22.9%	29.6%
Gasoline passenger vehicles*	1995-2005	22.8%	22.8%
Diesel freight vehicles*	1995-2005	6.5%	21.7%
Vending machines	2000-2005	33.9%	37.3%
Computers	1997-2005	83.0%	99.1%
Magnetic disk units	1997-2005	78.0%	98.2%
Fluorescent lights	1997-2005	16.6%	35.6%

* The energy efficiency improvement estimate is based on a simple average of the fuel efficiency of all vehicles offered for sale. In contrast, the energy efficiency target is based on a sales-weighted average. Please note that the effects of reducing consumption are indicated as inverse numbers because the coefficient of performance of fuel economy (km/L) is used as an energy consumption efficiency index.

Source: ECCJ, "Top Runner programme", October 2006, p. 9.

A labelling-related innovation introduced by Japan since the last review is the system for the assessment of energy-efficient product retailers. The system identifies outlets that excel at promoting energy-efficient products. Such outlets are authorised to carry a special logo.

Japan has also undertaken steps that address principal-agent problems. Principal-agent problems emerge in the energy efficiency context when the party responsible for designing or purchasing energy-using equipment is not the party that pays for the energy use. In the case of vending machines, the situation existed because vending machine owners would lease space for their machines from building owners, but the building owners would pay the electricity bill. Consequently, there was little incentive for the vending machine owner to maximise the machine's energy efficiency. Japanese law makes vending machine operators indirectly responsible for paying the electricity bill of the vending machine. Under this requirement, the building owner pays the electricity bill of the vending machine to the electric company.

Figure 12

Example of Energy Labels

Energy-saving label

Target fiscal year: 2006	Energy conservation standard achievement	Annual electricity consumption
	108%	175 kWh

Target fiscal year: 2006	Energy conservation standard achievement	Annual electricity consumption
	91%	206 kWh

Uniform energy-saving label

Multi-stage rating system
- Energy-saving performance is indicated in 5 stages, from 1 to 5 stars, from low to high performance of products offered on the market.
- In order to clarify the compliance level with the Top Runner standard, arrows are placed under the stars, showing achievement and non-achievement

Energy-saving labelling system
- Products which achieved the Top Runner standard carry a green "e" mark, while others carry an orange "e" mark.
- Achievement level and energy consumption efficiency (annual electricity consumption) are also indicated

Estimated annual electricity rates
- The estimated annual electricity rates are indicated to show the energy consumption efficiency (annual electricity consumption) clearly.

Source: Country submission.

However, the vending machine operator that leases a space from a building owner also faces the electricity bill indirectly because the contract must include an electricity component in addition to the rent for the location.[4] The performance of vending machines has made significant progress in energy performance, increasing by 33.9% between 2000 and 2005.

4. *Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency*, IEA/OECD Paris, 2007.

Table 13

Energy-Saving Labelling System for Retailers (Applicable Products)

Equipment	*Energy-saving labelling system*	*Expected annual electricity bill and annual fuel usage*	*Uniform energy-saving label**
Air-conditioners	O	O	O
Electric refrigerators	O	O	O
Electric freezers	O	O	
Lights	O	O	
Electric toilet seats	O	O	
Televisions	O	O	O
Computers	O		
Magnetic disk units	O		
Space heaters	O		
Gas cooking appliances	O	O (energy usage)	
Gas water heaters	O	O (energy usage)	
Oil water heaters	O	O (energy usage)	
Transformers	O		
Electric rice cookers	To be added	O	
Microwave ovens	To be added	O	
Video cassette recorders		O	
DVD recorders	To be added	O	

* The uniform energy-saving label provides information on expected electricity bills, rating in the multi-stage rating system, and energy conservation information in an integrated manner.

Source: Country submission.

Industrial sector

Japan uses a mix of regulatory measures, voluntary actions by industry and a combination of subsidies, tax exemptions and loans for investment to encourage energy efficiency improvement in industry. The energy-saving policy in Japan's industrial sector was developed with strong co-operation between the public and private sectors.

Under the Act on the Rational Use of Energy, large-scale factories have been subject to energy efficiency requirements since 1979. Since the last review, revisions to the Energy Conservation Law have extended the coverage of energy efficiency requirements to a greater number of factories and businesses. Specifically, factories and other workplaces with high energy consumption (an annual fuel use greater than or equal to 3 000 kl of crude oil equivalent) are required to appoint energy managers, prepare and submit mid- and long-term energy plans and periodical reports on energy use. Similarly, factories and other workplaces with medium energy consumption (greater than or equal to 1 500 kl crude oil equivalent) are required to submit periodic reports on energy consumption and appoint a qualified person for energy management. As of 31 March 2007, 7 457 high-energy-consuming factories and workplaces and 6 094 medium-energy-consuming factories and workplaces are covered under the law. This is a significant increase in business unit coverage since the last review.

On-site investigations have been conducted since 2001 on high-energy-consuming factories. Since the previous review, a random sampling method has been used for on-site investigations on factories so as to improve and enhance the quality of investigations. The government conducted over 40 on-site inspections, as well as about 2 000 on-site investigations, between FY2004 and FY2006. Inspections are conducted in cases where energy management is not sufficiently implemented. When METI finds the rational use of energy to be significantly insufficient (following the receipt of reports and/or on-site inspections), it instructs the installation to improve its performance, announces to the public the finding or can penalise a particular factory. To date, METI's advice following on-site investigations or inspections has succeeded in improving energy efficiency at such factories, and no penalties have been incurred.

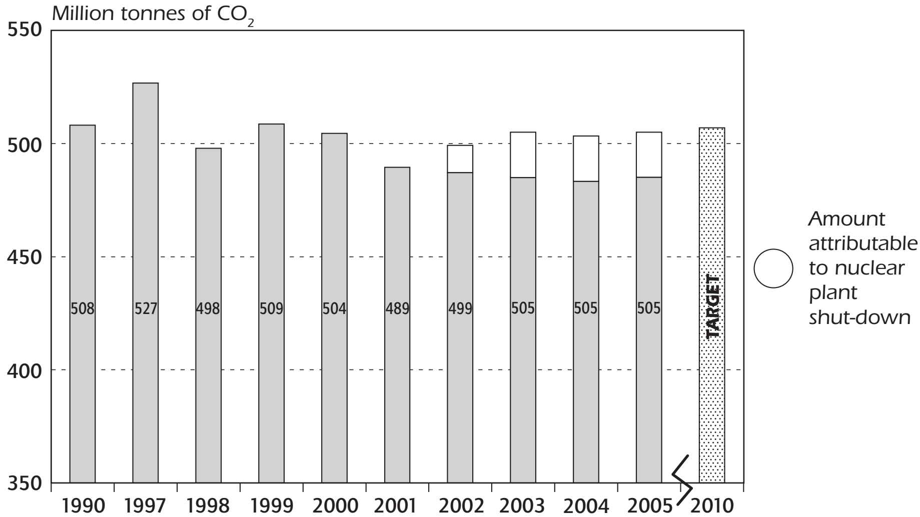
A key plank of Japan's industrial energy efficiency policy is the Keidanren Voluntary Action Plan on the Environment to reduce CO_2 emissions. This Keidanren plan was laid down by Nippon Keidanren (Japan Business Federation) in June 1997. The overall goal of the Keidanren plan is "to suppress the CO_2 emissions in 2010 from industrial and energy-conversion sectors below its 1990 level". The Keidanren plan aims to contribute CO_2 savings of 42.4 Mt CO_2 to the government's Kyoto Protocol Target Achievement Plan. Currently, 35 industries in the industrial and energy-conversion sectors (accounting for about 40% of total emissions in Japan in 1990) are involved in the Keidanren plan.

Evaluation of the effectiveness of the Keidanren plan programme is a difficult task. This evaluation takes place both within companies (through a quality review process) and externally by Industrial Structure Council meetings (membership of which includes industry representatives), which are open to the public. There is also a public consultation process based on the results of the reviews.

Information from Keidanren suggests that the programme-wide target has been met for the period 2001 to 2005. The agreements are set as CO_2 emission levels, and results indicate that the industrial sector achieved this target. The programme-wide target (to suppress CO_2 emissions in 2010 below their 1990 level) has been met for six years, beginning in 2000. Figure 13 shows CO_2 emissions from 35 industries in various sectors.

Figure 13

CO_2 Emissions by 35 Industries in the Industrial and Energy-Conversion Sectors



Source: Nippon Keidanren.

Another interesting development in Japan since the previous review is an increased focus on improving energy efficiency in small and medium-sized enterprises (SMEs). The government has established several fiscal schemes to assist SMEs in reducing their CO_2 emissions. These schemes include subsidies for the introduction of energy-efficient equipment and government loans. In addition, METI is considering a voluntary domestic offset scheme aimed at reducing greenhouse gas emissions from SMEs without legal or mandatory government-imposed obligations for emissions reduction. The purpose of this scheme is to encourage SMEs to implement potential energy-conservation projects through credit trading with large companies with limited energy conservation potential.

Residential, commercial and other sectors

With respect to buildings, Japan is making an effort to improve the energy efficiency of new and existing buildings through its 2002 amendment of the Act on the Rational Use of Energy. This law sets a mandatory scheme for the reporting of energy efficiency measures for large-scale non-residential buildings over 2 000 square metres (m^2) of space at the time of their construction or renovation. Importantly, a 2005 amendment extended the policy coverage of the 2002 amendment to include extensive repairs or facility works of non-residential buildings over 2 000 m^2, as well as making it mandatory for large residential buildings over 2 000 m^2 to report on energy efficiency measures, as had previously only applied to non-residential buildings. Specifically, the law now makes it obligatory for buildings, including residences, with a total floor area of 2 000 m^2 or larger to:

- Notify the relevant ministry of energy efficiency measures to be implemented during construction or modification of the building. When the energy efficiency measures reported are markedly inappropriate, the relevant ministry can issue instructions, and when an owner has failed to follow the instructions without justifiable grounds, the name of the owner will be publicly released.

- Provide periodic reports on building maintenance with respect to those energy efficiency measures that were submitted at the time of construction, modification and major repairs.

The buildings-related requirements of the Act on the Rational Use of Energy are complemented by voluntary energy efficiency standards in the building codes. These requirements were first introduced in 1980 and strengthened in 1992 (1993 for non-residential buildings) and 1999. Standards for facilities in common spaces of apartment buildings were added in 2006. As of 2005, 30% of newly-built houses and 85% of buildings with a total floor area greater than 2 000 m^2 complied with the voluntary energy efficiency standards.

In addition, a range of complementary energy efficiency measures are included in the Housing Qualification Assurance Law of 2000. These include the:

- Voluntary housing performance indication system, which enables consumers to compare the energy efficiency of houses by consulting housing performance evaluation reports published by evaluation bodies registered by the Ministry of Land, Infrastructure and Transport. The reports are prepared before the buildings are constructed and the issued performance evaluation report (including the energy efficiency components) is construed as an agreement to build a house with the performance described in the report. The housing performance indication system has been applied to about 910 000 buildings at the end of March 2007.

- Comprehensive assessment system for building environmental efficiency (CASBEE), which is used to conduct assessments on the improvement of habitability of indoor environment and the reduction of the environmental load of houses and buildings in an integrated manner. It is also designed to present evaluation results of comprehensive environmental efficiency in simple indices. Some local governments make the submission of a CASBEE assessment mandatory at the time of construction or modification of buildings. At the end of September 2007, approximately 1 900 reports had been submitted nation-wide.

Building owners are also encouraged to improve the energy efficiency of their buildings through fiscal policies. Owners of highly energy-efficient housing have access to low-interest mortgages (with an interest rate cut of 0.3%) through the Japan Housing Finance Agency. Owners of highly energy-efficient large-scale buildings also have access to low-interest loans through the Development Bank of Japan.

The government has also been investigating the introduction of the computerised home energy management system (HEMS) and business energy management system (BEMS) for offices. Both systems attempt to provide real-time information on energy consumption and cost. The BEMS has been supported by subsidies since 2002. A field test for HEMS was completed in 2005. The service utilising the HEMS system has overcome technical problems, but unfortunately is not cost-effective and as a result has not progressed further. Therefore, the government has been promoting the diffusion of energy-saving navigation meters, for the real-time provision of information on energy consumption to consumers.

Since the last review, both the government and manufacturers have demonstrated a high degree of awareness of the stand-by power issue, and have made efforts to reduce stand-by power in major products. Japan has also implemented monitoring processes to assess progress, and the monitoring appears to show that the policies are effective. The results suggest that Japan has reduced its stand-by power usage from 9.4% of average total household electricity consumption in 2003 to approximately 7% currently. IEA analysis of data from a 2005 stand-by power study in Japan shows that 62.3% of appliances measured have stand-by power consumption of 1 watt (W) or less, improved from 54% in 2004 and 50% in 2003. The Japan Industrial Association of Gas and Kerosene Appliances is also planning to achieve a 1-watt standard for its appliances by the end of 2008.

As noted in the 2003 IEA review, the extension of the Act on the Rational Use of Energy to cover larger offices and the obligation to appoint energy management staff was likely to lead to a greater number of energy service companies (ESCOs). However, according to the ECCJ, the ESCO market did not grow between 2003 and 2006, remaining around the JPY 50 billion level. As of January 2008, membership in the Japan Association of Energy Service Companies totalled 138.

Transport sector

Japan has made significant gains in the energy efficiency of its transport fleet. Policies that have contributed to this include the Top Runner programme, mandatory reporting for operators with large fleets of vehicles (combined with targets to decrease the rate of energy use), vehicle taxation, eco-driving campaigns, promotion of alternative fuels and promoting public transport and traffic management.

With respect to the Top Runner programme and its transport coverage, it is important to note the inclusion of freight vehicle energy efficiency standards, and the recent addition of large trucks and buses. Japan is the only country in the world with fuel efficiency standards for heavy-duty vehicles.

A new policy since the previous review is the mandatory reporting requirement for large carriers and consigners.[5] Introduced as part of the April 2006 Amendment to the Act on the Rational Use of Energy, large carriers must prepare and submit energy plans and periodic reports to MLIT. In addition, large consigners are also required to prepare and submit energy plans and periodic reports to METI and competent authorities regarding the consigner's type of industry. As with the other sectors covered by this reporting requirement (industry, residential and commercial buildings), when MLIT, METI and these authorities find that efforts to ensure rational energy use are significantly insufficient, they shall advise, announce to the public or order the company in question to undertake specific remedial action (and penalise the company if orders are not followed). The government has stated that large carriers and consigners are expected to:

- Decrease the rate of energy use by 1% or more per year over the mid to long term.
- Set up in-house systems for energy savings.
- Introduce efficient transport measures.
- Promote efficiency through the eco-driving concept.
- Promote higher transport energy efficiency performance.

MLIT, METI and supervisory authorities governing consigners check the submitted reports and, if necessary, carry out on-the-spot inspection of carriers and consigners.

Since 2001, the government has promoted the use of clean-energy vehicles through its automobile green tax. This measure reduces the automobile tax by about 50% and the automobile acquisition tax by about 2.7% on eco-friendly cars such as electric vehicles, CNG cars and hybrid cars, as well as fuel-efficient cars and low-exhaust certified cars. Currently, the government reports a total of 14.4 million clean-energy vehicles in Japan.

5. This policy applies to carriers with more than 200 trucks or more than 300 items of rolling stock and consigners that carry more than 30 Mt-kilometres per year. Consigners are entities that are contracted to perform transport or delivery services.

The government has also attempted to promote eco-driving through a range of measures including information provision (ten recommendations for eco-driving and a public website[6]), public promotion campaigns (through, for example, the "Soft Acceleration, e-Start for the Slow Start" campaign) and its Action Plan to Disseminate and Promote Eco-Driving (formulated in June 2006). The latter programme involves four ministries and relevant industries co-operating in promoting smart/eco-driving. Japan has set November of every year as eco-drive month during which the government promotes eco-driving behaviour. It is difficult to gauge the success of these programmes across the road transport sector. However, it does appear that eco-drive is more successful in freight than passenger vehicles.

In 2006, the government established the Biomass Nippon Strategy to promote the use of biomass fuels in transport. The government has introduced a goal for biofuels in transport of 0.5 million kl (crude oil equivalent) for 2010, which aims to contribute to a 1.3 Mt reduction in CO_2 emissions.

Japan is continuing to encourage public transport use through the construction of new rail lines – between 2003 and 2005, 13 new routes were opened covering a distance of 144 km throughout Japan – the improvement of train ticket technology, enhanced convenience for public transportation use, such as improving train-bus transfers, and the introduction of bus-location systems. These policies may have contributed, at least in part, to the decrease in private vehicle-kilometres travelled since 2000. In addition, the government has a range of traffic management measures under the Kyoto Protocol Target Achievement Plan. These include constructing ring roads, bypasses and cycle lanes; promoting the use of electronic toll collection systems (ETC) and vehicle information and communication systems (VICS); promoting cycling and reducing traffic congestion caused by road works.

MONITORING AND EVALUATION

Japan purports to have a well-structured energy efficiency policy and programme evaluation system. Formal evaluation of energy efficiency and conservation policies is closely tied to the government budget process and is carried out under the Government Policy Evaluations Act 2002. This evaluation process requires both *ex ante* and *ex post* evaluations. Public input into the process is introduced through the Administrative Procedure Act under the title "Procedures for Submitting Comments on the Establishment, Revision or Repeal of Regulations".

6. www.recoo.jp.

METI conducts *ex ante* evaluation of policy proposals and discloses the results every year when it makes a budget request. Where possible, METI and its associated advisory councils conduct quantitative evaluations of the policy context and the cost-effectiveness of policy proposals in order to justify policy action. From 2008, as a result of institutional reforms, the formats of budget and account-closing documents will be harmonised with the framework of policy evaluation to streamline budget management.

Ex post evaluation is also conducted regarding all measures and programmes every three to five years. *Ex post* evaluation attempts to verify the effectiveness of the individual programmes and measures, and to sum up the results by comparing these against the objectives and targets specified at the time of programme inception. The government publishes evaluation results every three to five years.

Japan has attempted to establish third-party verification of evaluations. For example, the Evaluation Committee for the Voluntary Action Plan on the Environment was established in 2002 to confirm that follow-up surveys for the Keidanren Voluntary Action Plans are performed adequately and to evaluate their transparency and credibility from an independent standpoint. It also identifies areas for improvement regarding the follow-up surveys for the Keidanren Voluntary Action Plan so as to contribute to further enhancing transparency and credibility. The ability for public input into the evaluation process is provided for under the Administrative Procedure Act of April 2006.

Japan also presents a robust monitoring programme. As mentioned above, METI produces regular energy demand-supply outlooks. In addition, there are a range of other modelling endeavours from agencies such as the Institute of Energy Economics, Japan (IEEJ). The IEEJ Energy Data and Modelling Centre also produces detailed energy statistics in its *Handbook of Energy & Economic Statistics in Japan* that provide a useful input into the policy process. This handbook provides time series information on energy use back to, in some cases, 1965. Importantly, the report appears to include useful detail on energy end-use in each sector. It also provides the results of factor (or a decomposition) analysis for all of the main sectors. For example, factor analysis suggests that:

- Between 1991 and 2000, manufacturing energy use increased by roughly $19\ 790 \times 10^{10}$ kcal. This increase was a result of three factors. First, declining energy efficiency of manufacturing (intensity effect) actually adding to the increase in energy use. Second, manufacturing industry shifted during this period to less energy-intensive products (industrial structure effect), counteracting the energy efficiency change and tending to reduce energy use. Third, manufacturing production levels declined during this period, again reducing energy consumption.

- Between 2000 and 2005 manufacturing energy consumption declined by 2 552 × 10^{10} kcal. This change in energy consumption was a result of a small decline in manufacturing energy efficiency and a significant change in manufacturing structure. The change in sector structure towards less energy-intensive industry was enough to counteract any increased energy use as a result of the significant increase in production levels.

CRITIQUE

Japan remains committed to sustainable energy policies, both enhancing its own energy and environmental policy framework and taking a strong leadership position, not only through its 2008 presidency of the G8, but also in the Asia-Pacific arena. In recent years, Japan has made important strides towards reducing energy use and greenhouse gas emissions in industry and, in particular, transport. Traditionally, the transport sector has been one of the most difficult sectors to address within IEA countries, thus we commend Japan for its successful efforts in this area and we are pleased to see it share its experience and lessons learned with the international community. This progress stems from the government's policy advances, including the expansion in the scope of the Top Runner programme and extension of the Act on the Rational Use of Energy to include large transport companies and consigners. Though Japan's energy-related CO_2 emission intensity is one of the lowest among member countries, its efforts to improve its energy security through efficiency and diversification of supply continue to contribute positively to its efforts to meet climate change objectives. One of the reasons for the progress on climate change appears to be the close co-operation between the various parties involved in it. The government, especially METI and MOE, have played an important role in this co-ordination and it should continue to do so. Building on this strong leadership domestically and internationally, and the progress on domestic policies, more can be done to enhance the country's sustainable energy policies.

Under the Kyoto Protocol, Japan has agreed to reduce its greenhouse gas emissions to 6% below 1990 levels. On the basis of the actual figures for 2005, greenhouse gas emissions are about 8% above 1990 levels. In the absence of further measures, Japan is not on track to meet its Kyoto commitment domestically. Thus, the government seeks to meet its Kyoto commitment through a combination of domestic reductions (including the use of its forest sinks) and international purchases – though the planned domestic reductions are relatively small. We are pleased to see a balanced approach to reducing greenhouse gas emissions, implementing policies to stimulate domestic action while also turning to the international market for cost-effective reductions. Nevertheless, while the government has provided estimates of the reductions it expects from its suite of policies and measures, it is not clear what the process and criteria have been for making this determination. As discussed more fully in Chapter 2, when selecting among a basket of domestic options to reduce greenhouse gas emissions, consideration should be given to least-cost options for meeting the target. Other factors may also be important, but cost-effectiveness should be a key criterion for determining the broad allocations among policies and measures. Japan should be clear about the cost-effectiveness of different policy options and be transparent on the process for choosing a specific package of domestic measures.

Japan has introduced a number of measures to address climate change, tending to rely most heavily on voluntary measures. The Keidanren agreements in industry are the most visible example of this voluntary approach. In response to an assessment of these agreements conducted in 2006, it was concluded that the government will need to build on its voluntary plan. Therefore, there seems to be recognition of the need to consider additional policy options. Japan should examine the effectiveness of this approach and consider complementing its voluntary approach with other policies and programme options, including standards, taxes and trading systems in order to reduce emissions in the industrial sector. Certainly the full suite of policies – including regulations and sector-specific benchmarks – should be considered. Given the need to complement the existing approach, the voluntary carbon offset scheme aimed at reducing greenhouse gas emissions from small and medium-sized enterprises would be a good step – building on the voluntary emissions trading scheme launched in 2005 that now covers 150 companies – as it will strengthen the market signal for greenhouse gas emissions in the economy.

A longer-term approach to greenhouse gas emissions reductions will be needed post-2012. To address this issue, Japan has set a target for energy efficiency improvement of 30% by 2030 from 2003 levels. It would be useful if this long-term target was supplemented by interim evaluations to enable progress to be adequately measured.

Efficiency levels in Japan are high compared to other countries. However, considering the challenges posed by the Kyoto Protocol Target Achievement Plan and the ongoing growth in energy consumption in the commercial and residential sectors, it is clear that there is still need and room for concerted action to improve energy efficiency.

Before moving to more specific energy efficiency recommendations, we urge the government to continue its work to make its policies consistent with the 16 energy efficiency policy recommendations the IEA presented to the Group of Eight (G8) in 2007. These policy measures were endorsed by both G8 leaders and the IEA in 2007 (see Box 3).

Box 3

IEA G8 Energy Efficiency Recommendations

At the Group of Eight* (G8) Summit in 2005 in Gleneagles, Scotland, the G8 countries asked the IEA to assist in developing and implementing energy efficiency policies. In 2007, responding to this request, the IEA prepared 16 recommendations for IEA countries to pursue, covering appliances, lighting, buildings, transport, industry and cross-sectoral policies, summarised below. The recommendations were subsequently endorsed in 2007 by all IEA member countries, who agreed to take them forward, and we urge Japan to continue its work to implement them.

Appliances

- Limit stand-by power use to 1 watt across all electronic appliances.
- Establish minimum energy efficiency requirements for television set-top boxes and digital television adapters.
- Establish and enforce mandatory energy performance requirements and, where appropriate, energy labelling across the full range of mass-produced equipment.
- Require individual and networked devices to enter low-power modes automatically.

Lighting

- Adopt best practice in lighting energy efficiency.
- Phase out the most inefficient incandescent bulbs as soon as commercially and economically viable.

Buildings

- Make voluntary energy efficiency requirements for new buildings mandatory and strengthen mandatory requirements such that they aim to minimise total costs over a 30-year lifetime.
- Promote very low-energy buildings to ensure they are commonly available on the market by 2020.
- Monitor, collect and analyse information on energy efficiency in existing buildings and on barriers to energy efficiency.

Box 3 *(continued)*

IEA G8 Energy Efficiency Recommendations

Transport

- Implement a fuel-efficient tyre programme.
- Introduce mandatory fuel efficiency standards for cars and vans.
- Adopt international test procedures for measuring tyre rolling resistance and require the fitting of a tyre-pressure monitoring system.

Industry

- Improve the coverage, reliability and timeliness of industries' energy-use data.

Cross-sectoral

- Provide adequate resources for national energy efficiency policy agencies and publish energy efficiency action plans.
- Encourage investment in energy efficiency by adopting a common energy savings verification protocol, reviewing fiscal incentive programmes and collaborating with the private financial sector.
- Report progress in the implementation of the proposed energy efficiency actions to the IEA.

* The Group of Eight is an international forum for the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States.

Programme evaluation is one area that requires effort to ensure that the government is focusing on the most cost-effective energy efficiency policies. Despite the appearance of comprehensive evaluation approach, some questions remain with respect to the evaluation method and transparency of results (for more detail see section above on Climate Change).

As mentioned before in the section on Climate Change, Japan relies heavily on voluntary measures to promote energy efficiency. A key component of this is the good support the government enjoys from the industries participating in voluntary agreements. Although there is concern over the level of ambition or "stretch" in the voluntary agreement targets and the method for evaluating target achievement, it must be noted that the government takes care to regularly review the targets. Particularly in the case of industries that have achieved or surpassed their targets, the government asks the industries to further raise them. As in all countries relying on voluntary agreements, ensuring the appropriate level of "stretch" in the efficiency targets should remain an important priority of the government.

Voluntary action plan targets are set and revised by participating industries to reflect their unique characteristics. And indeed, industries appear to have made progress in constraining CO_2 emissions and energy use in line with targets. The target under the Keidanren Voluntary Action Plan to suppress CO_2 emissions in 2010 below their 1990 level has been met for six years, beginning in 2000. This is commendable progress.

An obvious explanation for this achievement is that industries have been working hard to improve energy efficiency levels. However, another question that must be raised is whether there is potential to encourage further energy efficiency improvements in these sectors. These questions seem to have been addressed by voluntary action plan parties. In response to a follow-up assessment conducted in 2007 by the Industrial Structure Council and the Central Environment Council with regard to the 39 business sectors under METI jurisdiction, the government has announced that voluntary action plans will be implemented with increased attention to the recommended need to go deeper and broader. This could include measures such as:

- Encouraging business sectors without voluntary action plans to adopt such plans.
- Promoting a shift from qualitative targets to quantitative ones.
- Conducting a strict government follow-up.
- Promoting the adoption of higher targets.
- Conducting international comparisons of other voluntary agreement schemes.
- Investigating cost-effective policies and measures for industry to complement existing voluntary agreements.

We support the government's efforts to further enhance the voluntary agreements through these actions.

Another issue relating to the voluntary action plan concerns the method for evaluating the success of the programme. Specifically, the concern relates to how autonomous energy efficiency improvement is accounted for in evaluating voluntary agreements. In other words, an important question for the government to ask itself when evaluating the voluntary action plan is whether the energy efficiency improvement would have taken place without the plan. There is an open question whether the improvements would have occurred regardless of the government programme. In this case, government budget could possibly be better spent on other programmes that would achieve outcomes above and beyond business-as-usual ones.

While discussing the industrial sector, the government's newly introduced voluntary domestic offset scheme aimed at reducing greenhouse gas emissions from small and medium-sized enterprises is commendable as it will build on the country's efficiency improvements. The government should continue to promote such policies.

Japan has made some impressive advances in its appliance and equipment policies. These include its reported achievements in reducing stand-by power in appliances, the assessment system of energy-efficient products retailers and the combination of Top Runner and other legislation to address principal-agent problems in the vending machine market.

The Top Runner programme has also reported achievements. It has extended the coverage of appliances and equipment and has reported consistently meeting or exceeding its targets. A sign of its success, the European Commission is considering the Top Runner approach for a forthcoming action plan on sustainable production and consumption.

Nevertheless, there is still room for strengthening the Top Runner programme, particularly with respect to the scope of product coverage, interim reporting, verification and evaluation. The issue of verification is particularly important with respect to the increasing number of imported appliances and equipment covered by Top Runner.

There are still some products covered in other regions of the world that are not covered by the Top Runner programme. While not all products may be appropriate, the Top Runner programme should continue to be extended with a view to ensuring that residential, commercial, industrial and transport products that use significant amounts of energy are covered.

One area that could receive further attention in the Top Runner programme is lighting. Japan has been an international leader in setting energy efficiency requirements for fluorescent lamps, which dominate the national indoor lighting market. However, there are still outstanding energy-saving opportunities in other areas of lighting energy use – notably incandescent lamps and outdoor lighting (including street lighting).

At present, Top Runner programme compliance is only measured in the target year. During the interim period (between the time when the target is established and the target year), ECCJ attempts to track compliance with the target. It does this by publishing a biannual list of all products on the market and their energy efficiency performance. The number of products that meet the target requirements can be observed, with the proportion of compliant products increasing over time. However, the ECCJ catalogue does not report the sales volumes of the products. As the actual target is based on a sales-weighted average, the ECCJ information cannot be used to accurately reflect interim compliance. Accurate interim compliance is important if Japan wishes to understand the rate of energy efficiency improvements from the Top Runner programme. Such analysis of interim compliance can be undertaken while still encouraging enterprises to freely engage in technology development

The Top Runner programme could also strengthen its verification processes, particularly with respect to sales data accuracy. Data provided to METI as part of the target-year compliance report include technical information on the energy efficiency performance of appliances and equipment as well as sales data. METI has conducted some third-party testing of energy efficiency performance levels. For example, in 2005 it verified the reported efficiency levels of personal computers and servers. However, METI does not verify the accuracy of reported sales data, and efforts should be made to improve their verification.

Strengthening the verification process is particularly important as the number of imported products covered by the Top Runner programme increases. Monitoring and verification of data reported for imported goods may be more difficult than for the goods produced in Japan. However, in order to ensure the integrity of the Top Runner programme, Japan should ensure that procedures are in place to verify reported data on imported goods.

Evaluation of the Top Runner programme could also be strengthened in two areas. First, savings are evaluated on the basis of a comparison between the total energy consumption in the base year and the target year. As with the voluntary action plan evaluations, the savings estimates do not account for autonomous energy efficiency improvements. Therefore, the question remains as to what would have happened with energy efficiency improvement of appliances in the absence of the Top Runner programme. Normal evaluation practice is to compare energy consumption in the target year with a baseline projection.

A second area where the Top Runner programme evaluation can be strengthened is in the provision of cost-effectiveness estimates of the programme. In order to be able to fully appreciate the effectiveness of the programme, it is important to have accurate information on the financial cost of the programme to government, industry and consumers since its inception, as well as an estimate of the financial benefits for these sectors. Unfortunately, this information does not seem to be available.

A question remains as to whether the target-setting process ensures that all cost-effective improvements are taken into account. Established target levels seem to have been consistently achieved or exceeded. As with the voluntary agreement process, an obvious explanation for this achievement is that industries have been diligent in improving energy efficiency levels. However, the overachievement does raise the question again of whether the targets were set too low and whether all cost-effective improvements have been accounted for. The government is encouraged to evaluate its target-setting process to ensure that it provides for maximum cost-effective energy efficiency improvements (for example least life-cycle cost) in the Top Runner programme.

Labelling is an important complement to the Top Runner programme. As discussed, Japan has made some advances in this area since the last review, including improving the design of its recommended uniform label. However, Japan could further enhance the availability of energy efficiency information on appliances and equipment by considering extending the list of designated products subject to the requirement for energy efficiency information. Japan should make it mandatory for manufacturers of this extended list of designated products to apply comparative energy efficiency labels.

Since the last review, Japan has attempted to improve the information available on the energy performance characteristics of buildings through CASBEE and the building labelling system. It has also strengthened the reporting requirement for large buildings to cover residences and retrofits. However, two areas – building standards and the household sector – require attention.

Japan continues to maintain voluntary energy efficiency standards in its building codes. This is surprising, because despite Japan having a relatively temperate climate, it has acknowledged that it faces a challenge with respect to growing energy use in the building sector. As stated in the 2003 review, most other IEA countries have recognised the effectiveness of standards in improving energy efficiency and have made the standards mandatory. Japan should urgently establish its energy efficiency standards for buildings as a mandatory requirement.

Given the increases in energy use in the household sector, Japan should consider further programmes to stimulate energy efficiency in this sector. This should include a consideration of how to further extend the use of CASBEE as well as the provision of transparent pricing and innovative approaches such as smart metering.

RECOMMENDATIONS

The government of Japan should:

- *Regularly examine the effectiveness of the largely voluntary approach to greenhouse gas mitigation, and consider complementing this approach with other policy options, including enhanced standards and regulations, and greater use of policies that put a value on greenhouse gas emissions in the economy.*

- *Ensure implementation of the IEA 16 energy efficiency policy recommendations presented to the Group of Eight (G8) in 2007.*
- *Supplement the long-term 2030 energy efficiency target with interim evaluations so that progress towards the target can be evaluated.*
- *Build on voluntary agreements in industry by promoting quantitative targets, conducting strict government follow-up, and negotiating the adoption of higher targets.*
- *Investigate further cost-effective policies and measures for industry to complement existing voluntary agreements.*
- *Continue to develop flexible and innovative policies that will drive efficiency improvements for small and medium-sized enterprises, such as through the proposed voluntary domestic offset scheme aimed at reducing emissions from these entities.*
- *Build on the Top Runner programme by:*
  - *Establishing a system for verifying the accuracy of reported sales data.*
  - *Evaluating the cost-effectiveness of the programme and making this information publicly available.*
  - *Examining the method with which Top Runner targets are set to ensure all cost-effective improvements are taken into account.*
  - *Considering extending Top Runner to cover more appliances and equipment.*
- *Extend the list of designated products subject to the requirement for energy efficiency information and make energy labelling mandatory for manufacturers of such designated products.*
- *Make the energy efficiency components of building codes mandatory and investigate the potential to set higher energy efficiency standards and promote the adoption of passive and zero-energy houses and buildings.*
- *Consider how to stimulate greater energy efficiency action in households through information and transparent pricing, for example by innovative approaches such as smart metering.*

ENERGY SECURITY

Security of supply is one of the most important policy issues in Japan given its near-complete reliance on imported fossil energy – the country produces less than 20% of the energy it uses – its relative isolation and its large distance from other major supply and demand centres. Supply security took on an even greater importance, as it did throughout the world, after the supply shocks of the 1970s. Since then, Japan has paid utmost attention to diversification of supply, lowering oil dependence and increasing energy efficiency. Energy efficiency is a key priority area of the government's energy security policy, as it is a cost-effective means to reduce energy dependence, as discussed more fully in the previous chapter. The government also takes an active role in upstream energy resource development.

ENERGY SECURITY BY FUEL AND SOURCE

Japan's Basic Act on Energy Policy was enacted in June 2002. The act specifies that all energy policy should take due consideration of the need to secure stable energy supply, to ensure environmental suitability and to use market mechanisms. Based on this act, Japan's Basic Energy Plan was formulated in order to promote energy supply and demand measures on a long-term, comprehensive and systematic basis.

OIL

Japan amended the Basic Plan for Energy in March 2007, with emphasis placed on enhancing joint strategic and comprehensive efforts by the public and private sectors for activities such as diversifying energy supply sources, promoting oil development through assistance to resource development companies, strengthening overall relations with major oil-producing countries and expanding and enhancing the oil stockpiling system and other contingency measures.

Japan's oil stocks are well in excess of the IEA's 90-day net import requirements. As of January 2008, the country held the equivalent of 151 days of net imports, including state-owned and private-sector stocks. The government has continued its collaboration with the governments of other IEA member countries as shown in the internationally co-ordinated release of oil reserves to help cope with the impact of hurricanes Katrina and Rita in September 2005. As part of a new national energy strategy, the government is now preparing to hold public product stocks, which are to be managed by the Japan Oil, Gas and Metals National Corporation (JOGMEC).

Liquefied petroleum gas (LPG) stocks are also made up of state and private-sector stocks, and stood at the equivalent of about 83 days of net imports as of November 2007. The government has plans to increase public LPG stockpiles to 1.5 million tonnes (Mt) from the level of 0.61 Mt (equivalent to about 18 days of net imports) as of the end of November 2007. Industry has an obligation to hold LPG stockpiles equivalent to 50 days of imports. As of the end of September 2007, the LPG stockpiling level of the private sector was about 2.15 Mt, equivalent to about 65 days of net imports. In addition, for state stocks, three LPG bases have been completed and two more are under development.

The government is working to enhance security by lowering oil demand through the introduction of biofuels for transport. It has introduced a goal for biofuels in transport of 0.5 million kl (crude oil equivalent) for 2010.

With respect to refining capacity, the government considers the total refining capacity per refinery as relatively small compared to the rate in other neighbouring Asian countries, particularly given the new refineries in these countries. Nevertheless, the complexity of Japan's refineries remains higher than the Asian average. The industry has found it difficult to resolve the problem of excess refining and distribution capacities through independent rationalisation efforts. As a result, a realignment and consolidation process has been proceeding in the industry.

NATURAL GAS

Japan is a pioneer in the liquefied natural gas (LNG) trade and is the largest LNG importer in the world. Currently, companies that use natural gas – both electricity and gas companies – import from eight countries (Indonesia, Australia, Malaysia, Qatar, Brunei, the United Arab Emirates, Oman and the United States) under long-term contracts. Reflecting efforts to diversify the supply sources, Russia is expected to be added as the ninth supplier. Approximately 4% of natural gas consumed in Japan is produced domestically. In order to enhance supply security in the event of emergency, the government provides assistance for the construction of pipelines connecting terminals with one another. Given the high cost of LNG storage and the country's geology, along with the difficulties processing boil-off gas (BOG), LNG stockpiling is currently not used as a primary tool to ensure supply security as much as oil, nor is it expected to be used to such an extent in the future. Nevertheless, Japan can rely on existing inventories – the voluntary stocks of private companies held at LNG terminals are currently equivalent to 20 to 30 days of consumption. In addition, the government is investigating the possibilities for strategic storage (including medium- and long-term prospects for underground storage). Instead, as its primary means of maintaining supply security, the country takes advantage of diversity of supply sources, contract flexibility and spot market purchasing.

As part of the Basic Energy Plan, the government is making long-term efforts to facilitate the procurement and domestic distribution of natural gas. Given the expected increase in global LNG demand, utilities and the government are working to enhance their bargaining power with producing countries by strengthening Japan's comprehensive relationships with these countries and by making efforts to diversify supply sources in order to secure stable supply from overseas. From the perspective of the development of domestic gas supply infrastructure, which lags behind other countries, and further developing extensive gas distribution, the government is aiming to promote the development of gas pipeline networks and their interconnection. Third parties are encouraged to be involved in these developments through grants that give incentives for investment and through collaboration with relevant administrative entities.

COAL

Currently, Japan depends on imports for more than 99% of its domestic coal needs. In 2005, coal imports totalled approximately 180 Mt, around 60% of which came from Australia. In total, coal imports from Australia, Indonesia (the second-biggest coal supplier for Japan) and China (the third-biggest supplier) account for approximately 90% of Japan's total coal imports. Japan also imports coal from countries such as Canada, Russia, the United States and Vietnam.

As part of efforts to secure stable coal supply, Japan conducts government-to-government policy dialogue with coal-producing countries such as Australia, Indonesia and Vietnam and helps the transfer of clean coal technology to coal-producing countries in Asia, such as China, Indonesia and Vietnam. Japan also conducts geological surveys in coal-producing countries such as Indonesia and Mongolia jointly with the governments of those countries. Furthermore, Japan exchanges information with regard to the coal supply-demand conditions and coal utilisation technologies through international forums such as Asia-Pacific Economic Co-operation (APEC) meetings and meetings with the Association of South-East Asian Nations (ASEAN).

There is growing concern about rising Asia-Pacific demand for coal, particularly from China and Korea. In this area, Japanese companies are engaging in technology transfer. For example, Nippon Steel in Japan is assisting Chinese steel companies with enhancing the efficiency of operations as a means of reducing Chinese – and thereby world – demand for coal.

ELECTRICITY

Installed electricity capacity is well diversified, with sources spread almost evenly across coal, oil, natural gas, nuclear and hydro. Japan's reserve margins of installed capacity over peak load are comfortable – and they are on an increasing trend. Nevertheless, the country is at risk during tight supply periods, primarily owing to recent problems in the nuclear sector leading to bulk shut-downs of nuclear facilities and the limited ability to trade power across the borders of the country's nine mainland electricity supply regions. The government plans for nuclear to remain at 30% of electricity generation, and perhaps rise to as much as 40%.

In accordance with Article 29 of the Electricity Business Act, electric power companies (excluding specified electric utilities and specified-scale electric utilities) submit "supply plans" to the government every year. These plans explain the status of the utilities' supply-demand balance, power plant development plans and plans for building power transmission and transformation facilities for each of the next ten years. Upon evaluation of the plans, the government ensures they are sufficient to secure stable power supply. Electric utilities are able to offer optional contracts (time-of-use contracts) that help even out load on the supply system.

EMERGENCY PREPAREDNESS

Resource diplomacy is a priority of Japan's emergency preparedness policy, the aim being to prevent any challenges before they occur (see Box 4). Japan can also consider measures for controlling energy demand in the event of an emergency at its periodic Ministerial Meeting on the Promotion of Comprehensive Energy Measures, or at other meetings, such as the Conference on the Promotion of Energy and Resource-Saving Measures that took place in March 2003 in response to military actions in Iraq. The national and local governments are to take initiative in implementing those measures, make requests for co-operation and give guidance to the industry, citizens and others. If it becomes impossible to deal with the situation with the above-mentioned measures, demand will be controlled by law. Specifically, demand control measures under the Petroleum Supply and Demand Adjustment Act that are taken by the Ministry of Economy, Trade and Industry (METI) are implemented when a state of emergency is declared by the Prime Minister after going through a Cabinet decision. In addition, demand control measures under the Electricity Business Act are implemented by METI in consideration of the conditions of electricity supply.

The Conference on the Promotion of Energy and Resource-Saving Measures, the Ministerial Meeting on the Promotion of Comprehensive Energy Measures and other meetings have decided on measures for an information campaign to promote demand control depending on the conditions of the situation.

Box 4

Resource and Energy Diplomacy

Given the current situation perceived by the Japanese government, where producing countries are trying to protect their resources while consuming countries are intensifying their efforts to acquire resources, active resource and energy diplomacy at high levels has taken on greater importance. To that end, Japan has been actively engaged in the process. Below is a list of developments in resource and energy diplomacy since April 2007.

- Prime Minister Abe's visit to the Middle East (Saudi Arabia, the United Arab Emirates, Kuwait, Qatar and Egypt) in April 2007: Japan reached an agreement with Saudi Arabia for the establishment of a framework for industrial co-operation as well as a joint task force. About 180 members, including the chairperson of Keidanren, accompanied the Prime Minister with a view to strengthening bilateral ties through joint public-private sector efforts.

- METI Minister Amari's visits to, among others, Kazakhstan (in relation to co-operation in the nuclear power sector), Uzbekistan (in relation to uranium, oil, natural gas) and Saudi Arabia (as part of the Energy Forum and the Industrial Cluster Programme) from April to May 2007.

- Japan-China Ministerial Energy Policy Dialogue/Energy Co-operation Seminar in April 2007, attended by METI Minister Amari, and Ma Kai, Chairman of the People's Republic of China's National Development and Reform Commission.

- Japan-India Energy Dialogue, attended by METI Minister Amari, and Montek Singh Ahluwalia, Deputy Chairman of the Planning Commission of India, in April and July 2007.

Source: Country submission.

OIL

In the case of an oil emergency, the government will take such measures as requests for oil-producing countries' increased production, domestic demand curbs and oil stock releases.

While the government always collects oil supply and demand information, the Petroleum Stockpiling Act and the Petroleum Supply and Demand Adjustment

Act decree that the government is allowed to collect more detailed information from actors such as oil refiners, importers and dealers more frequently and as necessary in an emergency where the government must take various measures based on accurate, prompt and sufficient information.

With respect to oil stock releases, the government collaborates with the IEA in releasing oil stocks. In the past, the government has generally looked at emergencies in the context of oil supply interruptions and geopolitical risks in oil-producing nations. However, lessons learnt from the internationally co-ordinated oil stock releases responding to hurricanes Katrina and Rita in 2005 have led the government to consider risks in oil-consuming countries as well, and to prepare for the introduction of state stocks of petroleum products.

From the viewpoint that Asian energy market stabilisation is significant for Japan's own security, the government has recently concluded a bilateral agreement with the New Zealand government on co-operation in stockpiling oil (see Box 5), called for enhancing Asia's contingency capacity and carried out international oil-stockpiling co-operation, including the provision of relevant knowledge.

Box 5

Oil Stock Agreement between Japan and New Zealand

In November 2007, the Japanese and New Zealand governments signed an agreement on oil stocks contracts. The agreement creates a framework in which the New Zealand government can conclude oil stock contracts with Japanese companies. Under such contracts, the New Zealand government pays for rights to implement options to purchase a certain amount of oil from Japanese companies if the government is required to release oil stocks during contract periods. The New Zealand government can include the amount of oil for such contracts in its own oil stocks.

Source: Country submission.

NATURAL GAS

Japan procures about 25% of the LNG it uses from the Middle East, making its dependence on the Middle East for LNG relatively low. LNG supply to Japan has never been suspended, even during the past oil shocks. If supply through any one of the projects that supply Japan is temporarily suspended, it is possible to adequately deal with the situation by combining the following methods given Japan's diversified LNG supply sources from eight countries on a long-term contract basis:

- Voluntary liquidation of gas stocks (equivalent to about 20-30 days) by private companies.

- Use of excess supply capacity from other international LNG exporting projects (it is estimated that around 10% excess supply capacity is available with respect to each project).

- Mutual accommodations among LNG importers, such as LNG cargo swaps, as well as LNG volume exchanges in case of companies sharing the same LNG import terminals, in the face of differing storage or demand conditions between companies.

While Japan's LNG procurement centres on the voluntary efforts of private companies, the government is also making efforts to diversify supply sources by enhancing its bargaining power through active development of summit- and ministerial-level resource diplomacy with gas-producing countries.

ELECTRICITY

Private electric utilities are developing systems for emergency preparedness. Diversified energy sources for power generation are now available, and comfortable reserve margins exist.

Each year, all major electric utilities prepare a plan on the supply of electricity and the installation and operation of electric facilities for a defined period (typically ten years) as stipulated in the Electricity Business Act, and submit it to METI, whose minister may recommend to the relevant utility to revise the supply plan if it is considered inappropriate.

In addition, in the event of a disaster or other emergency, METI's minister may, if necessary and appropriate in order to secure public interest, give a supply order to electric utilities.

During such an emergency, for example in the case of a partial disruption of oil supply due to depletion, electric utilities will make voluntary efforts to secure stable electricity supply through shifts to other electricity sources. Relying on the Electricity Business Act, METI's minister may, among other things, recommend that electric utilities revise their supply plans or give them supply orders, with a view to promoting a shift to electricity generated from energy sources other than oil (*e.g.* coal, natural gas, nuclear and hydro) and securing appropriate electricity supply capability.

With regard to network security, the Electric Power System Council of Japan (ESCJ) has established rules that private electric utilities are in the process of implementing.

DEVELOPMENT OF OIL AND GAS TRANSPORT INFRASTRUCTURE

A number of oil and gas pipelines are under development that would bring more and more diverse energy imports to Japan. The Pacific Pipeline project is a 4 676-km pipeline that would have a capacity of 30 to 80 Mt of crude oil per year (0.6 to 1.6 million barrels per day). It runs from Taishet in eastern Siberia through Skovorodino near the border between Russia and China, to Perevoznaya along the Russian coast with the Sea of Japan. The government sees this as a promising project that would bring oil to the coast without passing any country borders, also helping to spark development in eastern Siberia. This project consists of two stages. The first stage covers the pipeline from Taishet to Skovorodino (2 757 km) and the second stage covers the pipeline from Skovorodino to Perevoznaya (1 919 km). Construction of the first stage of the pipeline began in April 2006. About 1 200 km of pipeline had been laid as of January 2008, and the first stage of the pipeline is scheduled to start operation in 2009. For the second stage of the pipeline, the date of installation and the date of starting operation have not yet been decided. The government is also actively monitoring the two Sakhalin projects in Russia, in which Japanese companies have a substantial stake in co-operation with JOGMEC. Under the Sakhalin-1 project, production of crude oil and natural gas for domestic use in Russia began in October 2005. The shipment of crude oil overseas, including to Japan, began in October 2006. With regard to natural gas, ExxonMobil, the operator of the project, and companies in China and Russia, among others, have been negotiating the supply of natural gas since October 2006. Under Sakhalin-2, oil and natural gas are to be brought to the southern tip of Sakhalin, with gas exported as LNG to customers, including Japanese electricity and gas companies. The estimated on-line date of this oft-delayed project is 2008 or 2009.

UPSTREAM HYDROCARBON DEVELOPMENT

As discussed in Chapter 2, the Japan Oil, Gas and Metals National Corporation (JOGMEC) is a government entity that has a strong role in upstream hydrocarbon and energy development. JOGMEC is an incorporated administrative agency that formulates medium-term and annual business plans and executes operations based on five-year targets stipulated by the government. While JOGMEC is given basic autonomy and independence, its business performance is evaluated each year by the government. (See Box 6 for further information on the structure and mission of JOGMEC.)

Box 6

Overview of JOGMEC

The Japan Oil, Gas and Metals National Corporation (JOGMEC) was established on 29 February 2004. Its 2006 budget was JPY 178 billion and the corporation has over 500 employees. The mission of JOGMEC is "to conduct the duties necessary to ensure a stable supply of oil, gas, combustible natural gas and non-ferrous minerals, whose supply bases are especially vulnerable, and to support the development of Japan's economy". Furthermore, JOGMEC is to undertake measures to prevent mining-induced pollution. To achieve its mission, JOGMEC has four primary activities:

- Support for exploration and development of oil and natural gas deposits.
  - Investment and debt guarantee.
  - Collection, analysis and provision of information related to exploration and development.
  - Tectonic examinations.
  - Technological development.
- Support for exploration and development of non-ferrous mineral deposits.
  - Investment, financing and debt guarantee.
  - Collection, analysis and provision of information related to exploration and development.
  - Tectonic examinations.
  - Technological development.
- Resource stockpiling.
  - Integrated management of state stockpiles, including oil stockpiles.
  - Financing for private stockpiling entities, etc.
  - Management of state stockpiles of rare metals.
- Support for prevention of mine pollution.
  - Financing for businesses related to prevention of mine pollution.
  - Technical guidance for measures to prevent mine pollution.
  - Solicitation of commission to operate effluent treatment facilities.
  - Management of funds for preventing mine pollution end related businesses.

JOGMEC is now supporting upstream development projects throughout the world, including 28 joint-venture resource examinations.

Source: Country submission.

One of JOGMEC's main functions is to assist Japanese companies that are active in exploration and the development of oil, natural gas, non-ferrous metals and minerals through investment and debt guarantees. The government sees the financing capability of Japanese upstream exploration and mining as limited compared with that of the major international companies, and is also concerned about the recent trend towards resource nationalism. To counter this, JOGMEC assists Japanese companies with equity financing and liability guarantees to encourage these companies to engage in exploration and production (E&P) activities. In addition, JOGMEC undertakes various projects itself, such as overseas geological surveys of fields or areas where geological or geophysical data are not sufficient for Japanese companies to evaluate prospects for future exploration activities, international technical collaboration between Japanese companies and oil-producing countries, and overseas E&P training programmes.

Recently, JOGMEC has enhanced its risk underwriting, raising the limit on certain projects of the share of the investment and debt guarantee it is willing to take, from 50% to 75%. This will apply to high-risk projects with high technical difficulties managed by a Japanese company.

CRITIQUE

Energy security continues to be the highest priority for the government, which continues its active policy to ensure this security. Most notably, the government remains actively engaged in bilateral and multilateral energy and resource diplomacy as a key means of enhancing its energy security. The country's oil stocks far exceed the IEA mandate and Japan continues to improve its oil security policies, taking a practical view to enhancing implementation. With respect to natural gas, the country is working to enhance its security through more diverse import sources and the possible future development of additional pipelines and routes. The difficulties in the nuclear sector along with limited interconnection capacity have negative effects on electricity supply security. A greater ability to trade power across borders would enhance supply security without the need for additional and costly new power generation. While increasing physical interconnection capacity is certainly also a lengthy and costly process, enhancing cross-border flows could be achieved more directly through greater use of dynamic and flexible means of allocating existing capacity according to willingness-to-pay principles. Boosting the operating rates of nuclear power plants is a key to stable electricity supply in Japan. Long-term stability of electricity supply may also benefit from enhanced understanding of the role of nuclear power in Japan.

Overall, Japan's oil emergency policy is well organised. With respect to its oil stocks, as discussed, the country holds more than is required by the IEA. Furthermore, we are very pleased to see the government's current efforts to have JOGMEC expand its crude oil stocks to include stocks of oil products. For some oil supply disruptions (such as a disruption of oil coming from the Middle East) this situation may not be a problem given the country's ample refining capacity. However, it could be a problem if there is difficulty importing products into the country as Japan imports more than twice the amount of products it exports, as discussed in Chapter 5. In addition, as seen in the United States after hurricanes Katrina and Rita, refinery outages could create difficulties in the domestic supply of oil products. The government might also consider putting emphasis on the possibility of using government stocks before industry stocks, depending on the nature of the emergency. The very high reliance on oil from the Middle East creates a security of supply concern; the lack of diversity could present difficulties in the event of emergencies on the Strait of Hormuz. Thus the government's efforts to further enhance supply source diversity are welcome. Finally, we encourage the government to evaluate the effects of demand restraint measures used in oil emergencies in the future.

As discussed more fully in Chapter 5, extending the gas network would help improve domestic competition and energy security. It could also enhance the possibilities for more import diversity. Specifically, the LNG portion of the Sakhalin project could provide competition with existing LNG, and we therefore support Japan's efforts in this arena. We encourage the government to continue to review, in conjunction with independent experts, the potential and time-scale for delivery of such projects. To further enhance the benefits of this increased import competition, the development of an integrated natural gas network throughout Japan is even more important.

Considering Japan's near-complete reliance on imports of LNG for supply, the government is duly concerned with natural gas security. In this light, it might be prudent to further investigate options to deal with natural gas supply emergencies, particularly as the government must rely on the voluntary stocks of private companies, which are currently equivalent to 20 to 30 days, along with mutual supply arrangements, in emergencies. When developing emergency plans, policies should incorporate a suite of measures. Though significant challenges remain – most notably cost – strategic storage might make sense in the right circumstances and, in this context, the government should continue to give consideration to the medium- and long-term prospects for underground storage. In general, however, Japan will need to rely on a variety of measures, with due attention to demand-side options, such as fuel switching and interruptible contracts.

The Japanese government is concerned about the impacts of resource nationalism by some oil-producing countries on the world oil market, fearing that more government control will restrict production and drive up oil prices. Furthermore, as Japanese companies engaged in oil and natural gas development are of a much smaller size than major overseas companies, such as those in the United States and Europe, and the global competition to obtain resources is intensifying, the government sees Japanese companies as being at a disadvantage. Consequently, the government is providing investment assistance and debt guarantees for Japanese companies investing in upstream oil projects overseas through JOGMEC. We understand the desire to secure long-term investment in hydrocarbon development, but we are concerned about the risk that the government efforts will promote inefficient investments and thus crowd out better resource opportunities elsewhere. In this regard, in most cases the international market is best able to assess – and manage – the high risks associated with hydrocarbon exploration and production. Therefore, the government should continue to evaluate the cost-effectiveness of its existing support mechanisms to Japanese companies engaged in exploration and development activities overseas, paying further attention to evaluating whether or not they are actually achieving the goal of enhancing Japanese supply security of hydrocarbons.

The government has undertaken efforts to steer the overall fuel mix of the country, with the aim of ensuring supply security. For example, the government foresees that nuclear will maintain a 30% share of total electricity generation, and will possibly rise to 40%. While it is common for governments to issue scenarios and planning forecasts to provide guidance to the market, the Japanese government should ensure that it does not unduly distort the strong incentives already in place for commercial companies to diversify. For example, the very high prices for fossil fuels currently already encourage companies to diversify into non-fossil fuel sources.

RECOMMENDATIONS

The government of Japan should:

- *Continue efforts to further diversify energy sources and routes in order to enhance security of supply.*
- *Continue to develop options to manage gas supply emergencies.*
- *Continue the policy of international resource diplomacy, including in matters concerning energy and environment co-operation, as a means of enhancing energy security.*
- *Continue to evaluate the effectiveness of government support mechanisms for Japanese companies engaged in exploration and development activities overseas.*

PART II

SECTOR ANALYSIS

FOSSIL FUELS

Japan is a dominant player in the international market for fossil fuels and a pioneer in the field of liquefied natural gas (LNG). With negligible domestic energy production, the country is the world's largest importer of coal and LNG. It is the second-largest importer of fossil fuels in the IEA, after the United States. Consequently, Japan places a very high priority on security of supply, and is actively engaged in diversifying import sources and enhancing domestic security provisions. The country's natural gas market is becoming more liberalised, though this is hampered because the network between the nine larger demand areas has yet to be developed.

COAL

SUPPLY AND CONSUMPTION

In 2005, coal accounted for 21% of Japan's TPES. Production from the eight remaining coal mines in operation in Japan is negligible, and more than 99% of supply is imported. (Most domestic production ceased in 2001.) Japan consumed nearly 120 million tonnes (Mt) of coal in 2006, representing a 27% increase from 2000 and a 126% increase from 1990 (see Table 14). As the world's largest importer of coal, Japan accounts for a quarter of the global seaborne coal trade. In 2006, most coal imports (59%) came from Australia, with Indonesia providing the next largest share, at 18%. Other suppliers include China, Russia and Canada. Coal imports from China peaked at 19% of total Japanese imports in FY2002, but declined to 11% in 2006 and continue to fall.

Table 14

Coal Consumption by Sector, 1970 to 2006

Unit: million tonnes	*1970*	*1980*	*1990*	*2000*	*2003*	*2004*	*2005*	*2006*	*Change 1990-2006*	*Change 2000-2006*
Electricity and heat	0	10 113	31 187	65 042	80 148	84 150	91 671	89 780	188%	38%
Share	*0%*	*57%*	*59%*	*70%*	*73%*	*74%*	*76%*	*75%*		
Industrial processes*	100	7 030	20 825	27 591	28 467	27 946	28 331	28 350	36%	3%
Share	*50%*	*40%*	*40%*	*29%*	*26%*	*25%*	*23%*	*24%*		
Residential, commercial and public services sectors	100	503	673	927	939	941	947	950	41%	2%
Share	*50%*	*3%*	*1%*	*1%*	*1%*	*1%*	*1%*	*1%*		
Total consumption	**200**	**17 646**	**52 685**	**93 560**	**109 554**	**113 037**	**120 949**	**119 080**	**126%**	**27%**

* includes coke ovens.

Source: *Coal Information*, IEA/OECD Paris, 2007.

COAL INDUSTRY AND POLICY

Industry structure and policy

Coal trade is fully liberalised in Japan; the government sets neither a floor nor a ceiling price for coal. While there is negligible production, one underground and seven opencast mines are in operation. Subsidies for domestic production were eliminated in 2002. Government coal policy now focuses on support for clean coal technologies (discussed in Chapter 9) and upstream coal resource development in other countries (see Chapter 4).

The emergence of China and India as major coal importers has placed enormous pressure on the international coal market, compounded by the Chinese government's decision to limit coal exports. Japan is facing unprecedented coal prices in a sellers' market, despite its dominant import position.

Domestic coal production liabilities

The government ceased to provide for measures to deal with mining pollution and subsidence (the sinking or settling of land over abandoned mine workings) in 2006 and the decision now allocates responsibility to the mining companies for dealing with legacy rehabilitation costs resulting from current operations. While the responsibility lies with mining companies, funds are provided by each prefecture, with METI subsidising these funds as well.

OIL

SUPPLY-DEMAND BALANCE

As detailed in Table 15, Japan's TPES of oil was over 240 Mtoe in 2006, an 8.1% decrease from 2000 and a 5.4% decrease from 1990. In 2006, it represented the greatest share of TPES, 46%, the seventh-highest share in the IEA and above the IEA average of 40% (2006 estimated data). The government has set targets for 2030 to further lower overall oil dependence to 40% (a target of 80% was set for the transport sector). The largest share of oil is consumed by the transport sector, 37%. Industrial consumption accounts for 30% and residential consumption for 6%. The share of oil used for electricity and heat, 9%, is relatively high compared to other IEA countries, though a sharp decrease from the 1980s and even the 1990s, when the share was 20% to 30%. At over 10%, Japan has the fourth-highest share of electricity fuelled from oil, following only Italy, Greece and Portugal (2006 estimated data).

Given increasing availability of district heating, along with a rise in penetration of electric heat, the use of oil for heating has been declining. Some utilities have been moving away from oil for electricity consumption owing to higher prices and as an environmental measure. Oil demand in the transport sector has declined in general owing to tighter efficiency requirements. In addition, the total passenger transportation volume (in terms of passenger-kilometres) declined in 2005, reducing oil consumption. At the same time, while freight transport volume increased, efficiency gains offset the effect on total oil consumption.

Table 15

Oil Supply-Demand Balance, 1970 to 2006

Unit: Mtoe	*1970*	*1980*	*1990*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Supply										
Indigenous production	0.9	0.6	0.7	0.8	0.7	0.6	0.7	0.7	0.8	0.7
Imports (net of exports)	202.6	251.7	262.7	270.1	252.3	257.9	259.7	255.7	257.9	244.9
Other	–18.2	–17.3	–9.1	–9.0	–1.5	–3.6	–4.7	–4.3	–8.1	–5.1
Total primary energy supply	185.2	235.0	254.3	261.9	251.5	255.0	255.7	252.2	250.5	240.6
Demand										
Electricity and heat production	46.5	62.9	50.6	27.5	21.5	25.6	26.6	24.7	26.9	22.5
Industrial consumption*	75.7	67.9	70.3	75.4	71.9	72.7	72.5	74.0	72.2	71.9
Transportation	31.6	54.0	74.8	93.0	93.5	92.8	92.0	92.4	90.8	89.5
Residential	5.9	9.7	13.5	16.6	15.5	16.2	15.2	15.1	15.9	14.7
Other final consumption**	18.9	26.3	29.7	30.7	32.4	33.1	31.5	30.2	28.5	25.0
Other	6.5	14.3	15.5	18.6	16.7	14.5	17.9	15.8	16.3	16.9
Total consumption	185.2	235.0	254.3	261.9	251.5	255.0	255.7	252.2	250.5	240.6

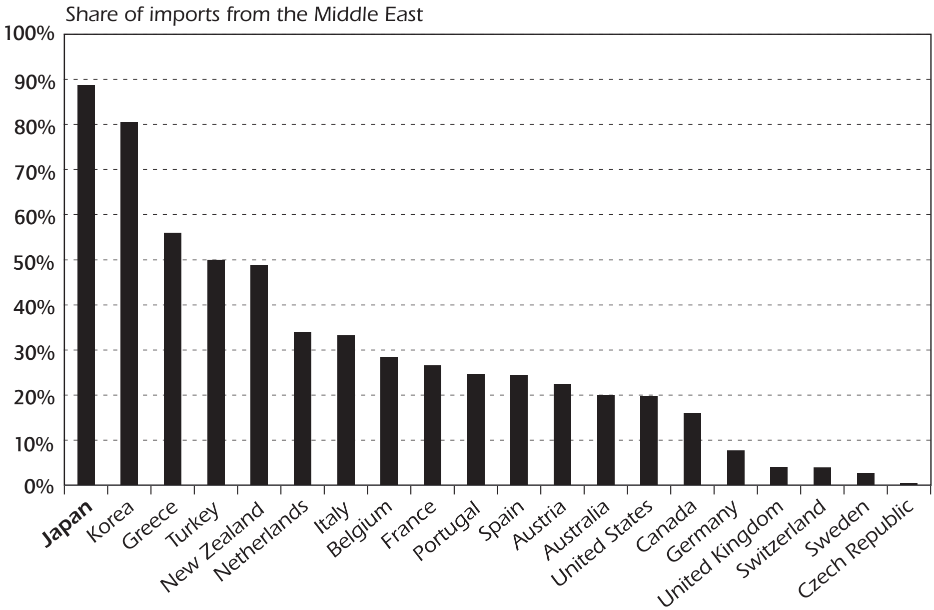
* includes non-energy use. ** includes commercial/public services, agriculture/forestry, fishing and non-specified.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

Japan has only a tiny amount of domestic production. Of its imports, the largest share, 28%, comes from Saudi Arabia, with the next largest share, 23%, coming from the United Arab Emirates. In total, 83% of imports came from OPEC countries and almost 90% from the Middle East in 2005, the highest share in the IEA (see Figure 14).

Figure 14

Share of Oil Imports from the Middle East in IEA Countries, 2005



Note: The Middle East dependence rate is zero for Denmark, Finland, Hungary, Ireland, Luxembourg, Norway and the Slovak Republic.

Source: *Oil Information*, IEA/OECD Paris, 2007.

Refinery output and product exports

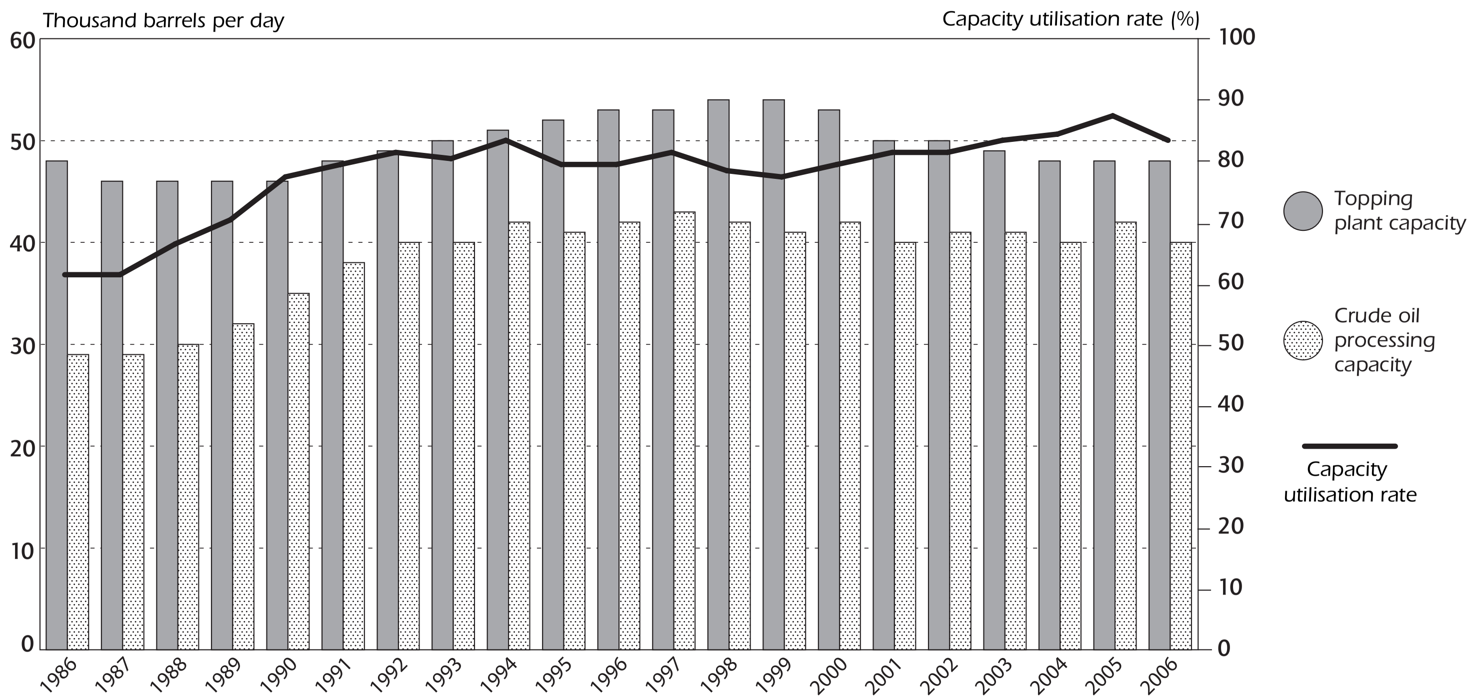
All of Japan's refineries are operated by private-sector companies, with no government ownership in any refinery. As most of the refineries in Japan were built many years ago, investments are being made for overhauling and expanding facilities at many of them in order to meet changes in the supply-demand conditions. Much of the investment is focused on improving the light product yield and, in the face of an increasingly heavy crude slate, upgrading the complexity of the refining capacity.

The capacity utilisation rate for Japan's refinery sector is shown in Figure 15. In 2006, Japan's refining capacity of 4.8 million barrels per day has been running at about 83%.

As shown in Figure 16, Japan imports about twice as much refined product as it exports. In recent years, exports of refined product have been increasing as refiners seek to maximise crude throughputs. The simultaneous increase in exports and decrease in imports – while capacity utilisation and total capacity has remained steady or declined somewhat – stem from the decline in total demand in Japan. Notably, the country's exports have been driven in part

Figure 15

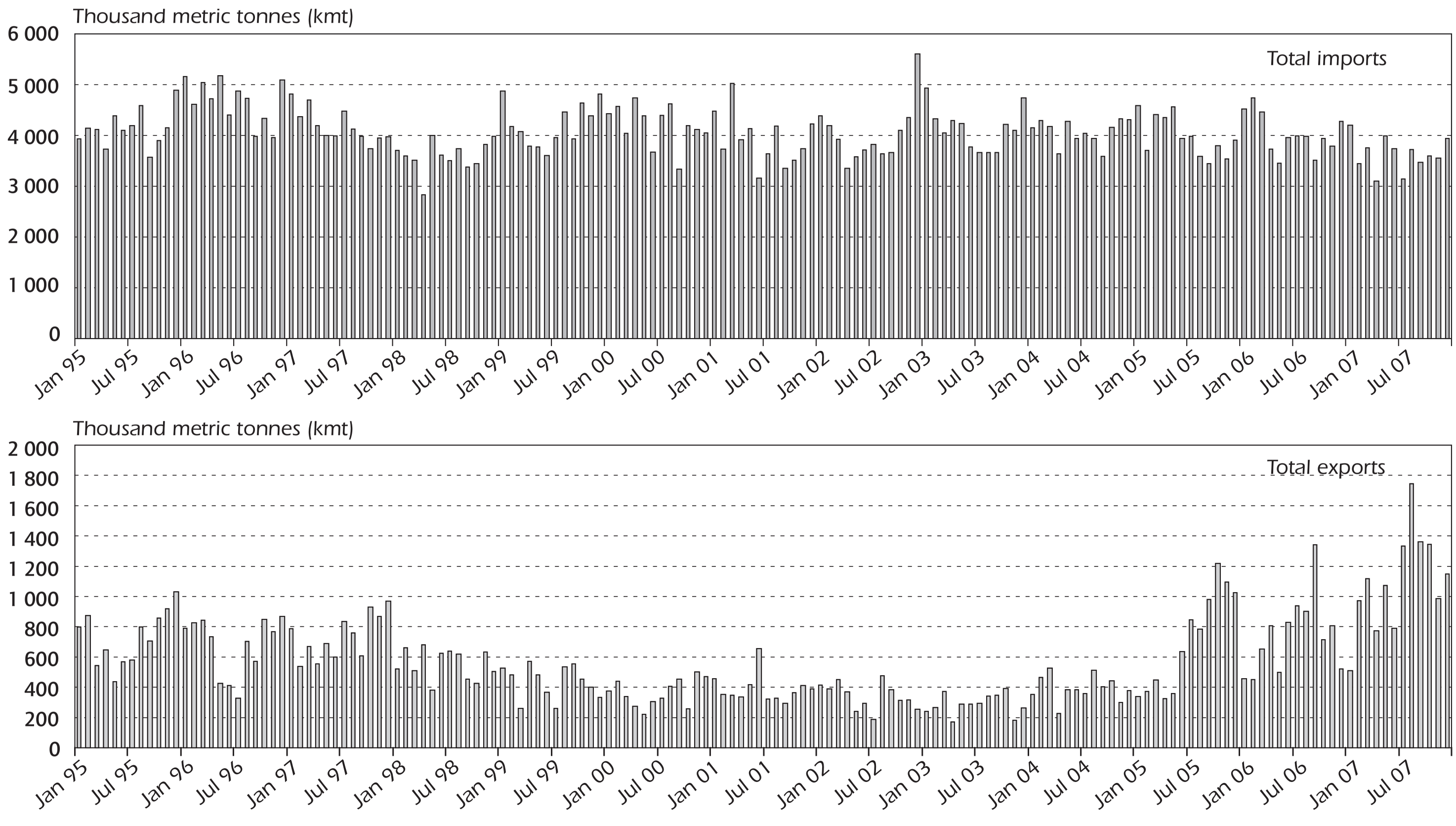
Refining Capacity and Capacity Utilisation Rate



Source: Country submission.

Figure 16

Total Refinery Product Imports and Exports



Source: Monthly Oil Data Service, IEA/OECD, Paris.

by demand for products from China. At the same time there is considerable interest in Japan's refining capacity; Petrobras and IPIC have both made investments in Japan's refining sector.

INDUSTRY STRUCTURE

Oil exploration and development are conducted by private-sector companies with the support of JOGMEC, which took over part of the operations of the now-defunct Japan National Oil Corporation (JNOC). (For more information about JOGMEC and upstream activities, see Chapter 4.) Shares in private-sector companies that had been owned by JNOC were taken over by the government and some were sold in the market thereafter.

Refining and distribution of oil products are conducted by private-sector companies, including foreign companies. Reflecting the intense competition after the abolition of the Provisional Measures Law on the Importation of Specific Kinds of Petroleum Refined Products at the end of March 1996, mergers and business alliances are proceeding among oil refiners and distributors. In addition, an industry realignment involving companies in the upstream sector is emerging.

In response to continued liberalisation and the diversification of consumer needs, the oil market has seen the entry of new companies, an escalation of price competition and gasoline service stations' moves to engage in a diverse range of businesses. The number of service stations and their operators has been on the decline since it peaked in 1994. The total number, around 38 000, is about 20% lower than the 1994 peak.

TRANSPORT FUELS

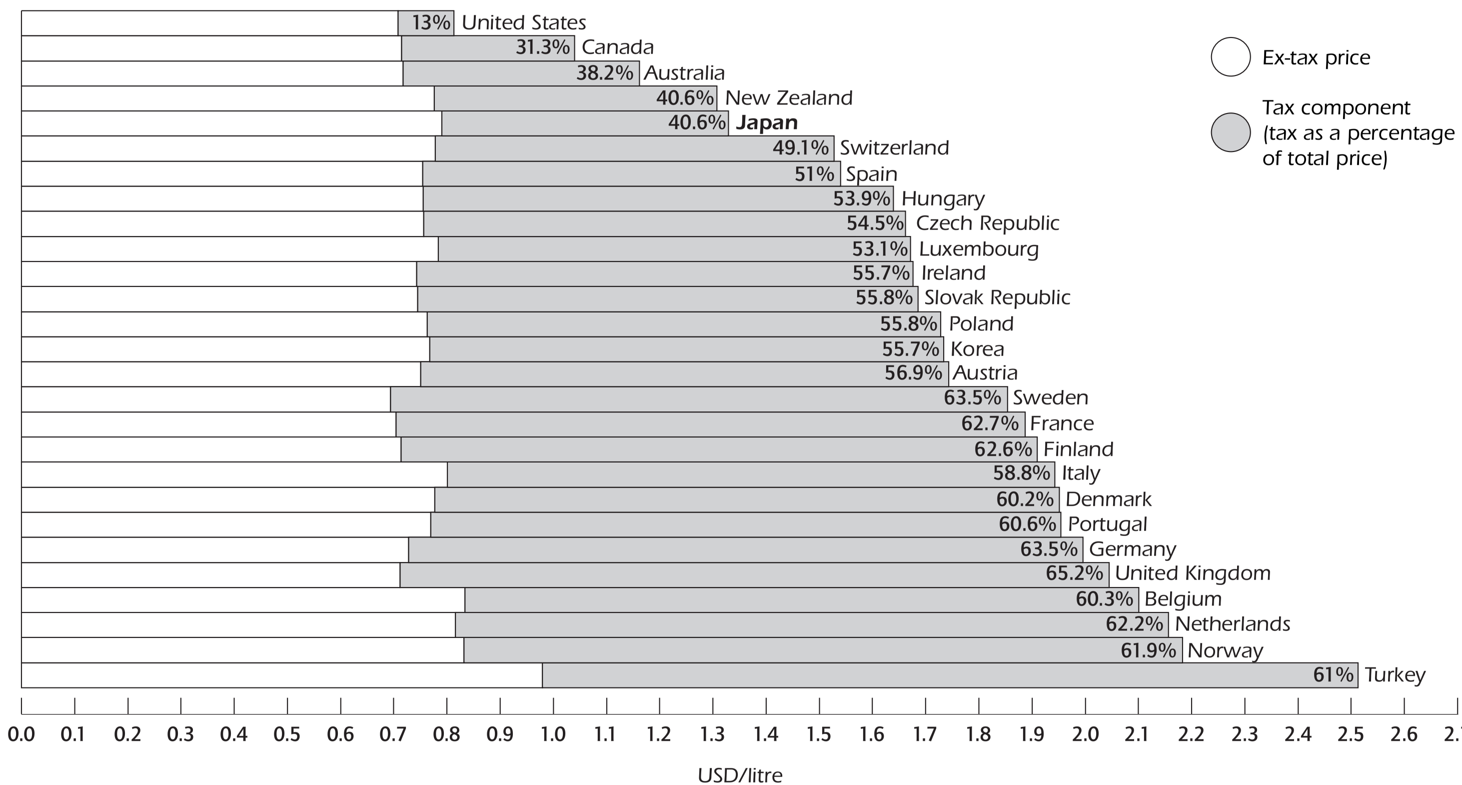
At 39%, Japan has the sixth-lowest share of diesel consumption in transport fuels of IEA countries. The share had increased to a peak of 48% in 1995, but has been decreasing steadily ever since. In terms of passenger vehicles, in 2005, diesel-fuelled vehicles made up only 0.04% of new purchases. (Most diesel consumption is in the commercial and industrial portion of the transport sector.)

According to Japanese data, if the share of diesel passenger vehicles increased by 10%, CO_2 emissions would be reduced by 2 Mt CO_2 a year in the transport sector.[7] In addition, if gasoline production fell by 4 million kl per year, this would translate into a 1.7 Mt CO_2 reduction in emissions in the oil refining sector.

7. According to tentative calculations made by the Petroleum Association of Japan and reported in "Next-Generation Vehicle and Fuel Initiative Report", Committees for Next-Generation Vehicles and Fuels, May 2007, Figure 3-6.

Figure 17

OECD Unleaded Gasoline Prices and Taxes, Fourth Quarter 2007

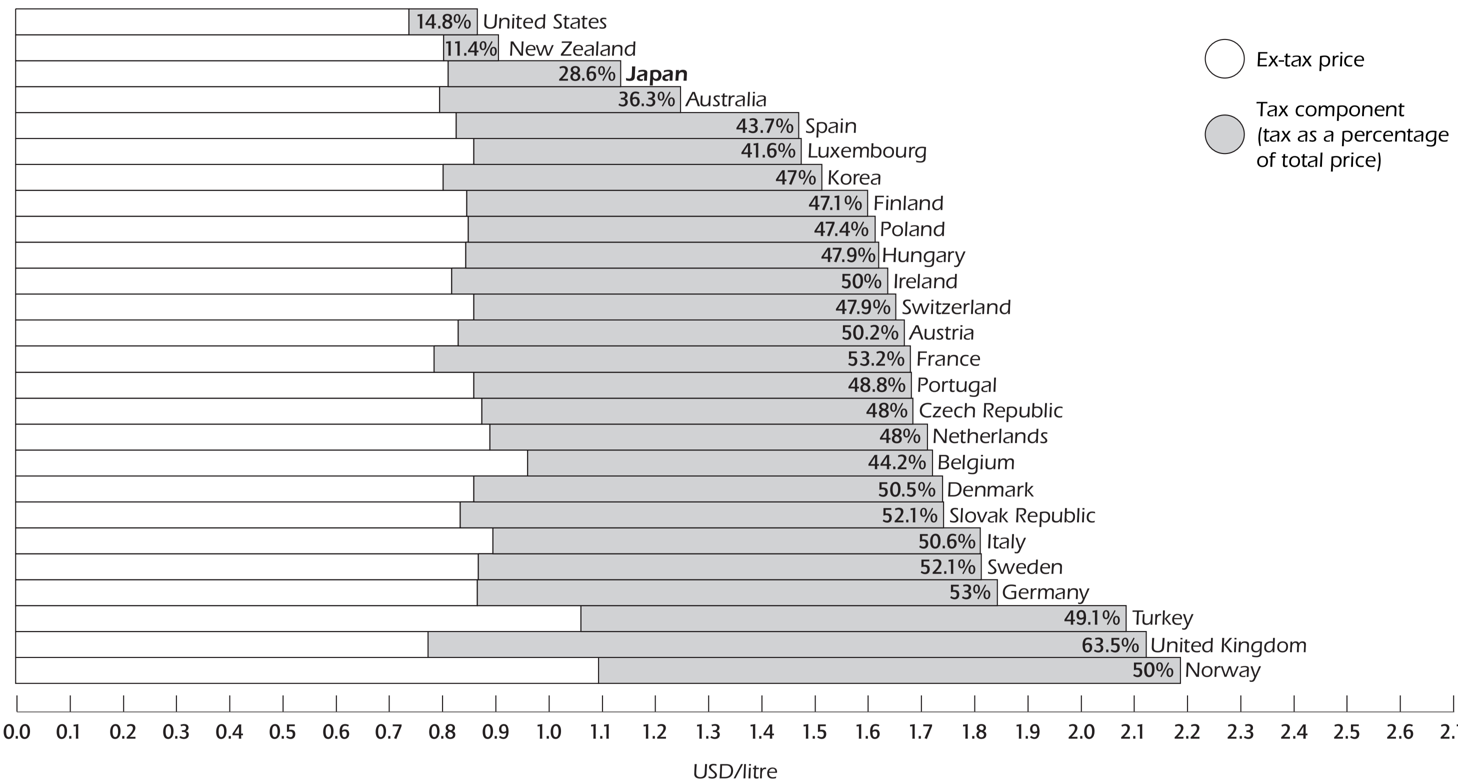


Note: data not available for Greece and Mexico.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

Figure 18

OECD Automotive Diesel Prices and Taxes, Fourth Quarter 2007



Note: data not available for Canada, Greece and Mexico.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

In general, Japan has not strongly promoted diesel-powered vehicles, as has been done in other countries, particularly in Europe, owing to concerns about exhaust emissions. Preferential tax treatment is in place for diesel-powered buses and trucks, but not for passenger vehicles. The New National Energy Strategy, adopted in May 2006, calls for promoting the use of diesel-fuelled cars that have an exhaust gas emission performance comparable to that of gasoline-powered vehicles.

PRICES

Japan's taxes on gasoline are relatively low compared to Europe, though higher than all other Asia-Pacific countries in the IEA except Korea (see Figure 17). Taxes on diesel are even lower. Figure 18 shows that taxes on diesel are lower than all IEA countries other than the United States and New Zealand.

NATURAL GAS

SUPPLY-DEMAND BALANCE

Natural gas currently makes up almost 15% of TPES. Japan domestically produces about 4% of the total volume of natural gas it consumes, with the remainder imported in the form of LNG as the country has no pipeline links. Nearly all LNG is imported from eight countries (Indonesia, Australia, Malaysia, Qatar, Brunei, the United Arab Emirates, Oman and the United States) under long-term contracts, with about three-quarters from Indonesia, Australia, Malaysia and Qatar alone in 2006. Russia is expected to be added as the ninth supplier in the near future.

As described in Table 16, total consumption of gas was almost 97 billion cubic metres (bcm) in 2006, representing a 15% increase from 2000. Currently 60% of natural gas consumption is for electricity generation, a share that has been declining since its peak in the 1980s. Natural gas provides about one-fifth of Japan's power production. Just under 20% of natural gas is used in the commercial and public services sector and 11% is used in the residential sector. While residential gas consumption remains modest, consumption has continued to grow. About 26 million households have natural gas connections at home. Under 10% is used for industrial processes, a share that has held steady since the 1980s.

Turning to the seasonal variations in gas demand, in 2005 the monthly volume of gas sales was the smallest in October and the largest in January, with the maximum volume exceeding the minimum volume by about 60%. In 2006, the volume of gas sales was the smallest in June and the largest in January, with the maximum volume exceeding the minimum volume by about 40%.

Table 16

Natural Gas Consumption, 1970 to 2006

Unit: million cubic metres	1970	1980	1990	2000	2003	2004	2005	2006	Change 1990-2006	Change 2000-2006
Electricity and heat	0	10 113	31 187	65 042	80 148	84 150	91 671	89 780	188%	38%
Share	*0%*	*57%*	*59%*	*70%*	*73%*	*74%*	*76%*	*75%*		
Electricity	1 381	18 170	39 537	56 060	58 120	55 870	52 844	58 086	47%	4%
Share	*35%*	*71%*	*68%*	*67%*	*65%*	*63%*	*60%*	*60%*		
Commercial and public services sectors	215	885	4 601	10 453	12 363	13 974	14 642	17 006	270%	63%
Share	*5%*	*3%*	*8%*	*12%*	*14%*	*16%*	*17%*	*18%*		
Residential sector	555	3 409	8 699	10 681	10 904	10 629	11 096	10 942	26%	2%
Share	*14%*	*13%*	*15%*	*13%*	*12%*	*12%*	*13%*	*11%*		
Industrial processes	1 735	2 491	4 729	6 299	6 796	7 310	8 293	9 121	93%	45%
Share	*44%*	*10%*	*8%*	*8%*	*8%*	*8%*	*9%*	*9%*		
Other	47	604	558	333	833	1 032	1 324	1 473	164%	342%
Share	*1%*	*2%*	*1%*	*0%*	*1%*	*1%*	*2%*	*2%*		
Total consumption	3 933	25 559	58 124	83 826	89 016	88 815	88 199	96 628	66%	15%

Source: *Natural Gas Information*, IEA/OECD Paris, 2007.

INDUSTRY STRUCTURE

The majority of natural gas is imported by Japan's electricity companies for power generation (see Figure 19). These utilities, and some large industrial users, import their gas independently from the city gas industry. Electric utilities also supply LNG to other new entrants to the gas market. At the same time, as discussed in Chapter 6, gas companies have also edged into the electricity market.

The city gas industry is fragmented into many vertically integrated regional companies. As of the end of March 2007, there were a total of 213 general gas utilities in Japan. Of them, 33 were public utilities. According to data on gas sales volumes for 2006, the four major gas utilities – Tokyo Gas, Osaka Gas, Toho Gas and Saibu Gas – held a combined market share of 76.4%. Tokyo Gas had a share of 36.4%, Osaka Gas 26.5%, Toho Gas 11.1% and Saibu Gas 2.4%.

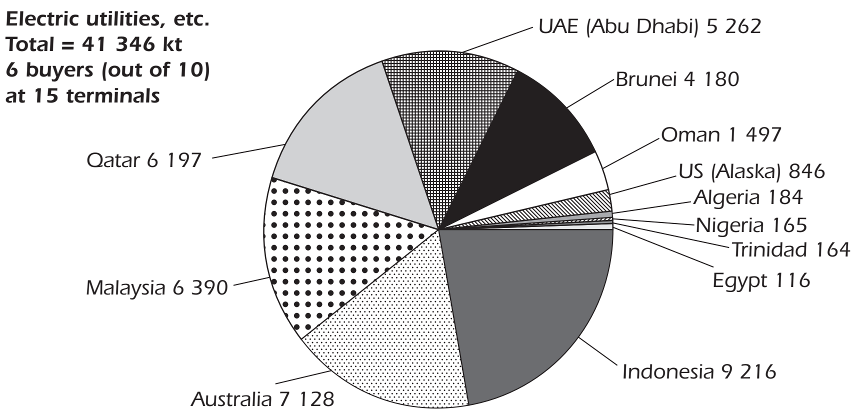
In addition to the 213 general gas utilities, there are also over 1 600 small, community gas utilities that feed 1.5 million supply points.

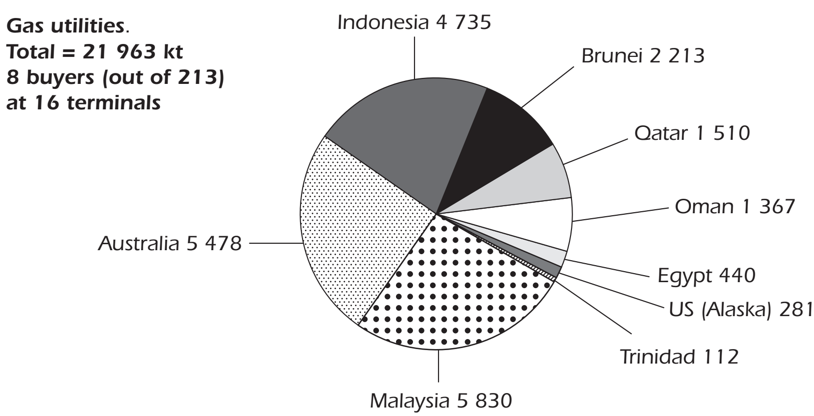
Japanese gas import companies procure more than 90% of their LNG under long-term contracts. They are preparing to meet expected growth in natural gas demand by concluding long-term contracts with new gas development projects. In addition, these companies import natural gas under short-term contracts or on a spot basis in the event of a sudden demand expansion due to factors such as severe winter weather, or unexpected power outages in other sectors.

Although most pipelines in Japan are owned by gas utilities, some power utilities and domestic natural gas producers own pipelines as service providers.

Figure 19

LNG Importers, March 2007





Source: Japan Gas Association.

The owners are responsible for the management of pipelines and grids. Some LNG terminals are owned individually by power utilities and gas suppliers while others are owned in co-operation through joint ventures.

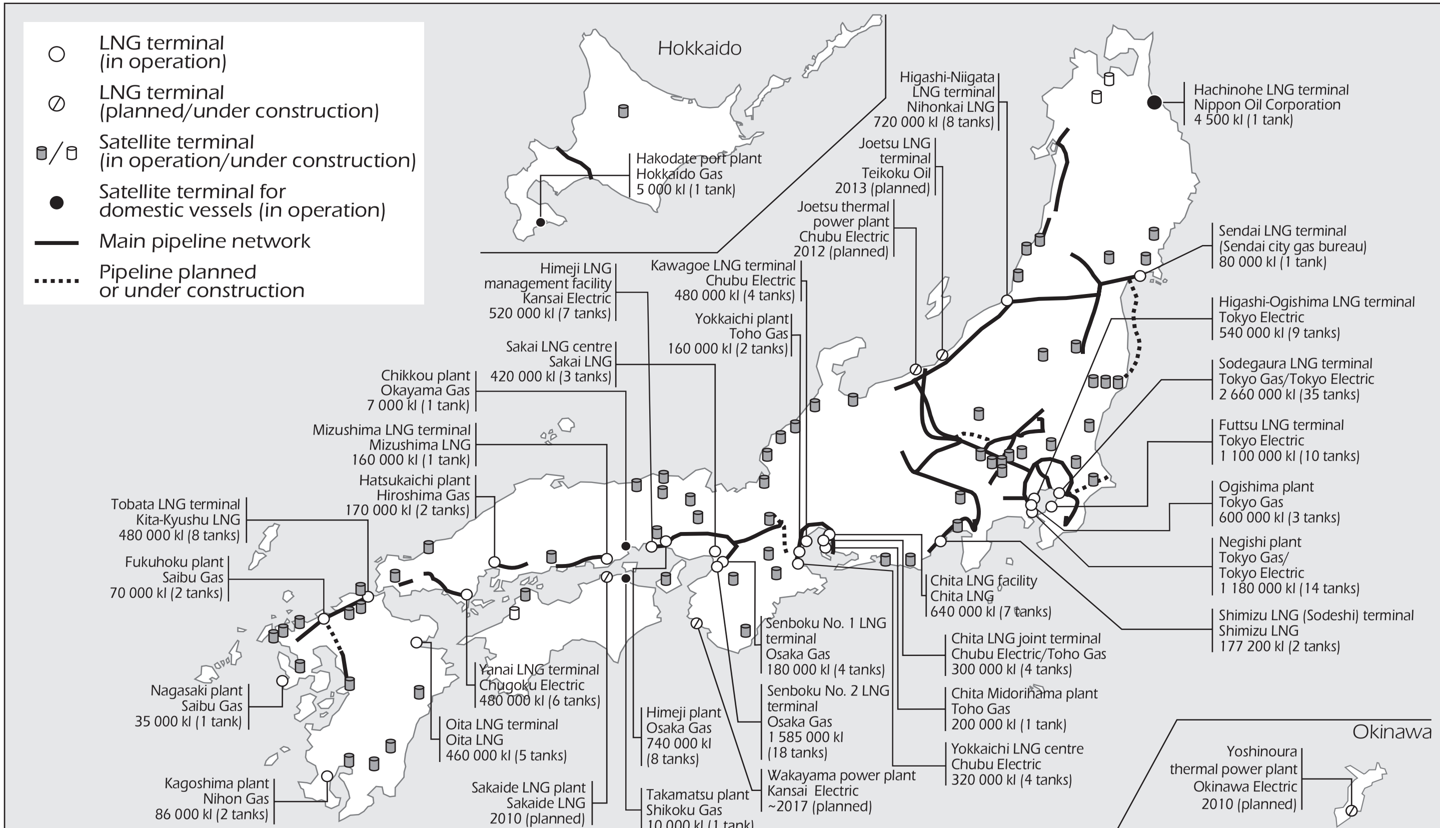
Japan's involvement in upstream hydrocarbon exploration and production is described in Chapter 4.

GAS NETWORK AND INFRASTRUCTURE

The total length of Japan's gas grid is 235 785 km, of which almost 4 414 km are high-pressure pipelines (see Figure 20). The gas grid extends throughout Japan, but the trunk line networks have developed separately around particular LNG terminals and are not necessarily connected with each other.

Figure 20

Map of the Japanese Gas Grid



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.
Source: Country submission (compiled by ANRE from data provided by relevant companies).

Japan has 27 operational LNG terminals, with six more planned or proposed to come on line starting in 2010 (see Table 17). In total, the country has import capacity of over 240 bcm per year, the largest import capacity in the world. It also has over 14 million cubic metres (mcm) of LNG storage capacity (equivalent to 9 bcm of natural gas) held at LNG regasification terminals in above-, in- and below-ground cryogenic tanks. Japan does not have underground storage of natural gas in its gaseous state, which is often seen in Europe and the United States, as there is very limited availability of places that meet the necessary geotechnical conditions. LNG storage in tanks is prohibitively expensive, with additional technical difficulties, such as treating boil-off gas (BOG). (Natural gas storage and emergency preparedness is discussed more fully in Chapter 4.)

International infrastructure projects

As discussed more fully in Chapter 4, private companies in Japan, in co-operation with JOGMEC, are involved in new international pipeline projects, including the Sakhalin project that would take natural gas and oil to the southern tip of the island of Sakhalin. This oft-delayed project would create a new LNG source for delivery into Japan. It is currently scheduled to start operation some time in 2008 or 2009.

GAS MARKET REGULATION

Gas production facilities and equipment, as well as gas businesses[8] are regulated by the Gas Business Act, and the use of LNG outside the scope of the gas business is regulated by other relevant laws such as the Electricity Utilities Industry Law and the High-Pressure Gas Safety Law. The regulations are enforced by METI.

Liberalisation of the gas sector began in 1995, when users with an annual contracted volume of 2 million m^3 or more were freed to contract for gas from somewhere other than the general gas utility. Most recently, liberalisation was expanded further in April 2007 when users with annual contracted volumes of 100 000 m^3 and over were freed to choose their own suppliers. Figure 21 elaborates on the liberalisation process in Japan since 1995. Evaluation and verification of the liberalisation process began in October 2007.

In total, the liberalised share of Japan's gas market accounts for approximately 60%. In addition, the amended Gas Business Act that came into force in 2004 requires all gas utilities to ensure third-party access (TPA) to their pipelines

8. A "gas business" refers to four classes as specified in the Gas Business Act: general gas utility businesses, community gas utility businesses, gas pipeline service businesses and large-volume gas businesses.

Table 17

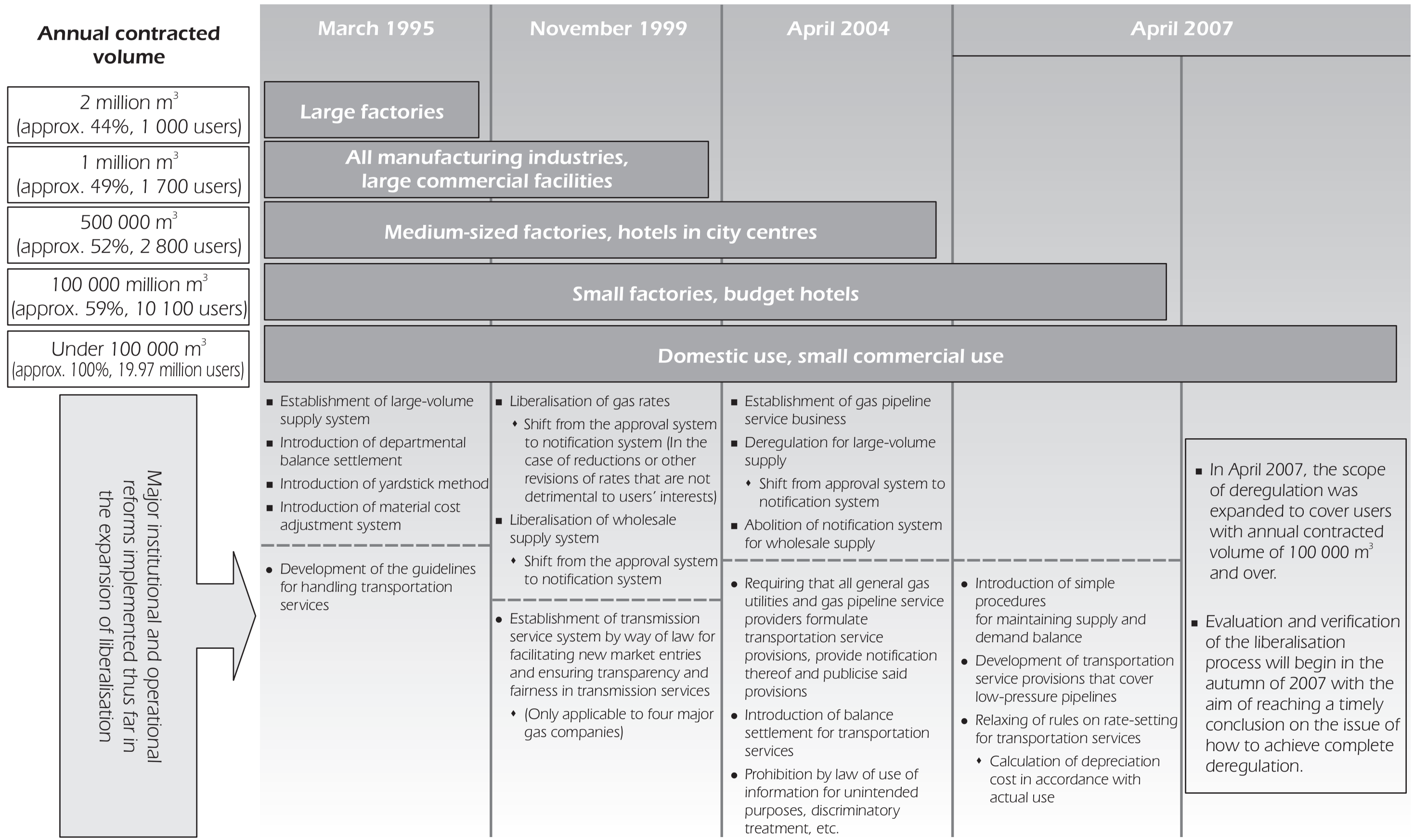
LNG Import Capacity

	Capacity		*Storage*	*Start*	*Status*
	bcm per year	*Million tonnes per annum (Mtpa)*	*m^3*		
Negishi	16.5	12.1	1 180 000	1969	Operational
Senboku I	3.4	2.5	180 000	1972	Operational
Sodegaura	39.9	29.3	2 660 000	1973	Operational
Senboku II	17.5	12.9	1 585 000	1977	Operational
Tobata	9.3	6.8	480 000	1977	Operational
Chita Kyodo	10.4	7.6	300 000	1978	Operational
Himeji LNG	11.6	8.5	520 000	1979	Operational
Chita	16.6	11.5	640 000	1983	Operational
Higashi-Ohgishima	21.1	15.5	540 000	1984	Operational
Himeji	6.8	5.0	740 000	1984	Operational
Niigata	12.2	9.0	720 000	1984	Operational
Futtsu	27.4	20.1	1 110 000	1985	Operational
Yokkaichi LNG Centre	9.7	7.1	320 000	1988	Operational
Oita	6.6	4.9	460 000	1990	Operational
Yanai	3.3	2.4	480 000	1990	Operational
Yokkaichi Works	0.9	0.7	160 000	1991	Operational
Fukuoka	1.2	0.9	70 000	1993	Operational
Hatsukaichi	0.8	0.6	170 000	1996	Operational
Kagoshima	0.3	0.2	86 000	1996	Operational
Sodeshi	1.2	0.9	177 200	1996	Operational
Kawagoe	7.5	5.5	480 000	1997	Operational
Shin-Minato	0.4	0.3	80 000	1997	Operational
Ohgishima	8.1	6.0	600 000	1998	Operational
Chita-Midorihama Works	7.3	5.4	200 000	2001	Operational
Nagasaki	0.2	0.1	35 000	2003	Operational
Mizushima	0.8	0.6	160 000	2006	Operational
Sakai	2.8	2.1	140 000	2006	Operational
Subtotal (operational)	*243.8*	*178.5*	*14 273 200*		
Sakaide	0.6	0.4	180 000	2010	Planned
Sodeshi expansion			160 000	2010	Planned
Kawagoe expansion			360 000	2011	Planned
Mizushima expansion	1.4	1.0	160 000	2012	Planned
Subtotal (planned)	*2.0*	*1.4*	*860 000*		
Joetsu				2012	Proposed
Wakayama				TBD	Proposed

Source: *Natural Gas Market Review 2007*, IEA/OECD Paris.

Figure 21

Gas Market Liberalisation Time Line



Note: Figures in parentheses indicate the share of gas sales by large-volume supply among total gas sales by the ten major gas companies, and the (settled) number of users supplied (2004). Annual contracted volume (m^3) is calculated on the basis of 46 MJ/m^3.

Source: Country submission.

and established the category of gas pipe service provider business. The guidelines on appropriate gas trading were partially amended in order to ensure the neutrality and transparency of the third-party access system and make effective use of LNG terminals.

Infrastructure access

The guidelines on appropriate gas trading, which were partially amended in August 2004, state that it is desirable that business operators that own or manage LNG terminals create manuals for negotiations about the use of LNG terminals by third-party companies so as to clarify the preconditions and rules for such negotiations from the viewpoint of ensuring fair and effective competition. The guidelines also stipulate that, from the same viewpoint, it is desirable that such business operators make sufficient information disclosure with regard to the capacity of LNG terminals, the current status of capacity utilisation and plans for future utilisation so as to enable an estimate of spare capacity.

There are no business restrictions on the construction of new LNG terminals, though it is necessary to meet the safety provisions of the laws relevant to LNG terminals, such as the Gas Business Act and the Electricity Utilities Industry Law.

No general gas utility or gas pipeline service provider is allowed to refuse third-party access unless there is a special reason to justify the refusal, such as a transport capacity constraint. Each gas pipeline service provider is required to provide third-party access. If the construction of a new pipeline by a new market entrant within the supply area of a general gas utility is deemed by the government to risk undermining the interests of gas users in the area, the Minister of Economy, Trade and Industry may order revision or cancellation of the construction plans. In the case where an area is not yet serviced by a general gas utility, but where one is expected, the criterion is whether or not the proposed development poses "a risk of harm to the commencement of the general gas utility business" and can similarly be rejected by METI. The construction of a new pipeline must also meet the safety provisions of the Gas Business Act.

As a result of the revision to the Gas Business Act in 2003, general gas utilities and gas pipeline service providers are now required to keep separate accounts for transportation services and other relevant services, and to publicise the accounting data. This accounting system was introduced in order to encourage new entry by establishing fair and transparent accounting provisions.

Revisions to the Gas Business Act in 2003 also relaxed requirements for conducting large-volume gas business, moving from a system where METI must approve the transaction to one where METI need only be notified. By the end of March 2007, 28 business operators had entered the large-volume gas supply market, sending 162 notifications to the government. These new entrants represent approximately 9.7% of all large-volume supply.

To invigorate the gas market and promote competition where the development of pipeline networks has not progressed to levels achieved in the United States and Europe, the government is promoting the construction of pipeline networks and connections between independent networks, while further facilitating the use of pipeline networks by third parties in a fair and transparent manner. Financial aid, such as low-interest loans[9] and tax benefits[10] are provided for the construction of major pipelines. In addition, the gas supply business conducted by way of large-capacity pipelines was established as a new business category under the name "gas pipeline service businesses". Table 18 shows pipelines currently under construction.

Table 18

Current Pipeline Construction

Name	*Section*	*Operator*	*Length*	*Construction start*	*Estimated construction completion*
Mie-Shiga Line and Chubu	Hikone-Yokkaichi	Osaka Gas Co. Electric Power Co.	60 km	September 2005	March 2010
Chiba-Kashima Line	Chiba-Kamisu	Tokyo Gas Co.	73 km	2006	2010
Gunma Link Main Line	Gunma Prefecture	Tokyo Gas Co. and Teikoku Oil Co.	100 km	2006	2012
Ise Bay Crossing Line	Kawagoe/ Yokkaichi-Chita	Toho Gas Co. and Chubu Electric Power Co.	19 km	2007	2013

Source: Country submission.

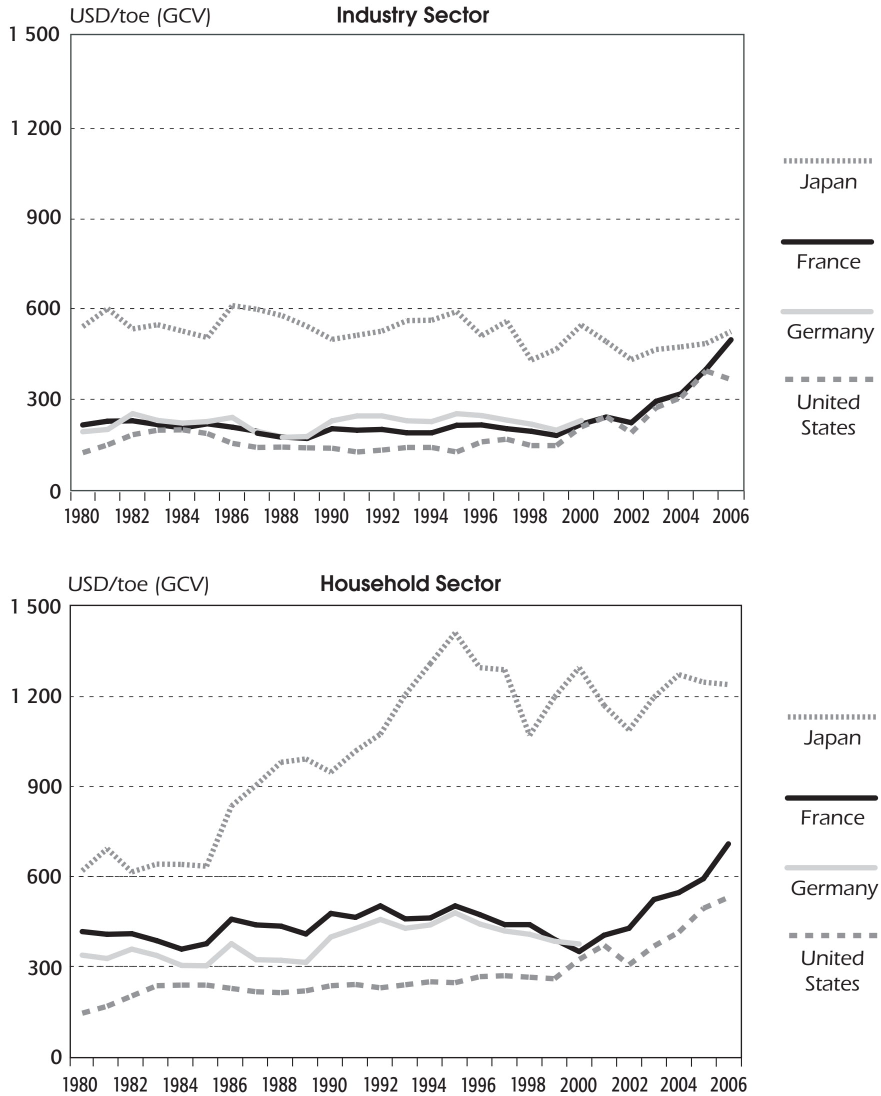
PRICES

Japan has historically had higher gas prices for industrial customers than most IEA countries (see Figure 22) owing in part to the high cost of shipping natural gas over relatively long distances. Furthermore, as compared with the United States and Europe, there is relatively lower gas consumption per household. However, in recent years, as international prices for natural gas have risen, the disparity in prices has shrunk. Prices for residential customers, however, remain above prices for other major industrialised countries.

9. Low-interest loans are provided by the Development Bank of Japan and the Japan Financial Corporation for Small and Medium-Sized Enterprises as long-term and fixed-rate funds for the development of LNG terminals and pipeline networks.
10. Tax benefits are provided under the tax scheme for promoting the reform of the energy supply and demand structure (corporation tax) and the special provisions for the tax base of the fixed asset tax (local tax); the tax reduction is implemented with regard to the construction of pipelines of local gas utilities and pipelines for the general gas business.

Figure 22

Gas Prices in Japan and in Other Selected IEA Countries, 1980 to 2006



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

CRITIQUE

Japan has been a pioneer in the import of liquefied natural gas – it received its first shipment of LNG in the 1960s and remains the world's largest LNG importer. It is also the largest importer of coal in the world, importing more than twice the amount imported by the second-largest importer. In total, Japan is the world's third-largest importer of fossil fuels, following the United States and China. With such a large reliance on imported fossil fuels, Japan has made security of supply a top priority. To manage this challenge, first and foremost the country places a high priority on energy efficiency, as discussed in Chapter 3. Japan has also been working to promote diversification of energy sources through combined efforts between the government and private actors. We are pleased to see that the country has successfully reduced its reliance on oil imports, falling from a high of 78% in 1973 to 45% in 2006. Building on this progress, the government has set ambitious targets for 2030 to further lower overall oil dependence to 40% with a target in the transport sector of 80%. Commendably, Japan goes beyond the requirements for oil stockholding, now holding almost 60 days above the IEA's 90-days requirement and taking up more than its required burden among IEA countries.

Building on the country's energy efficiency and climate change policies, there is room for the government to further promote diesel-powered vehicles. According to government data, if the share of diesel passenger vehicles rises to 10%, CO_2 emissions will fall by 2 Mt CO_2 a year in the transport sector. In addition, new diesel engines with modern diesel fuel produce fewer urban smog pollutants, alleviating concerns about diesel exhaust emissions. To take advantage of the greenhouse gas emissions benefits of moving from gasoline to diesel, the government has already taken steps to increase diesel penetration through preferential tax treatment for diesel fuel and for diesel-powered buses and trucks. We commend the government for its efforts in this area, and encourage the government to consider expanding this tax treatment to diesel-powered passenger vehicles. Given that the major barrier to entry appears to be public perceptions related to noise and tailpipe emissions, the government might consider enhancing public awareness of the environmental realities and benefits of diesel-powered vehicles.

The government has been steadily committed to a policy focused on security of natural gas supply. In this light, we are pleased to see the progress towards market opening that has been made since the last review as this will also help enhance energy security. A more competitive gas market will enhance market signals for the private sector to secure sufficient gas supplies and allow trading across regions to improve gas sector efficiency, flexibility and security. In particular, we view the involvement of market players from both the electricity and upstream oil sectors in the gas market as encouraging. However, there is cause for concern about the rule that prevents new entrants from competing with either an existing or a potential gas utility in the region if it could have the effect of undermining the interests of gas users in the area. This may create a barrier to competition, though we note that this rule is only intended to be used in exceptional cases. The IEA is pleased to see that the government places the protection of gas users as the primary policy objective. However, there is a danger that having this as the sole objective does not adequately balance customer protection with the long-term benefits of competition. The IEA encourages the government to undertake a review of the Gas Business Act to ensure that it sufficiently promotes competition. Critical to this objective is to ensure that any provisions that might allow for exceptions are subject to clear, transparent criteria.

The IEA welcomes the actions already taken to enhance competition, levelling the playing field for new entrants to the market, and encourages the government to continue its commitment to this policy. For example, the fiscal incentives provided by the government for the development of gas pipelines is a positive step, including the provision of low-interest loans and special tax arrangements. To build on this progress, greater competition and efficiency in the gas market can be achieved by extending the penetration of the gas network and by linking existing supply areas by trunk pipelines where physically and economically feasible. The government should evaluate whether the incentives provided to encourage pipeline development do, in fact, achieve the desired result. The government should particularly consider whether the current regime for grid access creates incentives for incumbent gas companies not to invest in such interconnections. In general, every effort should be made to allow for better integration of the natural gas network in a cost-effective manner. A well-integrated gas pipeline network brings liquidity to the market and will improve security of supply, but such a network will only materialise if incumbents are given the right incentives to make development happen.

Turning to the coal sector, in 2002 the government successfully eliminated subsidies to its small domestic producers, a welcome move. Building on this progress, in 2006, the government ceased providing for measures to deal with mining pollution and subsidence, allocating responsibility to the mining companies for dealing with legacy rehabilitation costs. Long-term liabilities associated with coal mining are a complex challenge. The government should continue to monitor the situation in regard to these legacy issues so as to ensure that, in the event that unforeseen local difficulties arise, the interests of the local communities are met.

RECOMMENDATIONS

The government of Japan should:

- *Encourage more rapid penetration of clean fossil fuel technologies, such as through preferential tax treatment for diesel-powered passenger vehicles, and continue work to overcome negative public perceptions of diesel-powered vehicles.*

- *Undertake a review of the Gas Business Act to ensure that it adequately promotes competition in the gas sector and requires sufficient transparency in the administration of regulations.*

- *Ensure that the market and regulatory framework creates the right incentives for the cost-effective integration of the natural gas network in light of the benefits of such integration on supply security.*

- *Continue to monitor subsidence, mine water discharges and other long-term liabilities associated with the domestic coal mining industry and ensure that the needs of the local communities continue to be met through effective and timely remedial actions.*

ELECTRICITY

Electricity supply is a part of the country's energy sector where Japan's challenges of security of supply, environmental constraints and economic efficiency are most evident. It is critical that this triangle of challenges is reconciled in a balanced way to sustain the competitiveness of the Japanese economy, and it is equally important that the electricity sector and the economy at large are responsive to changes in environmental and fuel supply constraints.

CAPACITY, GENERATION AND DEMAND

CAPACITY

Installed power generation capacity in Japan is well diversified, with approximately 20% in each of the main conventional energy sources: coal, oil, natural gas, nuclear and hydro. Other newer renewable energy sources still only play a very minor role, even given the significant percentage increase of solar and wind power since 2000.

Gas-fired capacity has more than doubled during the last ten years. Coal, nuclear and hydro capacity has also increased by 10% to 20%, while installed oil-fired capacity has decreased slightly. This development has covered the steady growth of peak load, and accordingly, reserve margins of installed capacity over peak load have been kept at a comfortable level and are on an increasing trend.

Capacity factors of installed capacity are relatively low in Japan (see Table 19). One reason for this is the relatively peaky demand in Japan, with great load variations, particularly during the summer. Capacity factors in oil-fired plants are low, indicating that they make up reserve capacity. Oil-fired capacity is relatively old and depreciated – as well as expensive to operate – so it is also often the least-cost option for reserves. The capacity factors of newer and capital-intensive nuclear and coal-fired plants are, however, also significantly below international standards. Average capacity factors of coal plants in the OECD were around 65% over the last five years compared to 45% to 55% in Japan. Average capacity factors of coal plants cover great variations, often depending on age and size. This is also the case in Japan. For example, coal-fired plants owned by the large vertically integrated utilities operated at 70% to 75% average capacity factors during the last five years. Average capacity factors of nuclear plants in the OECD were about 85% over the last five years compared to 60% to 70% in Japan. Putting such expensive plants to so little use adds considerable pressure on overall costs. Increasing capacity factors of, for example, nuclear power, the most capital-intensive generation source, from the current 70% to about 90% – a level achieved in more and more IEA countries – would correspond to adding almost 9 gigawatts (GW) of new capacity.

Table 19

Power Generation Capacity in Japan

Fuel	*Capacity, MW, 31 March 2006*	*Share*	*Capacity factor*					
			2000	*2001*	*2002*	*2003*	*2004*	*2005*
Coal	62 535	22.4%	44.2%	45.5%	46.2%	48.6%	51.7%	56.5%
Oil	61 476	22.0%	24.8%	20.0%	24.3%	24.8%	23.3%	27.1%
Gas	53 257	19.1%	69.5%	69.0%	66.7%	67.9%	57.2%	49.6%
Nuclear	49 580	17.8%	81.2%	79.5%	73.4%	59.9%	68.4%	70.2%
Hydro	47 292	17.0%	21.5%	20.7%	20.3%	23.1%	23.0%	18.9%
Wind	1 227	0.4%	20.9%	22.1%	20.9%	24.2%	23.4%	20.1%
Other renewables	3 457	1.2%	98.9%	87.8%	87.8%	84.4%	79.1%	75.2%
Total	**278 824**	**22.4%**	**44.2%**	**45.5%**	**46.2%**	**48.6%**	**51.7%**	**56.5%**
Reserve margin of total installed capacity over peak load			51.3%	45.4%	50.2%	62.7%	58.8%	56.9%

Sources: *Energy Balances of IEA Countries*, IEA/OECD Paris, 2007 and country submission.

ELECTRICITY GENERATION

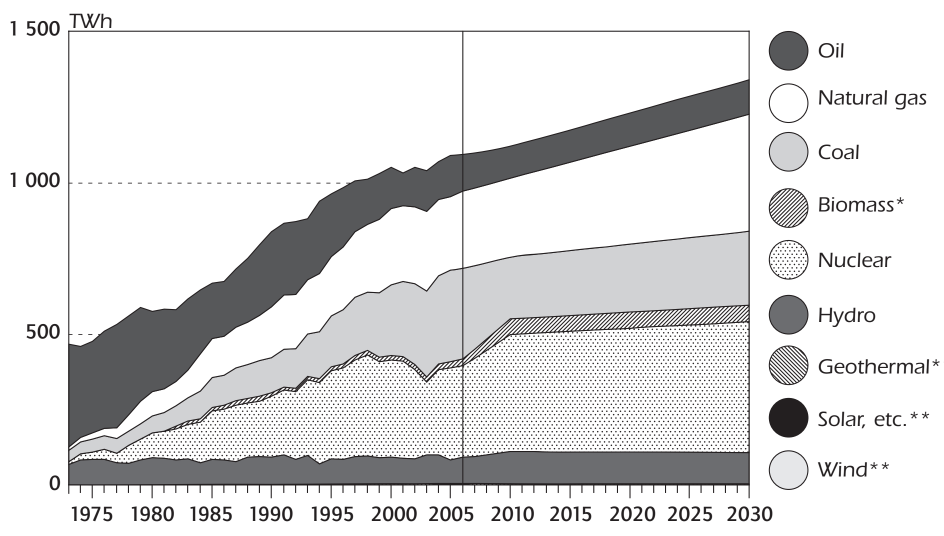
As shown in Figure 23, power generation is slightly more concentrated and less diversified than installed capacity. Hydro generation is bound by natural constraints and seems to be limited to capacity factors below 30%. Japan was greatly reliant on oil until the oil shocks in the 1970s. The share of oil in total power generation decreased from 30% in 1990 to 10% in 2006, which is still among the highest in IEA countries. The share of nuclear and gas has increased slightly, but coal has been the principal replacement for oil in power generation, increasing from a share of 14% in 1990 to 28% in 2006.

Gas-fired power generation has only increased slightly in importance since 1990, from a share of 20% to 23% by 2006. Considering that the share of installed gas-fired capacity doubled in the same period, gas-fired capacity is now becoming a considerable source of reserve capacity in the Japanese electricity system.

According to government projections, the share of coal-fired generation is expected to decrease rapidly to below 20%, mainly to be replaced by nuclear (35% in 2010 and 32% in 2030) and natural gas (23% in 2010 and 29% in 2030). A nuclear share of 35% corresponds to current nuclear capacity and the additional 912 MW scheduled to come on line in 2009, all operating at a capacity factor of 88%.

Figure 23

Electricity Generation by Source, 1973 to 2030



* includes industrial and municipal waste. ** negligible.

Note: Forecast data are to be revised by the Japanese government in 2008.

Sources: *Energy Balances of IEA Countries,* IEA/OECD Paris, 2007 and country submission.

DEMAND

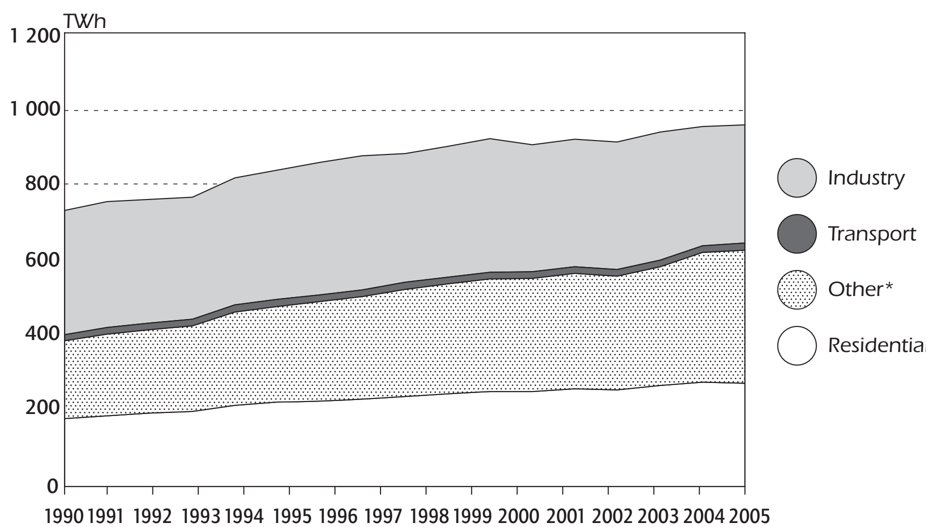
Annual electricity demand in Japan grew by an average annual rate of 3.3% in the 1980s, 2.3% in the 1990s and 1.1% from 2000 to 2006. In the 1980s, average real GDP growth was 3.7% per year, outpacing electricity consumption growth. The trend turned in the 1990s when average real GDP, at 1.5%, was slower than electricity demand growth. With slightly stronger average GDP growth since 2000, the picture has reversed again with GDP growth outpacing electricity consumption. Each year the Japan Electric Survey Committee publishes its expectations for annual demand growth for the next ten years. Expectations have decreased from some 2% in the late 1990s to below 1% in 2007.

As shown in Figure 24, the industrial sector is still the largest electricity-consuming sector with a 35% share in 2005, though this share has decreased from 45% in 1990. Most of this decrease has been replaced by an increase in the share going to the residential sector, which grew from 24% in 1990 to 34% in 2005. The commercial and other sectors have had a relatively constant share at around 30% and the transport sector has held relatively steady at 2%.

Peak demand was at 178 GW in 2005. It increased with an annual average of 1.6% in the 1990s, which was less than the increase in total demand. Since 2000 the increase in peak demand has slightly outpaced the increase in total demand with an average annual growth rate of 0.4%. Peak demand in Japan occurs during the summer, under strong influence from the use of electrical cooling. The load curve of Japanese electricity demand shows very marked differences between low load and maximum load during the day; peak demand can be up to 50% higher than demand during off-peak periods, with very steep increases in the morning. This makes peak load in Japan more challenging to meet than in most places in the world.

Figure 24

Final Electricity Demand by Sector, 1990 to 2005



* includes commercial, public service, agricultural, fishing and other non-specified sectors.

Source: *Energy Balances of IEA Countries,* IEA/OECD Paris, 2007.

The Japanese electricity sector has undergone several steps of market reform since the mid-1990s, similar to the experience in almost all other IEA countries but at a somewhat slower pace than most. Until the last review, two steps had been taken. In 1995 a system of bids from independent power producers (IPPs) was introduced with an amendment of the Electricity Business Act. A second amendment in 2000 introduced the concept of regulated third-party access (TPA).[11] The way of ensuring neutrality and transparency of transmission and distribution departments was left to the discretion of the individual utilities, whereas the necessary measures for functional separation have been specified in the *Guidelines for Proper Electric Power Trade.* A third amendment was agreed by the *Diet* in 2003, deepening the foundations for fully regulated TPA, which contains the establishment of a neutral system organisation, introduction of behavioural regulation (prohibition of the use of information for any other than the intended purpose in the wheeling service (transmitting power across networks) and accounting separation, and prohibition of discriminatory treatment) for the transmission and distribution segment of vertically integrated utilities (VIUs). The implementation of these amendments has been the main driver for market reform since the last review. The latter steps are measures taken within the electricity sector to fulfil the overall target of revitalising the Japanese economy through regulatory reform decided by the Cabinet in 2001 in the *Three-Year Programme for Promoting Regulatory Reforms.*

End-use customers have steadily become eligible to freely choose their electricity supplier in three steps. The extra high-voltage customers (above 2 MW) became eligible in March 2000. High-voltage customers above 500 kW became eligible in April 2004 and high-voltage customers above 50 kW became eligible in April 2005. A debate within the Electricity Industry Committee to further expand eligibility to all customers was initiated in April 2007 as planned. As a result of the discussion, it reported: "At present, it is evaluated that consumers in already contestable market segments do not have effective options to choose their suppliers sufficiently." Thus, the preconditions for expanding retail liberalisation have yet to be satisfied. If the eligibility to choose retail suppliers is expanded under these circumstances, it would not only provide the possibility of there being no merit for customers in the household sector, but also the high possibility that the inevitable transition costs may exceed social benefits. Therefore, the expansion of the liberalised sector is not preferable at this time, and it would be appropriate to first establish a more competitive environment in already contestable

11. In the United States and some other markets, "third-party access" (TPA) is typically referred to as "open access". This regime gives all market participants non-discriminatory and transparent access to transportation regardless of transmission line (or pipeline, in the case of natural gas markets) ownership or operation.

market segments. The first contestable customer group represents some 26% of electricity sales, the next 14% and the last 23%. Hence, by April 2005 customers with a share of some 63% of the load were eligible. The remaining smallest customers are very small factories, small shops and residential customers.

REGULATION AND MARKET DESIGN

Successful market reform in other IEA electricity markets has included significant reforms in three main interrelated areas: governance, incentives and rules. The biggest reform in governance has been to create structures that allow for impartial and independent decision-making within the legal framework set by government. This is to ensure that decisions balance and protect the interests of government, consumers, investors and other market players. The main body in such structures has been the independent regulator. Reform in the area of incentives has mainly been focused on eliminating the disincentives to compete. In electricity, these disincentives principally arise from the fact that traditional vertically integrated utilities own generation and service retail customers, as well as manage networks, with networks being a natural monopoly. Given the multiple roles, such companies have a clear incentive to limit and obstruct equal access to grids for their competitors. Finally, successful market reform has included a wide range of rules and regulations to reduce transaction costs and hence to ease access, particularly for newcomers and smaller market players. One crucial package of rules allows for the development of effective and smooth trading arrangements.

The responsibility for governance of the electricity sector lies with the Ministry of Economy, Trade and Industry (METI). Within METI, the Agency of Natural Resources and Energy (ANRE) is responsible for electricity issues. The Electric Utility Industry Council gives advice to METI on request. It is composed of participants from the academic world, representatives of utilities, new entrants, end-users and other social groups. The council established the Market Monitoring Subcommittee in 2005 with responsibility to monitor dispute settlement, results of METI inspection and regulation, and current electricity market conditions. The Japan Fair Trade Commission (JFTC) is responsible for monitoring the state of competition and has increased its surveillance of the electricity industry since market reform was initiated. The JFTC and METI have issued *Guidelines for Proper Electric Power Trade,* which, within the Antimonopoly Act and the Electricity Business Act, describes the principles and practices for trade that may violate the act, with a primary focus on the behaviour of the vertically integrated utilities (VIUs).

With the third step of market reforms in 2003, it was decided to strengthen functional separation and regulated third-party access by forming the Electric Power System Council of Japan (ESCJ). The ESCJ is a fully independent, private and non-profit body governed by its members. It was established in 2004 and commenced full operation in April 2005. It currently has 53 members: the country's 10 VIUs, 9 power producers and suppliers (PPS), 7 other wholesale electricity companies and 27 members from the academic world. The main roles for ESCJ are to establish rules for access to the transmission grid and to enhance transparency. A comprehensive set of rules was published in 2004 and has been expanded continuously since. The rules are divided into four areas: construction of new and expansion of existing network infrastructure; technical requirements for installation and connection of new generation facilities; transmission system operation by VIUs; and disclosure of information related to network availability and use. ESCJ has a unit, the so-called Liaison Co-ordination Centre, the task of which is to ensure reliability through co-operation in the transmission and distribution sectors of electric utilities and with the wholesale power exchange. It also provides an information service that gives updated information about demand forecasts, capacity on interconnectors and actual power flows.

VIUs are not required to fully unbundle their networks and system operation from other activities. It is assumed that ESCJ will be sufficient to secure the necessary independence in network expansion and system operation decisions, through establishing rules and information systems. There are some legal requirements on VIUs on functional unbundling. VIUs are required to establish information firewalls around network activities. It is prohibited to cross-subsidise network charges to other divisions and to take other discriminatory actions. The VIUs' creation of fair and transparent operation of network divisions is also stipulated under the Electricity Business Act and monitored by METI. Network tariffs ("wheeling" tariffs) must be set in accordance with a METI Ordinance and must be reported to METI. If such tariffs are inappropriate from the viewpoint of ensuring proper cost recovery, the authorities may issue an order to revise them. The act indicates in advance the criteria for issuing orders of revision, so as to secure predictability for electric utilities. Wheeling tariffs are charged from power producers and suppliers, who supply the eligible customers that have chosen to shift supplier, on the basis of the amount of electricity delivered. A system of charging additional wheeling fees when entering another network area (so-called pancaking) was abolished in 2005.

TRADE

The Japan Electric Power Exchange (JEPX) was established in 2003 and commenced operation in April 2005. Like ESCJ, JEPX was formed as a result of the third reform step with the intention of giving it a complementary role in wholesale electricity trade, but it is a body without direct involvement from

METI. JEPX is a non-profit corporation with 21 shareholders: nine VIUs, nine new-entrant power producers and suppliers (PPSs) and three other companies. It operates a physical spot market and a physical forward market. Liquidity in both markets is still marginal but increasing. Liquidity measured by turnover in the spot market corresponded to 0.1% of total Japanese demand in 2005, 0.16% in 2006 and 0.23% during the first five months of 2007. Trade in physical forward contracts totalled 723 GWh in 134 contracts during the first three years of operation until mid-2007. Half of these trades were concluded in the last four months through August 2007. Overall, JEPX plays a marginal role in the exchange of electricity along the supply chain from generation to final consumption. The more successful power exchanges in other IEA countries have spot turnover in the range of 20% to 70% of total demand. The most liquid markets for long-term contracts see trades corresponding to six to eight times the total demand.

Prices of exchange-based spot contracts have become the crucial reference price in most successful markets in IEA countries. Competitive bidding into a day-ahead or real-time spot exchange should result in prices that reflect the real costs. Japan has a wide variety of power generation technologies, several of them critically dependent on external fuel market forces, and on very volatile and peaky demand. It should be expected that cost-reflective spot prices are equally volatile. Such volatility has not occurred in JEPX spot trade and it is not dynamically reflected in balancing charging arrangements. For example, volatility has been just a little higher than in Nord Pool, the Nordic power exchange that manages trade in the heavily hydro-dependent Nordic system and therefore has notoriously low volatility. In contrast, volatility in Australia, with demand volatility similar to that in Japan, is several orders of magnitude higher. Cost-reflective prices that also reflect the volatility of demand would create incentives for appropriate investment in peak load resources and demand response. This has been the case in Australia where price spikes attracted investments in open-cycle gas turbines, an option which is sensible to meet peak load since it has low investment costs.

Transmission capacity between the VIUs, supposedly the main transmission bottlenecks in Japan, is allocated according to a first-come-first-served principle. It is accompanied with a use-it-or-lose-it rule that penalises fictitious reservations. One of the crucial factors in assigning a value to electricity produced and consumed at specific locations is the allocation of transmission capacity. Constrained transmission capacity has a major impact on prices in many of the successful exchanges in other IEA countries and is also a major contributor to liquidity in several markets. The prerequisite for that liquidity is that transmission capacity is allocated according to willingness-to-pay principles and is made tradable when it is sold on longer-term contracts. Some types of flows in Japan have priority across inter-regional transmission interconnectors. These flows include generation from nuclear power plants. Under a market-based allocation mechanism, such power flows would still get guaranteed access through bids that are based on the low marginal costs of the power source, in this case nuclear power. Hence, priority access for certain technologies is unnecessary and distorting in competitive markets with appropriate locational marginal pricing.

Real-time balancing of supply and demand is managed individually by the ten transmission system operation units of the VIUs. It is up to each VIU to decide how best to acquire the necessary resources to manage this task: regulating power, operational reserve capacity and other ancillary services. PPSs are required to ensure a balance between supply and actual demand every 30 minutes with the support of the VIUs, and are charged a balancing fee, depending on the size of the deviation between actual demand and supply. The fee has two tiers; one fee is on low-tier imbalances below 3% and the other, significantly higher, fee is on imbalances above 3%. The balancing fee is calculated by each VIU in accordance with the rules established by METI based on internal pricing calculation within the VIUs. Procurement of these balancing services is not based on a competitive bidding process, it is not directly linked to real costs and is not charged uniformly from all market players.

Entities with the PPS status, supplying to the liberalised segment of the market, are one of the main actors in the traded wholesale market. Other wholesale suppliers and distributed generators supply power to the grid according to contracts with VIUs as they have done in the past, and also supply power to PPSs.

A competitive electricity market that gives incentives for optimal dispatch and investment and that allows market participants to manage the risks related to operation and investment is based on a liquid spot market and a liquid market for long-term financial contracts. The spot market attracts competitive bids that lead to cost-reflective prices and are, in turn, used as a credible reference for financial contracts. As electricity only becomes "physical" at the moment of operation, there are only drawbacks and no added value in keeping long-term contracts "physical". Such a liquid market is not developing in Japan. Some of the rules directing trade tend to lock in the concept of long-term physical contracts. Priority access of nuclear power is one example. Another is the special status the numerous non-VIU and non-PPS suppliers have in the market. Rules on plans and schedules are a third example. ESCJ rules require that PPSs present four different plans and schedules: one for the current and next year, one for the next month, one for the next week, and every day at noon a balanced and committing schedule must be submitted for the following day. These plans and schedules describe trades in the liberalised segment of the market. The requirements for the demand side of the market to make such long-term plans encourage it to make long-term physical commitments, rather than basing the supply on a liquidly traded market. The demand side is excluded from making direct purchases on the JEPX.

TRANSPARENCY

ESCJ has created a Power System Information Service for registered users. This service includes information about available transmission capacity on interconnectors, forecasts for nationwide demand, real-time and one-day-old information about total demand, two-day-old demand by area (nine areas), maintenance plans and status for interconnectors, power flows on interconnectors and information about outages of interconnectors. The system has markedly improved information regarding demand and interconnection transmission capacity for registered users. Information about the power generation side of the market is still limited to general annual statistics on installed capacity and power generation output by fuel type.

Easy and reliable access to information, including information about the supply side, has in several IEA countries proven to be critical for the development of a liquid market. This information also includes the status of all installed generation units above a certain size, total generation by fuel type and by region, and sometimes real-time information about the status of individual power plants. It allows all market players to analyse and understand the market situation and it allows academia to explore the details of the functioning of markets. Such information is usually only made available with hesitation, in a trade-off of arguments about confidentiality on the one hand and the need for transparent information about market fundamentals from a regulatory point of view, on the other.

ENVIRONMENTAL REGULATION

Environmental performance of the electricity sector is largely addressed through a voluntary action plan by the Federation of Electric Power Companies of Japan (FEPC). The Environmental Action Plan by the Japanese Electric Utility Industry was first formulated in 1996 and has been reviewed annually since 1998. The effects – relatively lower emissions of nitrous oxides (NO_x) and sulphur dioxide (SO_2) from fossil fuel plants – show the power of such voluntary agreements. This voluntary action plan is also part of the government policy based on the Keidanren Voluntary Action Plan to Cope with Global Warming and is also intended to reduce the CO_2 intensity in the Japanese electricity sector. From FY2008 to FY2012, the agreements aim to reduce CO_2 emissions intensity by an average of approximately 20% from the FY1990 level, to about 0.34 kg CO_2 per kWh. With intensities currently at some 0.410 kg CO_2 per kWh and a forecast of 0.37 kg CO_2 per kWh, the target will have to be complemented by flexibility mechanisms and reductions in other countries. The future performance of nuclear power is immensely important for meeting the targets, and the biggest CO_2 impact will come if improved nuclear performance shifts out coal-fired generation rather than alternatives for less CO_2-intensive fuels such as natural gas. Whether nuclear will shift out gas or coal should be carefully balanced taking economic efficiency, energy security and the environment appropriately into account, but there are currently few direct financial incentives to meet the CO_2 targets. With current fuel prices, it seems likely that improved performance of nuclear power will shift out generation from expensive natural gas.

The Act on the Promotion of Global Warming Countermeasures introduces some soft incentives to reduce GHG emissions on the demand side. The act requires certain customers to report CO_2 emissions, and allows electricity suppliers to report their CO_2 intensities when they are below the default value decided by the government (0.555 kg CO_2 per kWh). Customers can calculate CO_2 emissions with the CO_2 intensities reported by their electricity suppliers and they can report the default intensity of 0.555 kg CO_2 per kWh if intensities of their suppliers are higher than the default value. To the extent that the CO_2 emissions with the end-use customers have an impact, this reporting could create some incentives to reduce CO_2.

INDUSTRY STRUCTURE

GENERATION

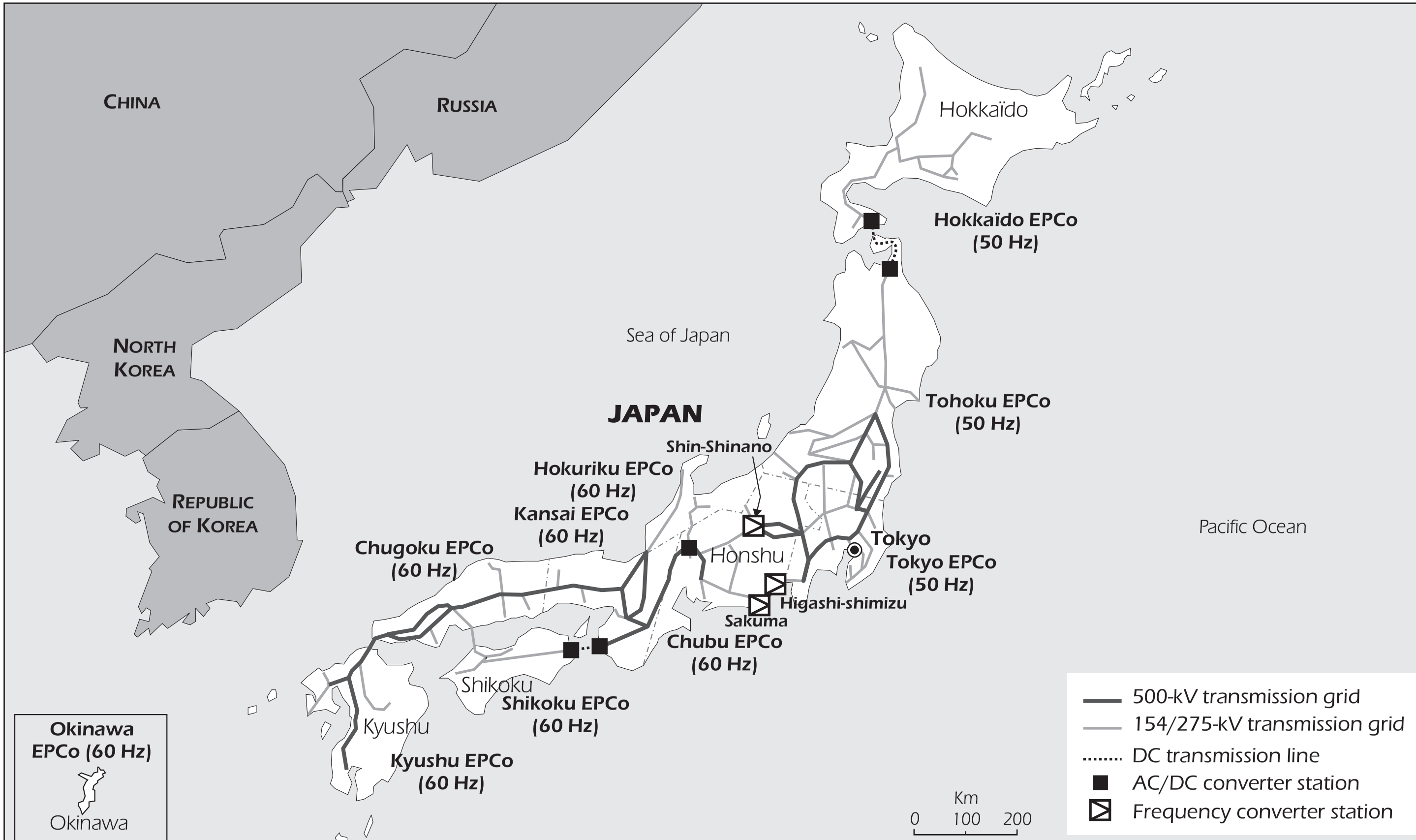
The Japanese power sector has ten vertically integrated utilities covering all the geographic regions of Japan (see Figure 25). In addition, there is one large wholesale supplier, J-Power and numerous other wholesale suppliers, municipal utilities and distributed autonomous generators. In the competitive segment there are 22 power producers and suppliers. In terms of installed capacity, the six largest companies are Tokyo Electric Power Company (22%), Kansai (13%), Chubu (11%), Kyushu (7%), Tohoku (6%) and J-Power (6%). In terms of power generation, the six largest generators are also: Tokyo (26%), Kansai (13%), Chubu (12%), Kyushu (8%), Tohoku (7%) and J-Power (5%). Tokyo Electric Power Company is one of the largest electric utilities in the world. As regards financial turnover, it was the fourth-largest in 2005.

New generation

Substantial new generation projects are both under construction and planned. New nuclear power plants play a crucial role in the New National Energy Strategy. A Nuclear Energy National Plan was formulated in 2006 following a Cabinet decision in 2005 on the framework for nuclear energy policy in Japan. According to this decision it shall be the aim of Japan to let nuclear power continue to contribute with 30% or even up to 40% of total power generation towards 2030 and beyond. Two nuclear power units are currently under construction. One is due to come on line in 2009 and the other in 2011. In the short term, however, as Table 20 shows, the largest increase is due to come from fossil fuel plants, mainly gas (LNG) but also coal. Table 20 does not

Figure 25

Supply Areas of General Electric Utilities



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.
Source: Country submission.

include autoproducers and other wholesale suppliers such as PPSs. These will tend also to focus on gas- and coal-fired plants, and, to some extent, on new energy sources. According to a METI survey in December 2005, PPSs plan to expand installed capacity from about 1 GW in 2006 to some 5 GW by 2009 and they are ahead of this schedule today.

Table 20

Plants under Construction or Planned by VIUs, J-Power and Japan Atomic Power

	MW (number of units)	
	Under construction	*Planned*
Coal	3 750 (5)	1 000 (2)
Liquefied natural gas	8 460 (12)	8 590 (10)
Nuclear	2 290 (2)	14 950 (11)
Hydro	5 110 (8)	80 (12)
Other (including oil)	<10 (1)	30 (11)
Total	**19 600**	**24 640**
Share of total installed capacity on 30 March 2006	7%	9%

Note: May not sum to total because of rounding.

Source: Country submission.

The Japanese electric utilities organised in FEPC have expressed intentions to follow the government's vision for a stable and perhaps even increased role for nuclear power in Japan. This is expressed in the voluntary agreements in the *Environmental Action Plan*. PPSs and other investors are investing in other generation sources, thereby potentially competing with new nuclear capacity. New nuclear investment should be able to stand up to this competition, particularly considering the advantages of reducing the reliance on often costly energy imports, but only under certain critical circumstances. Nuclear projects must first of all be completed within budget and on time. Secondly, they must be operated for as many hours as possible and capacity factors below 85% and even 90% could be a real threat to profitability. Finally, nuclear power has a significant competitive edge compared to technologies fuelled by fossil sources in that it does not emit CO_2 when generating electricity. Electric utilities can be expected to make investment decisions that take costs and implications for import reliance properly into account, but they do not see many financial incentives to take the positive CO_2 abatement effects into account. Removing this value from the equation may put the overall competitiveness of nuclear power at stake.

The Japanese transmission system is divided into two separate frequency areas, one northern system with 50 hertz (Hz) and one southern system with 60 Hz (see Figure 26). Historically, the ten VIUs, which own and operate all high-voltage transmission lines, were required to maintain self-sufficiency, so that interconnections between the ten supply areas were weak and mainly intended for operational system security purposes. The two frequency areas are interconnected with three frequency converters. The third converter is still under construction and is only partly in operation but will enter into full operation in 2011. Total interconnection capacity is 970 MW and an extra 200 MW will be added when the last enters into full operation.

Transmission and distribution losses have largely stabilised at 5.2% (5.2% in 2004) in this decade after seeing a slightly decreasing trend since the mid-1980s. The 5.2% figure does not take generation from autoproducers into account, which brings the loss factor to 4.5% to 4.8%. Distribution losses in Japan are among the lowest in IEA countries. They are on a comparable level with other densely populated, often smaller countries, but lower than most of the larger IEA countries.

System reliability is high in Japan. From 2000 to 2003, supply was interrupted for about ten minutes per customer per year. There is no information about the quantity of undelivered energy and interruptions divided into larger-scale transmission interruptions or local distribution-level interruptions. Evidence indicates that reliability in Japan is substantially higher than in many other IEA countries. Questionnaire surveys show that Japanese electricity customers rank reliability as one of the highest priorities. There is, however, no information about the actual marginal willingness to pay for reliability and a specific level of reliability is not a part of the regulatory framework based on a cost-benefit analysis.

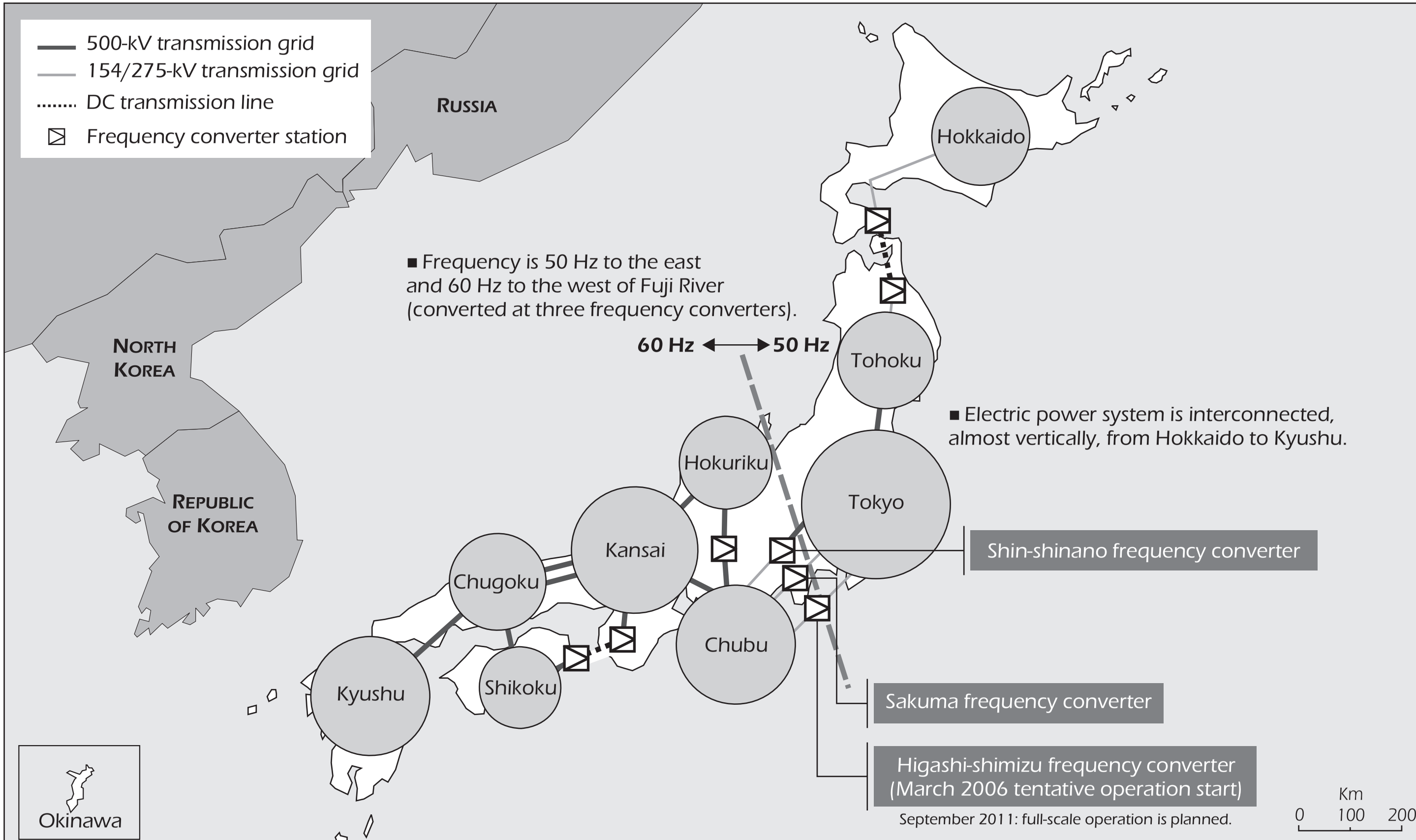
Grid access and investment

VIUs, in accordance with the ESCJ rules, take decisions as to whether to approve or deny connections of new generation or new load in their service areas. The ESCJ specifies rules on network access and transparency and within this framework, the VIUs publish the specific rules that will apply. With regard to the costs of access to the electric power systems from generation facilities, the entities operating the facilities, including the VIUs' generation facilities, shall bear the cost of "power lines" in its entirety for the initial access to the network from the generation facilities, whereas the entities operating the network shall bear the costs for system reinforcement of the related transmission network from the access point.

In 2005, several new high-voltage transmission projects are under construction or planned. There are currently 158 km of new 500-kV transmission lines under construction, with another 398 km planned. Some 145 km of 132- to

Figure 26

Transmission Interconnectors in Japan



Source: ESCJ.

275-kV lines are under construction, with another 115 km planned. None of these projects are across service area borders.

Customer switching

Customers representing 62% of the total load (all consumption above 50 kW) are eligible to freely choose their electricity supplier. Only customers representing 2.35% of this load (1.3% of total load) did choose a PPS as a supplier in FY2006, up from 1.96% in 2005. In addition, autoproducers are supplying their own demand and this represents 11% of the total. The level of switching has stagnated since mid-2006 after seeing an increasing trend over the previous 18 months. The customers that switch are mainly extra high-voltage (above 500 kW) and are mainly located in the Tokyo and Kansai areas. Almost no customers outside this segment have shifted supplier. There is only one example of a customer shifting from one VIU to another.

COSTS, ECONOMIC EFFICIENCY AND PRICES

WHOLESALE ELECTRICITY PRICES

The only transparent wholesale trade in Japan is the limited trade on JEPX. In 2006 average spot prices on JEPX were USD 81 per MWh. As is shown in the price duration graph in Figure 27, prices were relatively concentrated around the average, with no prices above USD 220 per MWh and no prices below USD 25 per MWh.

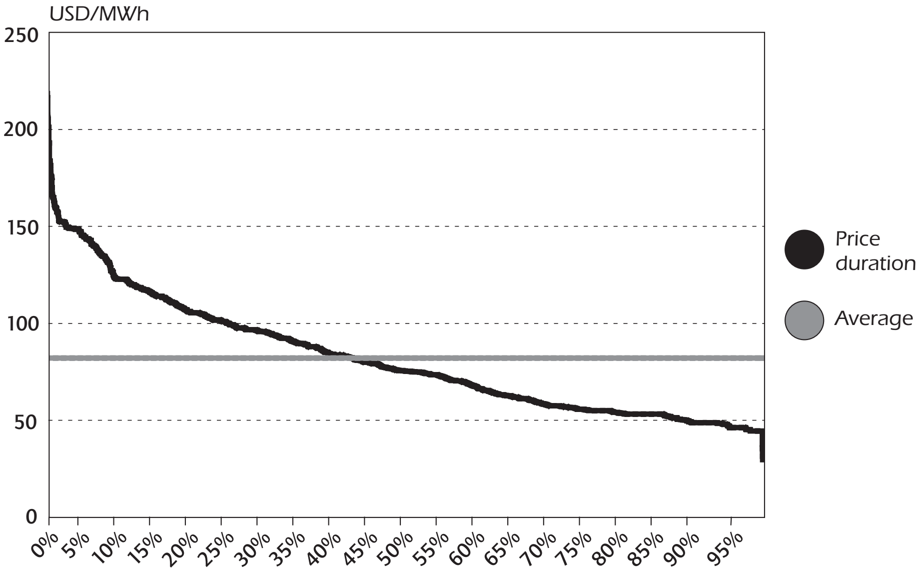
NETWORK COSTS

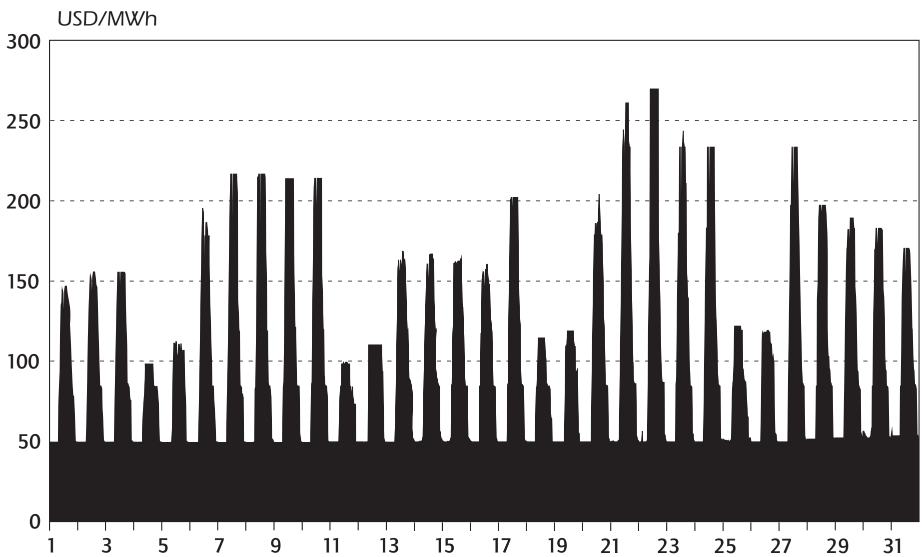
Investment in transmission decreased to about one-third of the expenditures spent from 1999 to 2003 and investment in distribution almost halved over the same period. Data on investment in transmission and distribution networks are only available before 2004, after which investment data are only aggregate. This was the timing of the required unbundling of accounts, which had the aim of enhancing transparency.

VIUs are required under the Electricity Business Act to functionally unbundle the natural monopoly parts of their businesses, namely network and system operation. One aspect of the rules is that accounts must be unbundled so that tariffs for network use can be separated from other charges, thereby allowing competitors a level playing field. The network tariffs charged to customers by incumbent suppliers should cover only network-related costs and be exactly the same as the tariffs charged by competing PPSs through the wheeling tariffs. The act requires the accounting separation in order to monitor whether or not the VIUs are using their network business to cross-subsidise their

Figure 27

JEPX Spot Prices in 2006 and August 2007





Source: JEPX.

competitive business. It is a legal obligation for VIUs to ensure fairness and transparency of their transmission and distribution department. On the other hand, the nearly complete absence of retail supplier switching – apart from extra high-voltage customers – could indicate that these customer segments are offered contracts below market prices.

RETAIL PRICES

End-use retail prices have decreased in Japan (see Figure 28). Prices had been among the highest in IEA countries, but during the past three to five years they have edged a bit lower, and are now only in the third-highest price group. Price differences between the ten VIUs have also decreased substantially. Several factors contribute to this development, including improvements in the efficiency of the sector, as can be partly illustrated by the decrease in employment. Higher levels of electricity are today delivered with 15% fewer employees than in 1995. Depreciation of assets have decreased substantially, partly reflecting that the sector is operating with a lower valued asset base, delivering the same output with less use of capital. The cost of the capital has also decreased substantially. The effect from the interest rate is external, largely outside the control of utilities. The better use of labour and capital and the decreased price differences between the ten VIUs can partly be explained by competitive pressure. The largest effect seems to have been triggered by the first step of reform, allowing independant power producery (IPPs) access to the generation market.

One of the reasons for the closing gap with other IEA countries is that prices in many countries have been on an increasing trend for the last two to three years after substantial decreases in previous years. In many cases, these increases are due to the effects of higher fuel costs. Lately in Europe, they are also a consequence of the price on CO_2 through the European Union's Emissions Trading Scheme (EU-ETS). In several of these markets, the wholesale electricity prices are determined dynamically on the basis of marginal costs. In such markets the cost of fuels as traded in reference markets flows directly through to the wholesale price of electricity, creating appropriate incentives in both the electricity and fuel supply chains. Since most electricity and fuel contracts in Japan are longer term, the effects of increasing fuel costs will probably take longer to have an effect on retail electricity prices.

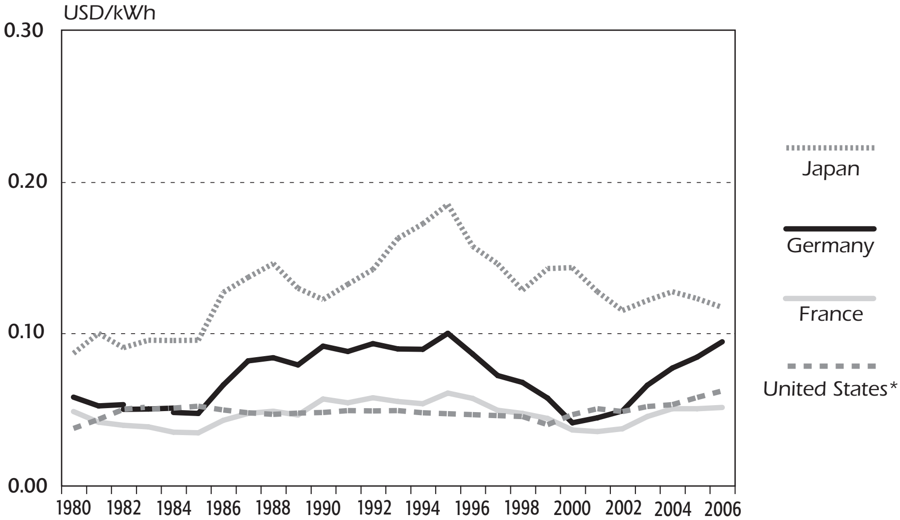
ELECTRICITY SECTOR EFFICIENCY

Security of supply is a driving force in Japan's energy policy and, according to polls, reliability of electricity supply is highly valued by electricity consumers. With interruptions of ten minutes in average per year, reliability in the Japanese electricity sector is among the highest in the world. Total installed capacity has an average margin of 54% over peak load during this decade. In 2003 this allowed the Tokyo Electric Power Company (TEPCO) the temporary closure of all of its 17 GW of nuclear power (28% of TEPCO's total installed capacity) without interrupting supply to any customers. Transmission and distribution losses stand at 4% to 5%, also among the lowest levels in the world, which could indicate that transmission and distribution systems are more extensive and robust than in most other countries.

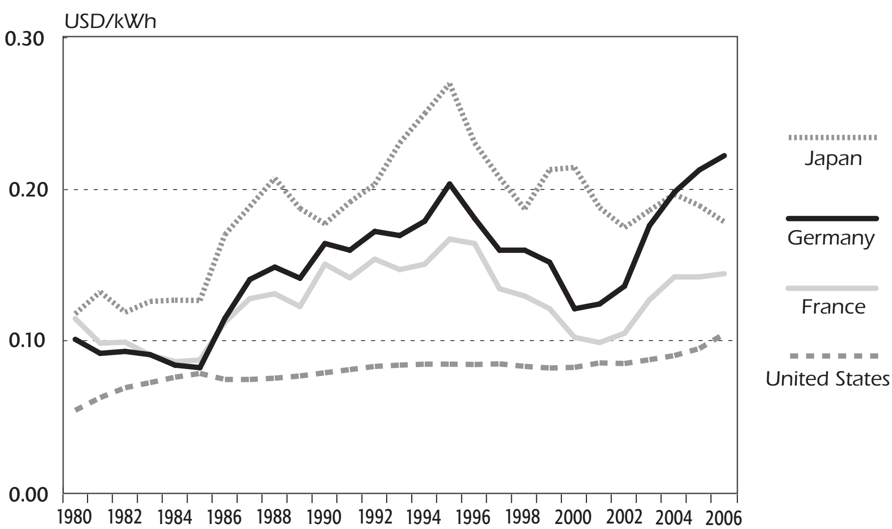
Figure 28

Electricity Prices in Japan and in Other Selected IEA Countries, 1980 to 2006

Industry Sector



Household Sector



*price excluding tax.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

Japanese electricity customers want reliability, but it is unclear what they are willing to pay for additional marginal reliability – and reliability comes at a cost. Since reliability of electricity supply has many of the attributes that are normally connected with public goods, consumers will not have incentives to disclose their true willingness to pay. It is unclear to what extent the Japanese electricity sector is aligned appropriately with the economic assessments of the actual marginal value of reliability.

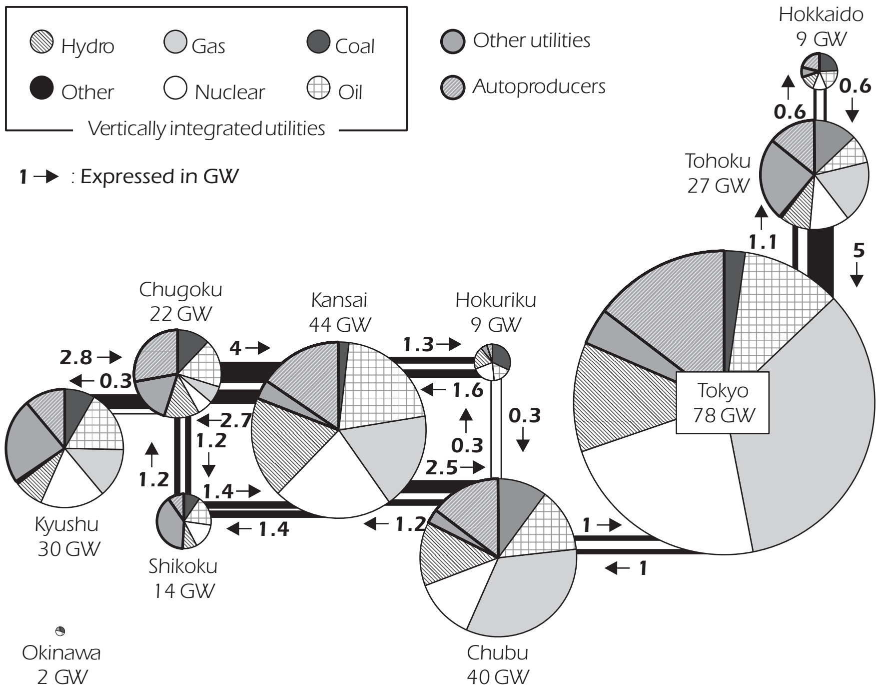
Electricity prices have decreased recently, from very high levels compared to other IEA countries. Competition is likely to be part of the explanation, putting pressure on utilities to perform better and enhance efficiency. As discussed, the increase in labour productivity is one indicator. Employment peaked in 2004/05, but has since decreased. Since 1999, it decreased by some 15%. Financial costs have also decreased. Depreciation decreased by 17% for the VIUs between 2000 and 2005 and interest rate expenditures decreased by 55%. Depreciation contributed to 18% of total expenditures in 2000 and interest to 7%. The strong impact from the decrease in these expenditures is the result of lower interest rates and improved use of capital. It may partly reflect that Japan is moving to another phase in the investment cycle, and that capital is being put to more efficient use such as shifting into less capital-intensive gas-fired plants.

As discussed, the effect from the interest rate is largely outside the control of utilities. More effective use of labour and capital plus the decreased price differential between the VIUs can partly be explained by competitive pressure. The first step of reform appears to have caused the largest effect – generation market access for IPPs.

Such developments indicate some of the positive pressures for a more balanced and efficient sector that competition is able to deliver. Great scope seems to exist for extending the benefits to be harvested from increased competition, in terms of improved sector efficiency and especially in terms of getting more security of supply with fewer resources. Figure 29 illustrates the allocation of generation resources and transmission interconnectors across the main regions in Japan. A liquid and dynamic market can quickly allocate the resources where they are of greatest use. For example, such trading would have allowed for a less costly management of the nuclear outages in 2003 and 2007, with less need for local reserve capacity. It has been pointed out that the VIUs have traditionally intended to provide self-sufficiency. As a result, all VIUs except the smallest have very similar compositions of generation portfolios. There is not great variation in resource endowments in the different regions of Japan, but the regional self-sufficiency approach is nevertheless likely to be a barrier to specialisation and excellence, also taking local conditions into account.

Figure 29

Generation and Transmission Capacity by Fuel Source



Sources: ESCJ, FEPC and IEA calculations.

CRITIQUE

The Japanese electricity system continues to be one of the most diversified in the IEA in terms of generation sources, which is of critical importance for a country deprived of natural resources like Japan. The sector has seen ongoing reform since the last IEA review and before. The establishment of the Electric Power System Council of Japan (ESCJ) has increased transparency and consistency in the rules for third-party access to transmission grids. Some new players have entered the market and retail prices have decreased, although price decreases are not only due to the effects of competition. The efforts of the government to maintain diversity and enhance competition are commendable. Some efficiency improvements have been harvested and reliability of electricity supply remains very high.

It is recognised that the stepwise approach to reform is undertaken with a view to carefully balancing the need to improve economic efficiency in the sector without jeopardising reliability of supply. Experiences from other IEA countries demonstrate that competition can also be an effective tool to meet reliability requirements – and at a lower cost – and so we urge the government to continue its efforts in this area. Effective competition creates incentives for improved performance, but also for dynamic interaction between all players in the supply chain. Within an adequately regulated framework, this has proven to make electricity systems responsive to changes and has allowed for efficient sharing of resources across jurisdictions. Scope seems to exist in Japan for further improving efficiency and reliability, particularly by better integrating the nine mainland Japanese supply regions.

The government needs to continue the reform process to be able to harvest these benefits. Consideration of the benefits, risks and costs should be based on modelling of optimal system dispatch across all Japanese supply and regions. Particular attention has been given to the effect reform may have on other energy policy priorities, such as the cost-effective development of nuclear power. It must, however, also be considered that partial liberalisation undermines transparency of incentives – including the incentives to invest. Such partial liberalisation risks undermining the regulatory certainty that investors require. Rather than trying to ensure that policy priorities are met in a partly regulated and partly competitive market, it is more efficient, transparent and secure to ensure policy objectives through direct incentives, such as reflecting the value of low-CO_2-emitting energy sources. Clarifying incentives for operation and investment through advancing market reforms is becoming urgent. Investment decisions taken today will affect future incentives and investment decisions to build, for example, nuclear power. Decisions by power producers and suppliers (PPSs) to build new combined-cycle gas turbines (CCGTs), for example, will change the competitive framework for new nuclear power plants.

Two of the most critical steps to further develop a dynamic and responsive business climate are to establish both a market-based balancing mechanism and a market-based mechanism to allocate inter-regional transmission capacity. Competitive pricing is the cornerstone in an incentive-based market framework and it is the feature that allows market participants to communicate and interact in a way that delivers optimal outcomes – pricing is the glue of competitive markets.

Turning first to the balancing system, the current charges for imbalances, set in accordance with the METI ordinance, are punitive and are not transparently related to real costs. Various market-based systems for balancing have been established successfully in several IEA countries. System co-ordination of inter-regional bids for regulating power would allow for the sharing of resources across Japan, enhancing reliability for the entire country. Greater regional co-operation and competitive bidding of operational reserves and other ancillary services would enhance the scope for the sharing of expensive reserves, but requiring due caution paid to the implications for system security.

There is frequent congestion on the weak interconnection between the two frequency zones. Considering the relatively low transmission capacity made available at most other regional interconnections, more frequent congestion in other parts of the transmission system are likely to appear when competition and trade are allowed to develop further. Japan has introduced various measures for congestion management, such as having the ESCJ establish rules for using transmission systems. In addition to these rules, transmission capacity should be allocated through market-based measures to ensure the optimal dispatch of generation resources across regions, and also to reflect the value of further enhancing interconnection capacity. There are several models for market-based allocation of transmission capacity that can be used as inspiration for the development of a system that meets the particular circumstances in Japan. A first step could be a simple explicit day-ahead auction where maximum available transmission capacity between the supply regions is auctioned one day ahead, for each half-hour interval of the following day. This will put a price on transmission congestion and will allow for better optimisation of all generation and transmission resources across a larger region.

A vertically integrated utility does not have incentives to create and operate a balancing market based on competitive bidding, and it does not have incentives to maximise available transmission capacity between supply regions. Some form of organisation of independent system operation is required for further enhancing the scope for seamless trade and co-operation. The Co-ordination of Load-Dispatching Operations Centre within the ESCJ could be a building block for such a development. The greater the responsibility within and across supply regions that such an independent organisation is given, the greater is the scope for improved efficiency, reliability and competition.

The establishment of ESCJ has improved the framework that regulates third-party access to transmission grids, but there is still only limited scope for independent market players to operate profitably in the market. In general terms, considering the weak level of unbundling of networks from generation and sales, the process of *ex post* regulation of network wheeling tariffs, based on METI ordinance and notification, also risks undermining transparency and leaves scope for cross-subsidisation. Currently rules and criteria for tariff revision are published in advance, giving utilities some necessary predictability, but a regulatory process fully based on pre-set performance targets (*i.e. ex ante* regulation) and regular scrutiny can be used to further enhance transparency and performance while maintaining incentives for adequate investment. *Ex ante* regulation forces the regulated entities to act within predetermined standards and boundaries, giving the regulatory body more regulatory clout.

Independent regulatory institutions in IEA countries have proven best to guarantee regulatory stability and fairness when they are independent from government. Japan has improved the level of independence of some areas of regulation through the allocation of roles and responsibilities of the Agency for Natural Resources and Energy under METI, the Japan Fair Trade Commission and the Market Monitoring Subcommittee, which also includes neutral experts. Japan could, hovewer, benefit from making the regulatory functions in METI fully independent as well as able to issue binding orders.

Effective competition will only develop over time and cannot always be guaranteed, even in a mature market. Ongoing market monitoring and surveillance is essential, both with a view to taking necessary legal action against abuse of market power but perhaps more importantly to establishing an understanding of the market functioning that allows for improving the regulatory framework. Japan should enhance market monitoring with the development of the market through a well-resourced market monitoring unit, for example within the realm of the Japan Fair Trade Commission. A tool to be considered in future cases involving possible competition violation or in negotiations with dominating market players is to commit large market players to become market makers, such as in the JEPX spot and forward markets. Market makers are committed always to give purchase bids and sale offers for particular products.

The government has generally chosen a strategy of stepwise reform measures based on light-handed regulation. Regulatory functions are only weakly independent compared to other IEA countries. Natural network monopolies are only weakly separated from generation and retail supply. Rules and market design that should lower transaction costs for free trade between market players are only sporadic compared to markets where trade is vibrant. Market reform at the current state has delivered some benefits, but it is unlikely that a dynamic and liquid market will be able to deliver within the present framework. The current partial liberalisation has muddied incentives for all market players, including the vertically integrated utilities. An approach based on voluntary agreements, such as with regard to environmental policy and nuclear power, is likely to face considerable challenges with such unclear incentives. The main hurdle for substantially advancing market reform appears to be that vertically integrated utilities have clear incentives not to allow for a level playing field with smooth and competitive electricity trade. For the same reason, these utilities have strongly objected to unbundling in most IEA countries. The government is encouraged to continue to strengthen the effective separation of transmission system operation from generation and sales activities, and to consider the merits of a long-term goal to fully unbundle transmission system operation and ownership. The government is also encouraged to continue to enhance the regulatory footprint in market design and network regulation.

Japan is in a good position to establish a well-functioning and highly competitive market for electricity, with ten vertically integrated electric utilities, and several other companies participating in the competitive segment of the electricity market. Several of the particular challenges that Japanese electricity supply is faced with could benefit greatly from the dynamics and responsiveness a competitive and liquid market can offer. Electricity demand is, for example, more volatile than in most countries in the world, so the scope and benefits in supporting price responsiveness from the demand side carry great value. Japan can harvest considerable benefits from further market reform, ultimately with a view to opening the market fully and giving all Japanese electricity consumers freedom of choice. Focusing the next steps to improve competition on improving trade and co-operation across Japan's regions is likely to bring considerable benefits in terms of improved dispatch, more reliable system operation in tight situations, less need for expensive reserve generation resources and, in general, from improved competition between otherwise isolated companies.

RECOMMENDATIONS

The government of Japan should:

- *Establish, as essential steps to further improve efficiency and reliability, fair and transparent mechanisms for:*
  - *Balancing power based on reasonable expenditures, where the fee system precludes any anti-competitive effect, and develop as quickly as possible a market-based system.*
  - *Allocation of inter-regional transmission capacity that is based on, among others, willingness to pay and that develops appropriately with the development of the market.*
- *Further develop independent system operations within the Electric Power System Council to guarantee effective regulated third-party network access and to ensure better inter-regional co-operation for efficiency and reliability.*
- *Continue to establish a regulatory framework for fully regulated third-party access; place greater emphasis on making network wheeling tariffs fair and transparent; consider the use of* ex ante *network regulation to improve performance; and ensure regulatory independence and predictability.*
- *Further develop ongoing market surveillance with the development of a transparently traded market in order to monitor the level of competition, including by full understanding of price formation.*

Japan's focus is on the development of renewable energy technology, both for domestic use and for export. The country has the second-largest amount of installed solar photovoltaics (PV) capacity in the world and is the largest producer of solar panels. Nevertheless, the country has a relatively small share of renewables in its supply mix, particularly when hydro is excluded. The two key promotion policies are technology support and a renewable portfolio standard (RPS), or renewables obligation, on the electricity sector.

SUPPLY-DEMAND BALANCE

PRIMARY ENERGY SUPPLY

According to IEA data, renewables make up over 3% of total primary energy supply, a share that has held roughly steady since 1990. As shown in Table 21, over 40% of renewables supply comes from hydro, followed by 36% from biomass and 17% from geothermal. A small amount, 3% and 1%, comes from solar and wind, respectively.

Table 21

Renewable Primary Energy Supply, 1970 to 2006

Unit: ktoe	*Hydro*	*Biomass**	*Geothermal*	*Solar*	*Wind*	*Renewables supply*	*TPES (all sources)*	*Renewables as share of TPES*
1970	6 484	0	0	0	0	6 484	257 585	2.5%
1980	7 593	0	774	0	0	8 367	345 846	2.4%
1990	7 680	4 775	1 576	1 168	0	15 199	443 788	3.4%
2000	7 504	5 180	3 099	808	9	16 600	526 663	3.2%
2001	7 238	4 847	3 175	747	22	16 029	518 163	3.1%

Table 21

Renewable Primary Energy Supply, 1970 to 2006 (continued)

Unit: ktoe	*Hydro*	*Biomass**	*Geothermal*	*Solar*	*Wind*	*Renewables supply*	*TPES (all sources)*	*Renewables as share of TPES*
2002	7 085	5 078	3 128	740	36	16 066	518 622	3.1%
2003	8 136	5 260	3 224	636	72	17 328	514 190	3.4%
2004	8 089	5 245	3 122	579	113	17 148	530 826	3.2%
2005	6 576	5 610	2 987	568	151	15 893	528 383	3.0%
2006	7 375	6 117	2 848	568	151	17 059	527 560	3.2%
Share of renewables supply in 2006	43.2%	35.9%	16.7%	3.3%	0.9%			
Share of TPES (total) in 2006	1.4%	1.2%	0.5%	0.1%	0.0%	3.2%		
Annual change (1990-2000)	–0.2%	0.8%	7.0%	-3.6%	n.a.	0.9%	1.7%	-0.8%
Annual change (2000-2006)	–0.3%	2.8%	-1.4%	-5.7%	58.9%	0.5%	0.0%	0.4%

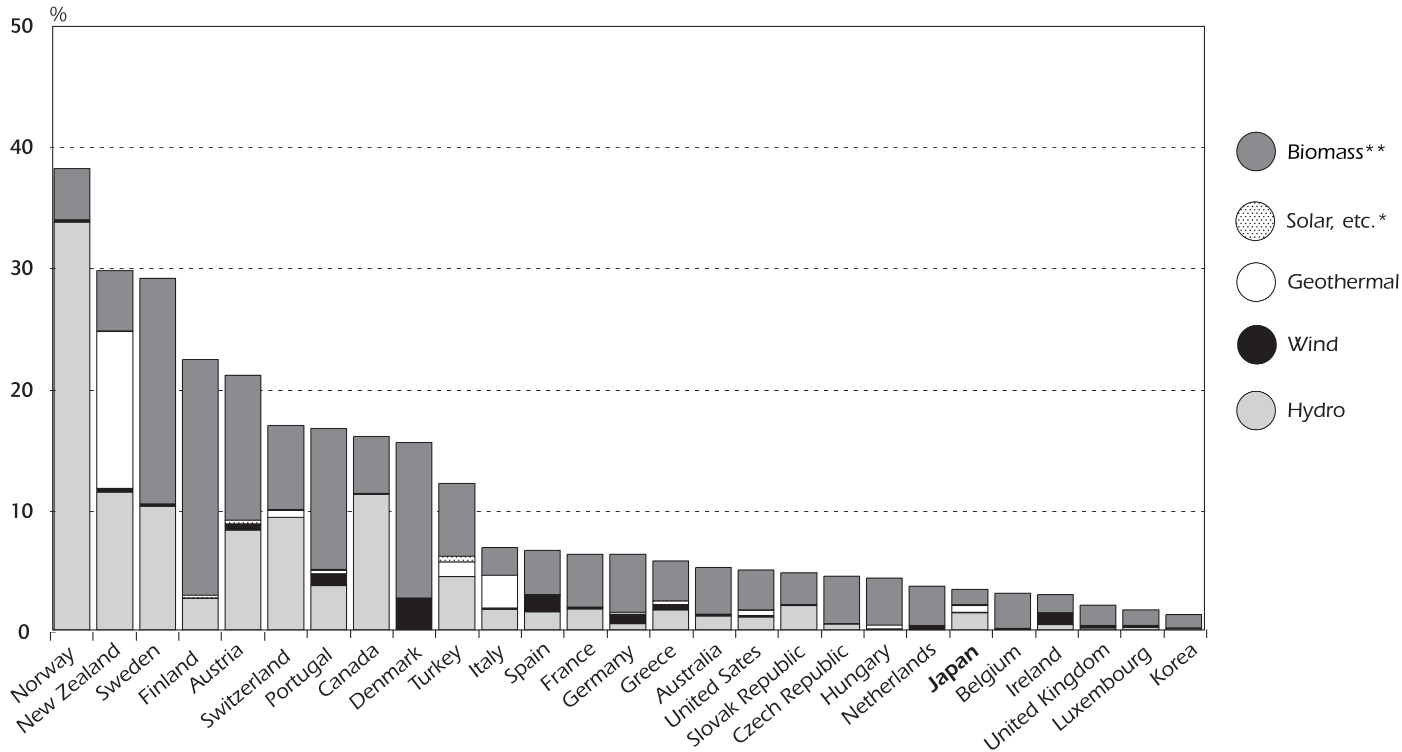
* excludes industrial and non-renewable municipal waste.

Source: *Renewables Information*, IEA/OECD Paris, 2007.

As shown in Figure 30, Japan has the seventh-lowest share of renewables in its TPES; it has the eighth-lowest share when hydro is excluded. It has relatively high rates of geothermal and solar as a share of TPES compared with the other 26 IEA countries. In contrast, it has the third-lowest share of biomass and the eighth-lowest share of wind in its TPES.

Figure 30

Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Countries, 2006*



*estimated. **excludes industrial and non-renewable municipal waste.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

ELECTRICITY

As shown in Table 22, about 10% of Japan's electricity is generated from renewables. Hydro has the largest share of renewable electricity generation, 79% in 2006. Biomass has the next-largest share, 17%, followed by geothermal (3%) and wind (2%). Solar photovoltaics (PV) have a negligible share. While the amount of hydro has increased since the 1970s, it has not done so at the same rate as overall growth in electricity generation. As a result, the share of renewables dropped from over 20% in the 1970s to about 10% since the 1990s. It has remained at around 10% since then.

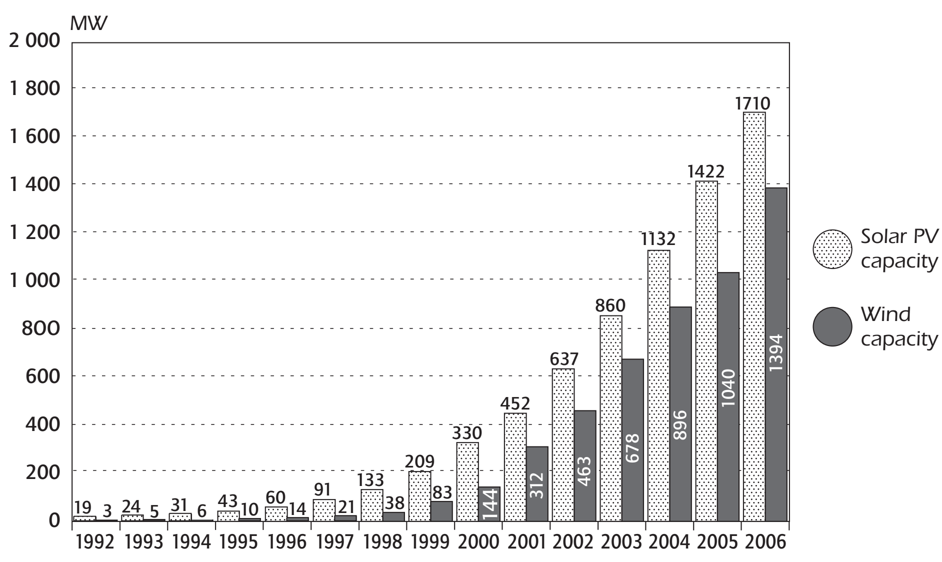
Japan has the second-largest amount of solar PV, at 1 422 MW in 2005, ranking just slightly behind Germany. Japan's wind capacity is the thirteenth-highest in the world at 1 394 MW. Installed capacity of both these technologies has grown rapidly in recent years (see Figure 31).

As is the case with a build-up of wind and other intermittent technologies in most countries, the utilities are concerned that greater expansion of these technologies could have adverse consequences on the grid.

Japan's production of solar panels has been the largest in the world since 1999 and three of the top five producers are Japanese companies.

Figure 31

Installed Capacity of Wind and Solar PV, 1992 to 2006



Source: Country submission.

Table 22

Renewable Electricity Generation, 1970 to 2006

Unit: GWh	*Hydro*	*Biomass**	*Geothermal*	*Wind*	*Solar PV*	*Renewable electricity generation*	*Electricity generation (all sources)*	*Renewables as share of total electricity generation*
1970	75 400		0	0	0	75 400	354 800	21.3%
1980	88 292	0	900	0	0	89 192	572 531	15.6%
1990	89 305	9 616	1 741	0	1	100 663	835 514	12.0%
2000	87 253	12 762	3 348	109	2	103 474	1 048 639	9.9%
2001	84 166	12 589	3 432	252	2	100 441	1 029 834	9.8%
2002	82 378	13 471	3 374	415	2	99 640	1 048 371	9.5%
2003	94 607	14 390	3 484	833	2	113 316	1 037 511	10.9%
2004	94 063	14 684	3 374	1 310	2	113 433	1 067 160	10.6%
2005	76 470	16 176	3 226	1 754	1	97 627	1 088 435	9.0%
2006	85 760	18 536	3 077	1 753	1	109 127	1 090 548	10.0%
Share of renewable electricity generation in 2006	78.6%	17.0%	2.8%	1.6%	0.0%			
Share of all electricity generation in 2006	7.9%	1.7%	0.3%	0.2%	0.0%	10.0%		
Annual change (1990-2000)	–0.2%	2.9%	6.8%	*n.a.*	7.2%	0.3%	2.3%	–2.0%
Annual change (2000-2006)	–0.3%	6.4%	–1.4%	58.9%	–10.9%	0.9%	0.7%	0.2%

* excludes industrial and non-renewable municipal waste.

Source: *Renewables Information*, IEA/OECD Paris, 2007.

TRANSPORT FUELS

There is no consumption of biofuels (such as biodiesel or bioethanol) in the transport sector. Nominal production capacity is in place in a few trial plants. As touched on in Chapter 9, a number of experimental biofuels projects are in place throughout the country.

POLICIES AND MEASURES

TARGETS, STRATEGIES AND OBJECTIVES

In order to accelerate the introduction of new energy, in June 1997 Japan established the Law Concerning Special Measures to Promote the Use of New Energy (the New Energy Law), which specifies the roles of energy users, the government and other parties concerned and provides for financial assistance.

Japan has set a target, previously established in June 2001 and confirmed in March 2005, for the introduction of new energy[12] equal to 19.1 million kl of crude oil-equivalent, approximately 3% of TPES by 2010. A target similar to this one was also set in April 2005 as part of a plan for achieving the country's CO_2 emissions reduction target under the Kyoto Protocol. The details of the target, including technology-specific sub-targets, are outlined in Table 23.

As indicated in note 1 of Table 23, Japan aims for an annual consumption of 500 000 kl of crude oil-equivalent of biomass-derived fuels for transport use, including bioethanol, by 2010 in its plan to achieve its greenhouse gas emissions reduction target under the Kyoto Protocol.

In April 2003 the Special Law on the Use of New Energy by Electric Utilities came into effect. The law puts in place a renewable portfolio standard (RPS), or renewables obligation, to be met by electric utilities and other electricity retailers (self-generation by industry is excluded). Under the RPS, in March 2007 the target volume for new energy-derived electricity for 2014 was set at 16 billion kWh (large hydro and most conventional flash-type geothermal are excluded). Utilities and electricity retailers can meet this obligation with a mix of new and renewable fuels – there are no minimum levels required for particular fuels. Estimating that total electricity generation will be about 1 200 TWh in 2014, this is equivalent to about 1.3% of total generation. In 2006, electricity generation from renewables covered almost 10% of generation, but only 1.6% when hydro is excluded.

12. A review conducted between July 2005 and October 2006 categorised "new energy" as the types of renewable energy whose diffusion needs assistance. In addition, new technologies that could help to secure the supply of renewable energy, markedly improve energy efficiency and diversify energy sources were identified as advanced utilisation technologies for innovative energy.

Table 23

2010 Renewables Targets and Current Progress

Supply side		*FY2005 level* Kilolitre (kl) of oil-equivalent	*FY2005 level* kW-equivalent (for power generation)	*FY2010 target* Kilolitre (kl) of oil-equivalent	*FY2010 target* kW-equivalent (for power generation)
Power generation	Photovoltaic power generation	347 000	1 422 000	1 180 000	4 820 000
	Wind power generation	442 000	1 078 000	1 340 000	3 000 000
	Waste and biomass power generation	2 520 000	2 010 000	5 860 000	4 500 000
Heat	Solar thermal use	610 000		900 000	
	Thermal use of waste	1 490 000		1 860 000	
	Biomass thermal use	1 420 000		3 080 000[1]	
	Unused energy[2]	49 000		50 000	
	Black liquid, waste material, etc.	4 700 000[3]		4 830 000	
Total		**11 580 000**		**19 100 000**	
Rate in total primary energy supply		2.0%		3.0%	

Demand side	*FY2005 level*	*FY2010 target*
Clean energy vehicles[4]	326 000	2 330 000
Natural gas co-generation (*i.e.* CHP; kW)	3 590 000	4 980 000
Fuel cells (kW)	10 000	2 200 000

Note: Each breakdown of the power generation and heat fields are a rough standard for achieving the target.

1. includes biomass-derived fuel (500 000 kl) for transport. **2.** includes snow ice cryogenic energy. **3.** 2004 data. Black liquid and waste classified as part of biomass and partially include those used to generate power. The introduction volume of black liquid, waste material, etc., depends on the production level of pulp and paper in an energy model, so it is tentatively calculated using the model endogenously. **4.** includes electric, fuel cell, hybrid, natural gas, methanol and diesel-alternative LPG vehicles.

Source: Country submission.

Japan's Basic Plan for Energy does not have specific policy objectives or targets for renewables.

POLICIES AND MEASURES

Electricity

Under the RPS law, an obligation rate is assigned to each of Japan's ten electric utilities, along with new entrants such as power producers and suppliers (PPSs). The total obligation has been determined up to 2014, while the obligation rate applied to each utility to achieve that target is set as a percentage of the utility's electricity sales in the previous year. Electric utilities and other electricity retailers covered by the RPS have the same renewables obligation. For example, in 2006 the obligation rate was 0.50% of the previous year's sales volume, equivalent to about 4.4 billion kWh. Table 24 gives the obligation amounts up to 2014. Companies are allowed to bank any excess renewables for the next year. In 2006, all utilities met their obligation. Most companies exceeded their obligation, with a total of 6.5 billion kWh of electricity. This includes both amounts to be credited to the 4.4 billion kWh obligation in 2006 and amounts that can be carried over to the following year if necessary.

Like traditional renewable portfolio standards in use elsewhere, such as in the United States, Australia and Europe, the Japanese RPS allows for trading between utilities. Only limited trading data are disclosed by the government. Utilities can choose to meet the obligation through their own generation or by purchasing from other generators that have certified facilities both in their own region and in other regions. The banking provision allows for trading between years.

As in other RPS models, Japan separates the so-called "green" portion of electricity generation as a specific product from the electricity itself. Renewable electricity generators create green RPS credits from their generation and can sell the credits in the RPS market while selling the electricity to the power market, to different buyers.

Indirectly related to the RPS, some solar PV also receives direct assistance, similar to a feed-in tariff. The rate paid for solar PV was JPY 19 to JPY 23 per kWh in 2006. Under the excess power purchasing menu, electric utilities voluntarily purchase excess power primarily from residential generators that self-supply and sell their excess power back to the grid. The amount equivalent to the "green" portion of this electricity is included in the obligation amount assigned for each utility under the RPS (*i.e.* no electricity self-supplied by a residential user counts towards the utilities' obligation, only the excess supply purchased).

Table 24

Renewables Obligations, 2003 to 2014

Unit: billion kWh	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Renewables obligation amount	3.28	3.60	3.83	4.44	6.07	7.56	9.46	12.20	13.15	14.10	15.05	16.00
Total renewable electricity	4.06	4.91	5.58	6.51								
Renewables obligation as a share of total electricity generation*	0.31%	0.34%	0.35%	0.42%								

*This estimate is based on the renewables obligation as a share of total electricity generation. Because the renewables obligation only covers a subset of electricity generation (*e.g.* it excludes self-generation), this share is lower than the obligation rate applied to generators.

Source: Country submission.

Transport fuels

Japan has set an upper limit on the ethanol content of gasoline at 3% (E3) and biodiesel in diesel at 5%. The limit is set with a view to minimising the potential negative effects of biofuels mixing, including impacts on vehicle safety and exhaust emissions.

Promotion policies for biofuels are generally technology focused, with the government funding demonstration projects. The government does not have a biofuels mixing obligation in place. It is working to set up a scheme to exempt the gasoline tax and local road tax in proportion to biofuels in the fuel mixture. This policy would be implemented during 2008 and is currently scheduled to end in March 2013.

Currently, ten bioethanol projects are in place in various regions in Japan. The government has also undertaken to develop a concept bioethanol island on Miyakojima. It will enter full operation in 2008. The project aims to produce bioethanol from sugar cane and change all gasoline consumed on the island (about 24 000 kl per year) to E3. There are about 20 000 vehicles on the island.

BUDGET

The 2007 budget for renewables and new energy is JPY 140.8 billion, including the budgets from all ministries. Table 25 provides a breakdown of budget items from METI. In general, funding has declined somewhat from its peak in 2004.

Table 25

METI Budget for Renewables and New Energy, 2006 and 2007

	Category	Projects	Budget for 2007 (budget for 2006 in parentheses)
Technology development	To conduct technology development to reduce the cost of new energy technology and improve performance	• New energy technology R&D: JPY 4.58 billion • Fuel cell-related projects: JPY 14.8 billion • Strategic technology development for commercialisation of next-generation storage battery: JPY 4.9 billion	Approx. JPY 33.1 billion (approx. JPY 40.8 billion)
Demonstration testing	To implement demonstration tests based on technology development already implemented, with a view to identify and resolve problems that may hamper the commercialisation of new energy technology and verify its effectiveness	• New energy technology field test project: JPY 10.82 billion • Demonstration project for introduction of biomass-derived fuel: JPY 0.95 billion • E3 regional distribution standard model project: JPY 0.76 billion • Solid oxide fuel-cell demonstration research: JPY 0.77 billion	Approx. JPY 24.5 billion (approx. JPY 28.9 billion)
Introduction promotion	To create initial demand for new energy at the initial stage of commercialisation in order to induce mass production and early market growth and promote the use of new energy by supporting efforts of companies and local governments to introduce such energy	• Support for new energy business enterprises: JPY 31.58 billion • Projects related to regional new energy planning: JPY 1.33 billion • Promotion of regional introduction of new energy: JPY 4.47 billon • Projects related to wind power grid connection: JPY 2.68 billion • Support for introduction of clean-energy vehicles: JPY 1.98 billion	Approx. JPY 57.7 billion (approx. JPY 68.4 billion)

Source: Country submission.

The government estimates that the cost of achieving the RPS goal of 16 billion kWh in 2014 will be JPY 110 to JPY 130 billion. This is equivalent to the excess cost paid by consumers in 2014 for the renewable electricity generation mandated by the RPS law (and not covered by the government).

PRICES

METI conducts annual surveys on prices for renewables, the results of which are presented in Table 26. These surveys ask retailers about the selling price for renewable electricity. The estimates indicate that prices for wind, while higher than for other renewable resources, are continuing to decline. Prices for biomass have increased in recent years.

Table 26

Prices for Selected Renewables, 2003 to 2006

Unit: JPY/kWh (weighted mean price)		*2003*	*2004*	*2005*	*2006*
"Green" portion of renewable generation plus electricity	Wind power	11.8	11.6	11.0	10.7
	Hydro	8.1	8.5	8.4	8.4
	Biomass	7.2	7.5	7.6	7.7
"Green" portion of RPS only (sold independent of electricity)		5.2	4.8	5.1	4.9

Note: As only a few independent generators install PV systems on a commercial basis – most PV is for self-generation – solar is not included in this table, though it can be traded under the RPS. Its price is determined on the basis of the rate for power sold by electric utilities. The household rate was about JPY 19-23/kWh.

Source: Country submission.

CRITIQUE

Japan is a recognised world leader in the field of renewables. The country has the world's second-highest level of installed capacity of solar PV and has been the world's largest producer of solar panels since 1999. Three of the world's five largest solar PV companies are Japanese. Perhaps more notably, the government is investing very large amounts in R&D into new and renewable energy technologies, as discussed more fully in Chapter 9. This good progress in technology and manufacturing is bringing benefits to the international arena, helping the market to grow and reducing costs for clean technologies, and thereby contributing to greenhouse gas reductions on a global scale. Building on this strong position in renewables on the international market, improvements to domestic policy are recommended.

Japan has set detailed technology-specific targets for renewable energy supply until 2010, but has only set one longer-term target, specifically for renewable electricity generation. These 2010 targets call for a 65% increase in total renewables supply between 2005 and 2010. Despite the low starting level, these are ambitious targets for the very near term, with a large increase in a short period of time. To build on this framework, the government should now set longer-term targets. Investors will require the certainty of targets that go beyond the next two years. Furthermore, a longer time horizon can help bring down overall compliance costs as investors can better plan and tailor the needed investments. With respect to the level of the targets, the high priority the government gives to security of fossil fuel supply should also be expanded to renewables supply. These longer-term targets should aim for the same level of ambition as is seen for fossil fuels and in the current targets that are about to expire. We urge the government to set longer-term targets for renewable energy supply, at the same time avoiding too many technology- or sector-specific targets as these diminish investor flexibility and can raise overall costs.

The two key means of promoting renewables in Japan are technology support and a renewable portfolio standard (RPS). The country is a world leader in technology funding and development, spurring development of a global market for sustainable energy technologies. This subject is discussed more fully in Chapter 9. Turning to the RPS, which specifically promotes renewable electricity generation, in 2003 the government established quota levels for all utilities and other electricity retailers to meet, with procurement quotas rising from 3.3 billion kWh in 2003 to 16 billion kWh in 2014. First, we commend the government for taking advantage of a prescriptive policy approach that creates a market for renewables. We are also pleased to see the government set longer-term targets for renewable electricity generation. With a goal of 16 billion kWh in 2014, and an estimated total electricity supply of about 1 200 billion kWh in 2014, this is equivalent to less than 2% of total electricity generation. We recognise that domestic potential for renewables deployment depends on geographic and other factors – and is not the same for all countries. Furthermore, it is commendable that the average annual growth rate of the RPS targets will move from an average of 11% between 2003 and 2006 to an average of 17% between 2006 and 2014. Nevertheless, room may exist for the government to set more ambitious longer-term targets for renewable electricity, ensuring that the targets for renewable electricity are broadly aligned with those for energy supply and that the scheme’s cost-effectiveness is a key factor. To allow for continued policy evaluation in order to enhance the effectiveness and efficiency of the scheme, greater transparency of trading data will be necessary.

The RPS in place lays a solid foundation for cost-effective expansion of renewable electricity. The RPS quotas do not set technology-specific targets, and thus give utilities flexibility in how they meet their targets. The advanced clean energy industry in Japan can take advantage of this flexibility to develop new, innovative and less expensive means of meeting the overall renewables target. The system also allows banking of credits, allowing investors to spread the costs of compliance. Nevertheless, the system is certainly a large investment, with the government estimating it to cost JPY 110 to JPY 130 billion by 2014. One means to lower the overall cost would be to encourage greater trading between utilities and further development of a certificate scheme, so that renewable power is produced where it is cheapest.

One challenge foreseen by the government is the effects on the electricity grid of a larger introduction of renewables. Many IEA countries are facing this challenge, and experience and new research suggest that grids are able to handle higher levels of intermittent sources than previously thought. Many factors affect this capacity. For example, greater interconnection capacity between regions allows for higher levels of intermittent sources to be connected to the grid because grid operators can rely on the interconnections to carry imports or exports when necessary. Turning to the experience of other IEA countries, we encourage the government to look further into the costs and benefits of providing expanded connections to the grid for renewables, which would be helpful in developing cost-effective renewables deployment. Sound market rules and regulations are critical to sending the right signals for proper renewables deployment and interconnection. To that end, the government should continue to streamline and harmonise market rules on grid interconnections, with a view to minimising barriers to entry and encouraging cost-effective renewables connections.

While there is currently negligible penetration of biofuels for transport in Japan, the government is working on a number of projects for their use for transport, targeting technology development as the key means to promote biofuels. In addition, the government plans to implement a scheme to exempt transport fuels from the gasoline and local road taxes in proportion to the amount of biofuels in the mix. At present the government is concerned about the overall costs and benefits of biofuels. As in a number of IEA countries, there are fears that the use of biofuels for energy purposes using existing technologies in some cases may not be sustainable and that expanded use would require imports. Furthermore, there are questions about the impact of greater consumption of biofuels for transport on domestic and international food markets as land currently devoted to food production would be taken over for fuel development. Nevertheless, the potential benefits of biofuels – reduced CO_2 emissions, reduced oil imports, greater supply diversity and greater energy import diversity – merit their continued analysis, particularly with respect to second-generation biofuels.

RECOMMENDATIONS

The government of Japan should:

- *Further investigate the potential for domestic deployment of renewables, including the need for long-term targets.*
- *Build on the RPS obligation for renewables with a view to setting, and potentially increasing, the quota levels cost-effectively.*
- *Continue to streamline and harmonise market rules and regulations to ensure sufficient access in order to connect greater amounts of renewable energy to the electricity grid.*
- *Analyse further the potential for cost-effective and sustainable production, import and use of biofuels in gasoline and diesel, with a view to second-generation biofuels.*

NUCLEAR ENERGY

Japan is a world leader in nuclear energy. Nuclear power provides about 30% of its total electricity, a share that may increase further in the future. In recent years, the industry has been affected by a number of issues that have eroded public confidence in the sector. Government regulation, which has historically been very conservative, has therefore continued in this vein, leading to relatively short intervals between mandatory inspections and relatively long off-line periods. Consequently, Japan's capacity factors for nuclear are below world best practice.

OVERVIEW

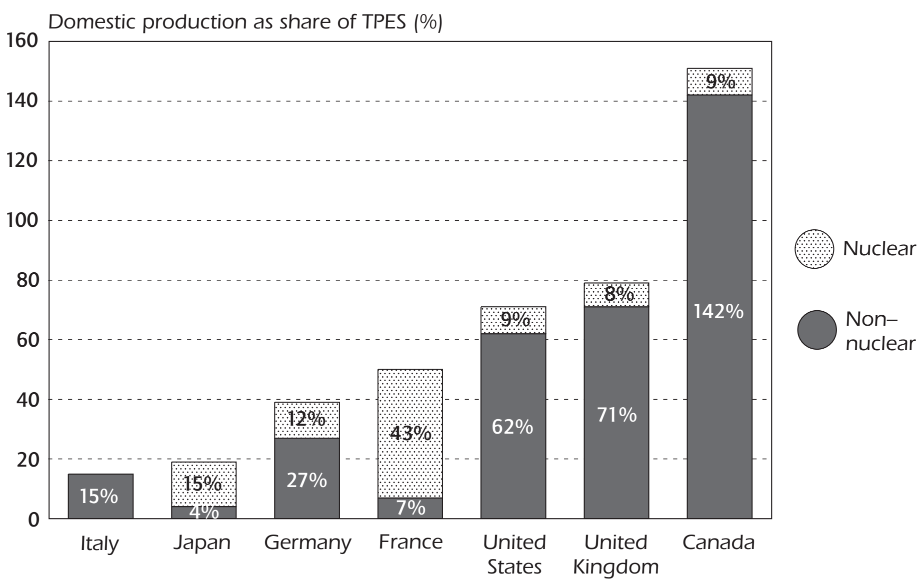
BACKGROUND

Nuclear power is a key strategic element of Japan's energy policy and, as such, it has received long-term government support. Japan, as the only country ever to incur an atomic bomb attack, has promoted research, development and use of nuclear energy for peaceful purposes only, in line with the Atomic Energy Basic Law of 1956.

As shown in Figure 32, Japan has the lowest energy self-sufficiency ratio of any of the major industrialised countries. In the absence of nuclear power,

Figure 32

Energy Self-Sufficiency in Japan and in Other Selected IEA Countries, 2006*



* estimated.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

Japan's energy self-sufficiency ratio would be only 4%. Nuclear power can be considered as a quasi-indigenous source of energy, raising Japan's self-sufficiency ratio to 19% of TPES in 2006.

CURRENT STATUS OF NUCLEAR POWER

There are currently 55 commercial nuclear reactors in operation in Japan, with a total capacity of 49 500 MW_e (see Figure 33). In 2006, this fleet generated 291 542 GWh of electricity. Of these 55 reactors, 28 are boiling water reactors (BWRs), 4 are advanced boiling water reactors (ABWRs) and 23 are pressurised water reactors (PWRs). A further two units are under construction (one PWR and one ABWR), and 11 additional units are in the planning stage (see Table 27 and Figure 33).

Table 27

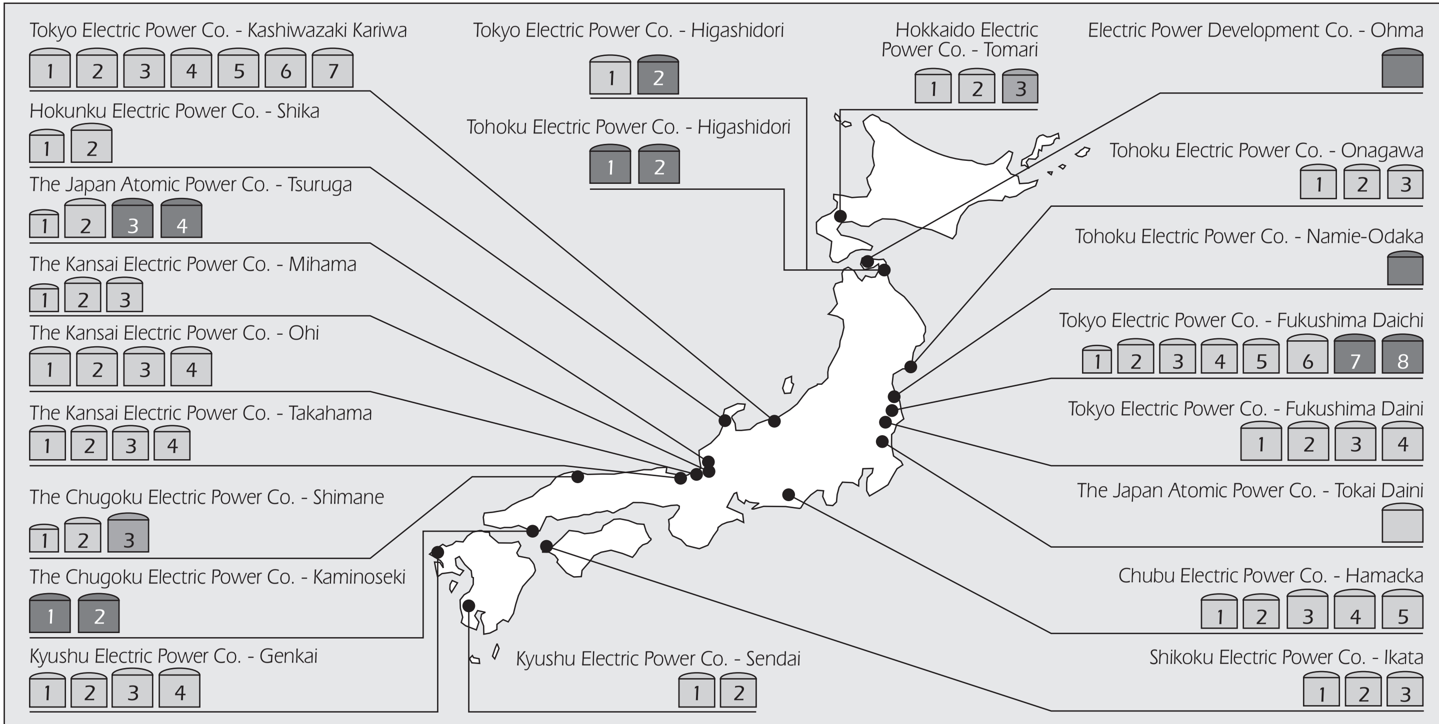
Future Nuclear Capacity Construction Programme

Plant name	*Operator*	*Status*	*Location*	*Output (MW)*	*Type*
Tomari 3	Hokkaido	Under construction	Hokkaido	912	PWR
Shimane 3	Chugoku	Under construction	Shimane	1 373	ABWR
Namie Odaka	Tohoku	Construction preparations	Fukushima	825	BWR
Higashidoori 2	Tohoku	Construction preparations	Aomori	1 385	ABWR
Fukushima 1-7	Tokyo	Construction preparations	Fukushima	1 380	ABWR
Fukushima 1-8	Tokyo	Construction preparations	Fukushima	1 380	ABWR
Higashidori 1	Tokyo	Construction preparations	Aomori	1 385	ABWR
Higashidori 2	Tokyo	Construction preparations	Aomori	1 385	ABWR
Kaminoseki 1	Chugoku	Construction preparations	Yamaguchi	1 373	ABWR
Kaminoseki 2	Chugoku	Construction preparations	Yamaguchi	1 373	ABWR
Ohma nuclear	J-Power Japan	Construction preparations	Aomori	1 383	ABWR
Tsuruga 3	Japan Atomic	Construction preparations	Fukui	1 538	APWR
Tsuruga 4	Japan Atomic	Construction preparations	Fukui	1 538	APWR
Total (under construction)				**2 285**	
Total (construction preparations)				**14 945**	

Source: Country submission.

Figure 33

Nuclear Power Plants in Japan



	Number of units	Total output (MW)
In operation	55	49 580
Under construction	2	2 285
Preparing for construction	11	14 945
Total	68	66 810

Source: Country submission.

In addition, three other non-commercial facilities are of particular interest, as described below.

The first power demonstration reactor, JPDR, was shut down in 1976 and completely decommissioned from 1986 to 1996 as a demonstration and technology development project.

In terms of future systems development, the Japan Atomic Energy Agency owns a 280-MW_e sodium-cooled fast-breeder reactor, Monju, which achieved first criticality – the point at which power is first produced – in 1994. However, in December 1995 the reactor suffered an accident when sodium leaking from the secondary (non-radioactive) circuit caused a significant fire. The accident and insufficient transparency by the operator (at the time, the Power Reactor and Nuclear Fuel Development Corporation) associated with the event caused significant public disquiet. A series of court cases resulted in a final decision by the Supreme Court to allow restart. The declared intention is to restart the plant, and modifications to the design of the facility are being implemented following the lessons learned from the leakage and fire. The restart is planned for 2008.

The Japan Atomic Energy Agency (JAEA), following a reorganisation, owns and operates the high-temperature test reactor (HTTR). This facility is a 30-MW_{th} reactor that does not generate electricity, but is used for basic research on high-temperature reactor engineering. Its particular significance is that it is being used to promote the development of hydrogen production, a technology that holds promise for future CO_2-free energy systems, particularly transport.

POWER PLANT AGE

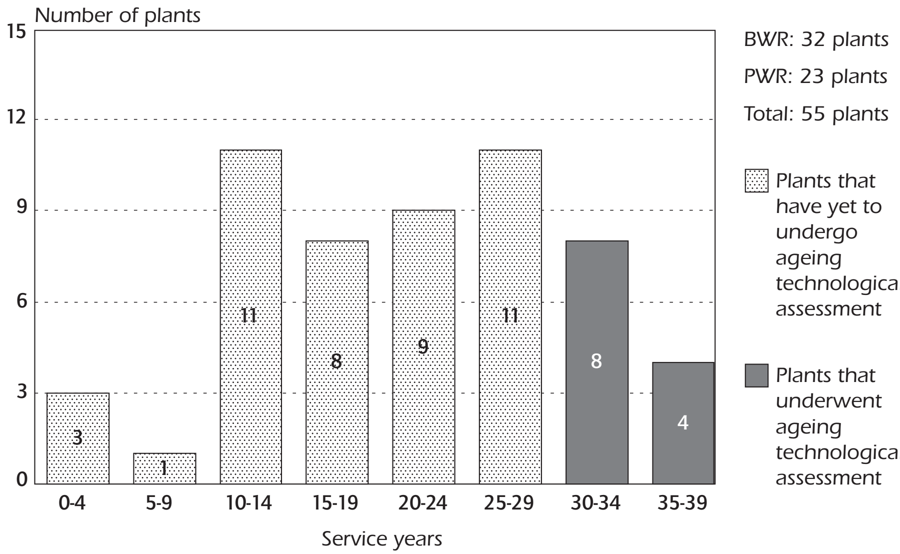
Figure 34 shows the ages of the current fleet of 55 reactors, a significant number of which have or will soon reach 30 years of operation or more.

PERFORMANCE

In terms of operational performance, the number of automatic shut-downs is often used as one of the indicators (though not the only one) of good performance. On this basis Japan does well, as shown in Figure 35, which compares its performance with the good performance of the largest national fleet of operating reactors.

Figure 34

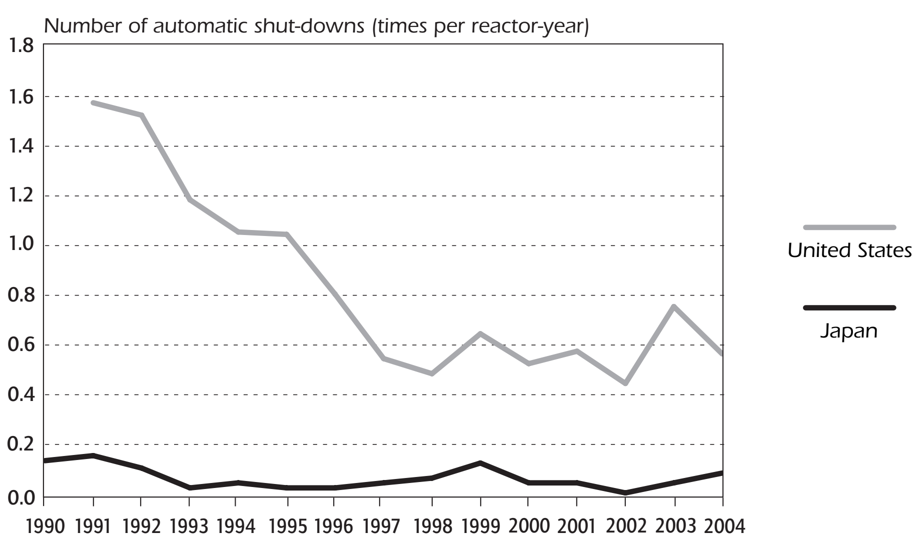
Number of Nuclear Power Plants vs. Service Years, August 2007



Source: Country submission.

Figure 35

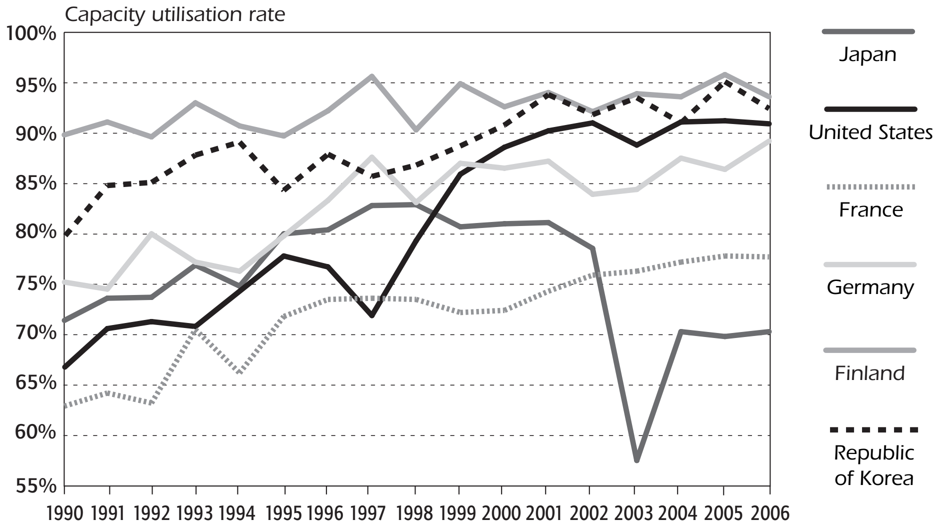
Number of Automatic Shut-downs in Japan and the United States



Source: Country submission.

Figure 36

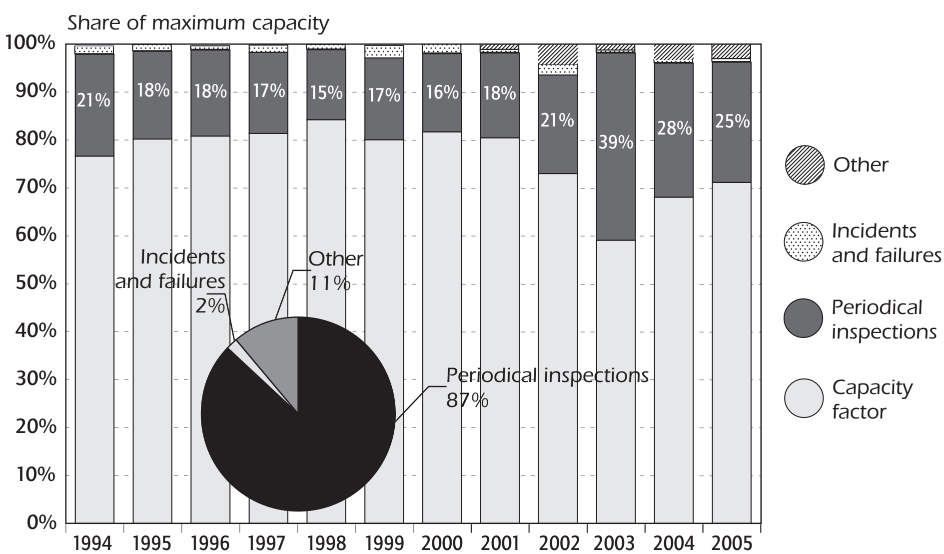
Capacity Utilisation Comparisons



Source: Country submissions.

Figure 37

Causes of Nuclear Plant Unavailability in Japan



Source: Japan Nuclear Energy Safety Organisation, "Current Status of Nuclear Facilities in Japan, 2006", Section A-1-C, available from www.jnes.go.jp/english/database/pdf/2006/a-2-c.pdf.

However, in terms of operational availability the performance in Japan is far less good, as seen by the capacity factors shown in Figure 36 (note that the availability of French reactors is reduced because of the need for load following in some plants, where output is reduced to match periods of lower demand, given the very high percentage of nuclear generation in France).

One cause of the low capacity factors is the mandatory inspection intervals for reactors, which are limited to no longer than 13 months. Shut-downs are also long in comparison to practice elsewhere and represent the majority of the loss of generating availability (see Figure 37). This length is partly due to a continuing policy of time-based maintenance, as opposed to reliability- and condition-based maintenance.

POLICY FRAMEWORK AND REGULATION

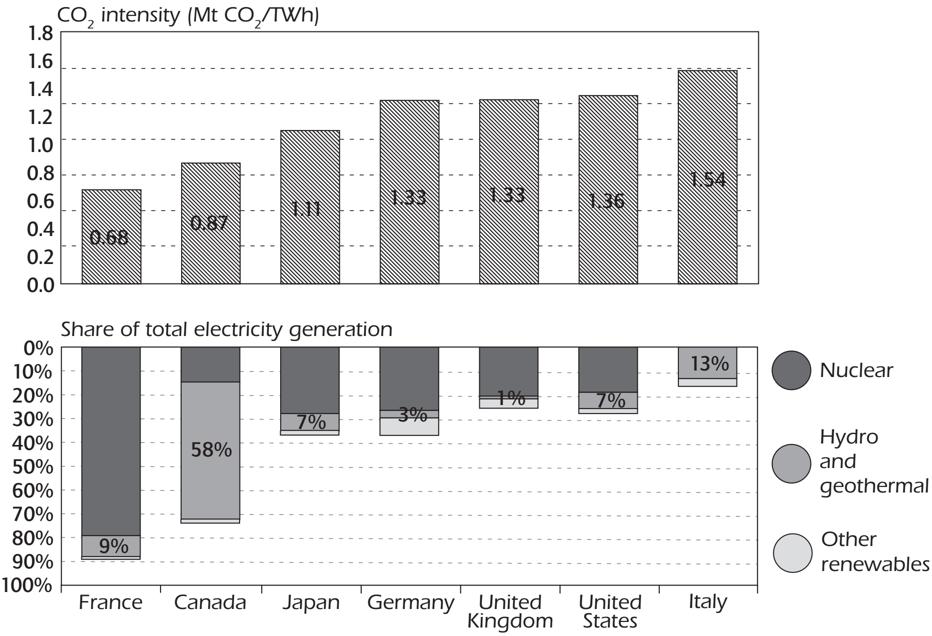
BACKGROUND

A further and more recent factor for the strategic importance of nuclear power to Japan has been the increasing worldwide concern with respect to carbon dioxide emissions and climate change over the last two decades. Nuclear power, as a virtually CO_2-free generation source, is a significant component in holding down Japan's overall emissions of CO_2 and is expected to be a continuing contributor in this respect. Figure 38 shows the CO_2 emissions intensity for Japan's electricity sector in comparison to a number of other major developed world economies. With relatively little hydropower, Japan's nuclear generation enables it to maintain a modest CO_2 intensity.

In regard to these two factors, the Kyoto Protocol Target Achievement Plan (agreed by the Cabinet in April 2005) notes that "nuclear power generation does not emit carbon dioxide in the power generation process, so it occupies an extremely important position with respect to the promotion of global warming countermeasures. In future, with the assurance of safety as the major premise, the government will work towards the further utilisation of nuclear power generation and will steadily promote public sector-private sector co-operation for nuclear power generation as a key power source". The subsequent Energy Master Plan (agreed by the Cabinet in March 2007) notes that "nuclear energy needs strict safety management in consideration of its risk. However, as nuclear energy contributes to stable supply of electricity and has superior characteristics in terms of measures against global warming, nuclear power generation will be promoted as a main power source in the future, including the nuclear fuel cycle, with the ensuring of safety as a major premise, while paying high regard to the Framework for Nuclear Energy Policy as a basic policy". The declared intention is that nuclear power should at least maintain its share of generation and possibly increase this from the current 30%, up to 40% from now to 2030 and beyond.

Figure 38

CO_2 Emissions Intensity in the Electricity Sector



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

GOVERNMENT POLICY

Activities to support nuclear research, development and use in Japan began when the Atomic Energy Basic Law was established on 19 December 1955. The law specifies that these activities shall be promoted, limiting them to peaceful purposes. It also makes it a principle to assure the safety of these activities – making the results transparent – with a view to securing energy resources for the future, promoting science and industries and, as a result, contributing to improving welfare living standards. On 1 January 1956, the Atomic Energy Commission was established in order to implement national policies for pursuing these goals and nuclear energy policy in general in a democratic manner.

Both the Atomic Energy Commission and the Nuclear Safety Commission, which is responsible for assuring the safety of Japan's nuclear-related activities, are part of the Cabinet Office. The Ministry of Foreign Affairs (MOFA), the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Ministry of Health, Labour and Welfare (MHLW), the Ministry of Agriculture, Forestry and Fisheries (MAFF), METI, the Ministry of Land, Infrastructure and Transport (MLIT) and the Ministry of the Environment (MOE) support Japan's nuclear-related activities, consistent with the Atomic Energy Basic Law and the Framework for Nuclear Energy Policy as well as with relevant international agreements and guidelines. Actual activities are conducted by research organisations, universities and private companies, including electric utilities. The administrative organisations for nuclear energy policy in Japan are shown in Figure 39.

The Atomic Energy Commission has formulated a total of nine long-term plans for nuclear-related science and engineering, approximately every five years since 1956. In October 2005, the latest Framework for Nuclear Energy Policy targeting the next ten years was adopted by the Cabinet.

According to this framework, the goals for Japan's nuclear-related science and engineering include promoting nuclear power generation to secure stable energy supply, as a measure against climate change, and to apply radiation technologies to science, industry, agriculture and medicine. These activities are strictly limited to peaceful purposes and place the greatest importance on safety.

Under this framework, there are three basic targets:

- Maintaining the current 30% level of nuclear power generation or increasing it to 40% even after 2030.
- Steady advancement of the light-water reactor fuel cycle.
- Commercial operation of fast-breeder reactors and the necessary fuel-cycle systems by 2050.

The government has also set out five basic guidelines for Nuclear Energy Policy (see Table 28) and nine implementation policies in Japan's Nuclear Energy National Plan, agreed in August 2006 (see Table 29).

Table 28

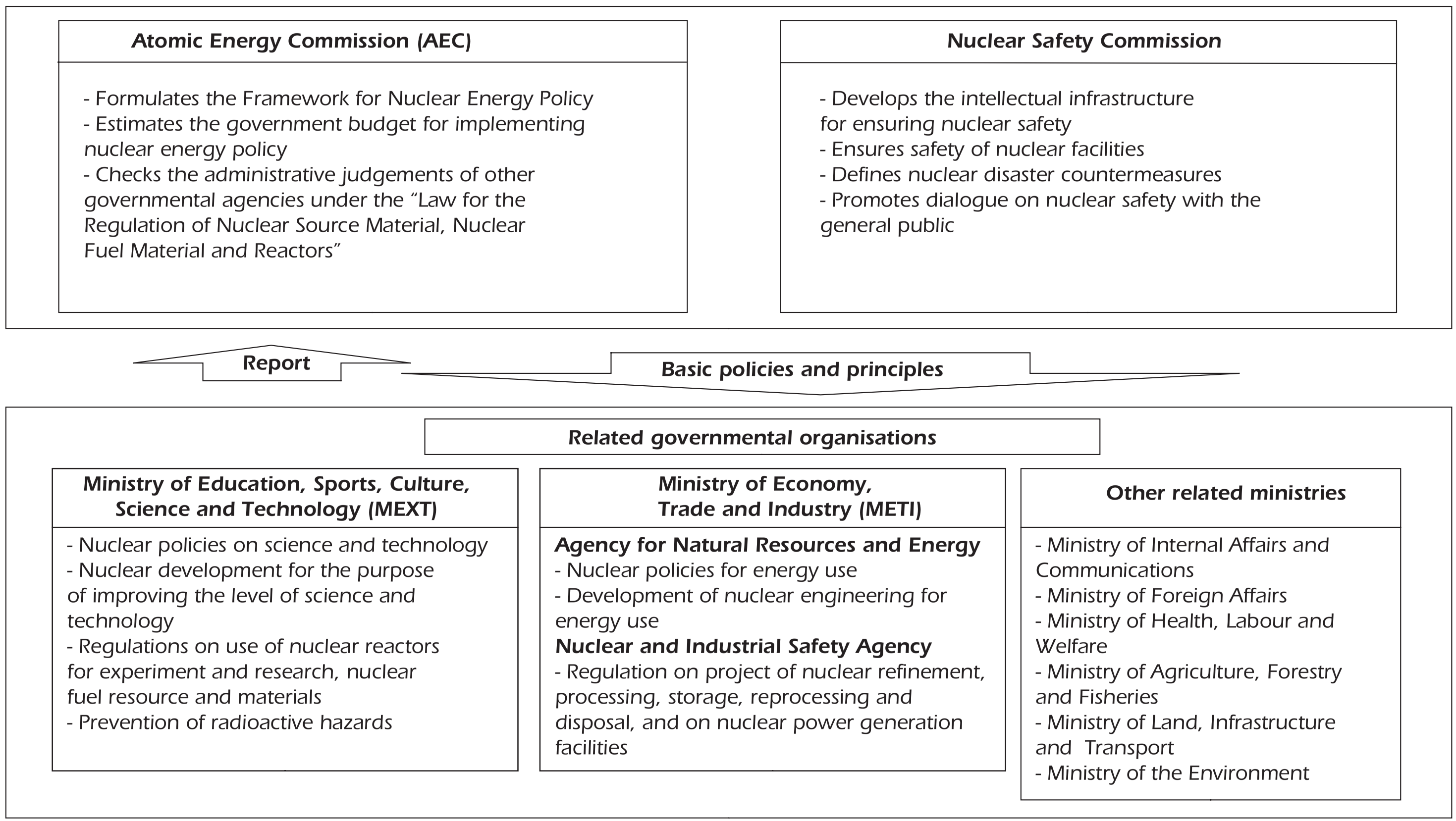
Five Basic Guidelines for Nuclear Energy Policy

1.	Establish a steadfast national strategy and policy framework that will not blur over the mid to long term.
2.	At the same time, retain strategic flexibility for individual policies and specific times, responding to international conditions and technology trends.
3.	Strengthen constructive co-operative relations among the government, electric power utilities and plant makers. To this end, adopt a shared vision and achieve genuine communications among the concerned parties, with the government taking the first step by indicating the general direction.
4.	Emphasise policies for individual regions in line with the national strategy.
5.	Secure policy stability by setting policy based on open and fair discussions.

Source: Country submission.

Figure 39

Administrative Organisations for Nuclear Energy Policy



Source: Country submission.

Table 29

Implementation Policies in Japan's Nuclear Energy National Plan

1.	Investment to construct new nuclear power plants and replace existing reactors in an era of electric power liberalisation.
2.	Appropriate use of existing nuclear power plants with the assurance of safety as a key prerequisite.
3.	Steady advancement of the nuclear fuel cycle and strategic reinforcement of nuclear fuel-cycle industries.
4.	Early commercialisation of the fast-breeder reactor cycle.
5.	Achieving and developing depth in technologies, industries and personnel.
6.	Support for the international development of Japan's nuclear power industry
7.	Active involvement in creating an international framework to uphold both non-proliferation and the expansion of the peaceful use of nuclear energy.
8.	Fostering trust between the State and communities where plants are located; highly detailed public hearings and public relations.
9.	Steady promotion of measures for disposal of radioactive wastes.

Source: Country submission.

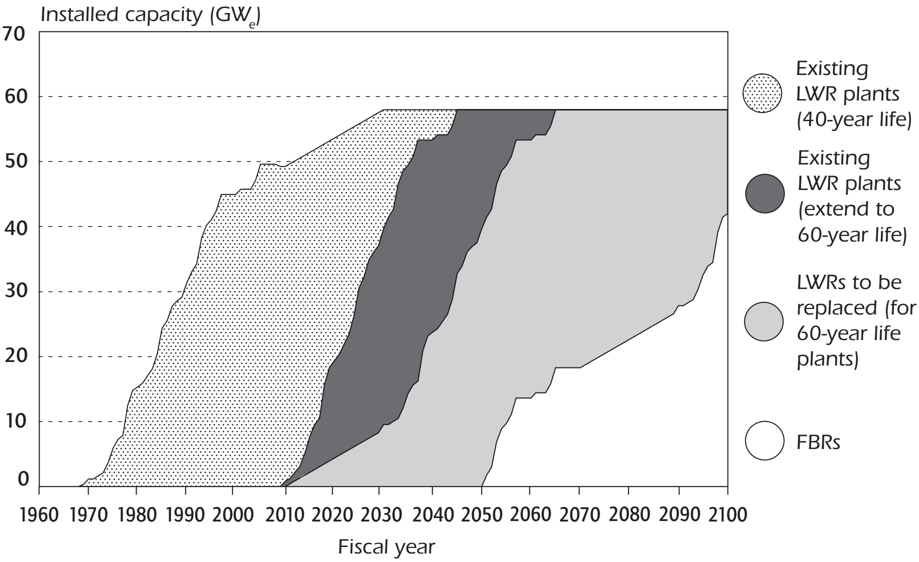
Behind each of these implementation policies lies an analysis of the issues and the necessary government responses. This provides a well-developed strategic plan for how the technology must progress over the coming decades, identifying the key issues and proposing routes by which they will be addressed. This looks out to time-scales of 2050 and beyond. Few other countries have set out such a clear strategy.

Figure 40 shows the intention with respect to meeting the first of the five basic targets listed in Table 28. The current generation of reactors will need to have their operating lives extended to 60 years (in line with some international practice) with light-water reactors (LWRs) being replaced progressively as their operational lifetimes expire. Commercial introduction of fast-breeder reactors (FBRs) is intended from 2050 onwards, in view of their much greater efficiency in the use of uranium as compared to current reactor designs (a factor of 60 or more energy from the same quantity of uranium is possible).

To accomplish the objective of commercial operation of fast-breeder reactors around 2050, the intention is to restart the Monju reactor in 2008 as a platform for the development of experience with the technology. In parallel, the Japan Atomic Energy Agency is working on the Fast Reactor Cycle Technology Development (FaCT) project for the commercialisation of the FBR fuel-cycle systems, with a view to having a concrete R&D programme developed by 2015. Demonstration of commercial FBRs and other related facilities is intended for 2025 and operation of the second (replacement) reprocessing facility will be before the termination of the Rokkasho reprocessing plant currently in operation, perhaps around 2045.

Figure 40

Long-Term Framework for Nuclear Energy in Japan



Note: For illustrative purposes, the installed capacity is assumed to reach saturation at 58 GW.
Source: Country submission.

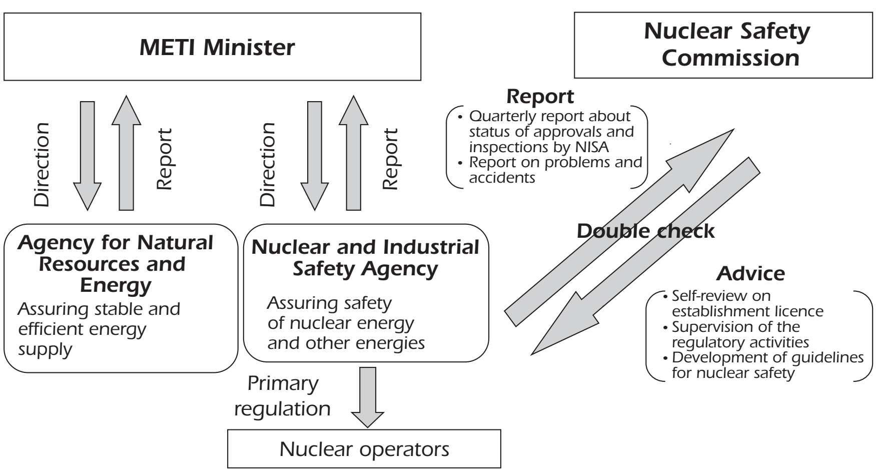
In pursuit of its strategic objectives with respect to nuclear power, the government is also active on the international scene. It is a member of the Generation IV International Forum, a collaborative venture of member countries to share in the development of advanced reactor systems for deployment from about 2030, and it is a member of the United States-initiated Global Nuclear Energy Partnership, which has the objective of enabling safe and proliferation-resistant nuclear power to be widely available to collaborating countries around the world. Japan has been active in the international discussions on the assurance of nuclear fuel supply as a means of increasing proliferation resistance. Japan also participates in the Multilateral Design Evaluation Programme, where a group of countries is working to enable the current nationally based reactor licensing processes to take more effective and co-operative cognisance of each other's efforts, in a step towards internationally recognised designs. It is a key player in the Forum for Nuclear Co-operation in Asia and has a wide range of bilateral co-operation agreements with numerous country partners. For the longer term, it is also a key partner in the International Thermonuclear Experimental Reactor (ITER) project to develop fusion energy systems, which complements its own work in the fusion field.

NUCLEAR SAFETY REGULATION

In January 2001, after the reorganisation of ministries and agencies, METI assumed sole responsibility for the safety regulation of nuclear power for energy use. The Nuclear and Industrial Safety Agency (NISA) was established as a dedicated organisation for the oversight of nuclear and industrial safety. It was deliberately established to be independent of the Agency for Natural Resources and Energy in METI, although it is a part of METI and reports to the same minister. NISA operates as the primary regulatory agency, while the Nuclear Safety Commission, established in the Cabinet Office, monitors NISA activities, in what is described as a "double check" system. The relationship between these bodies is shown in Figure 41.

Figure 41

Outline of Nuclear Safety Regulation



Source: Country submission.

NISA is supported by a technical support organisation, the Japan Nuclear Energy Safety Organisation (JNES), established in October 2003. NISA operates with a staff of 300 and the support organisation, JNES, with a staff of 460. These numbers reflect considerably increased staffing for NISA over recent years and the establishment of more permanent technical support for the regulator. It is important that the responsibilities between the Nuclear Safety Commission, NISA and JNES are clear and that the interfaces between them are effective.

NISA employs two main categories of professional staff, policy makers and experts, and adheres to the government policy of job rotation. It strives to maintain its expertise and experience in two ways: the experts are rotated within NISA and the policy makers are expected to stay at least three years. A comprehensive set of training requirements and regular training programmes have been established. Steps have also been taken over recent years to ensure the availability of skilled resources for regulatory activities via the establishment of JNES, where the policy of staff rotation does not apply.

FUEL CYCLE AND RADIOACTIVE WASTE MANAGEMENT

FUEL CYCLE

Japan has no domestic uranium production or conversion capability. The supply of uranium ore and conversion services are procured by Japanese utilities from the international market. There is some domestic enrichment capacity, providing just over 20% of demand, and the rest is currently procured on the international market. Around 2010, enrichment capability will be enhanced by the introduction of more advanced centrifuges in the Rokkasho uranium enrichment plant. Fuel fabrication is mainly provided from domestic sources, with more than enough domestic capacity to meet the demand.

Japan has a nuclear fuel cycle strategy with a declared intention of reprocessing, use of extracted plutonium and uranium that is not necessary to reserve for the fast reactor programme for mixed oxide (MOX) fuel, and eventual movement to commercial fast-breeder reactors. The small Tokai reprocessing plant has been in operation since 1977 and Japan has been a major customer for French and British reprocessing services. A major new reprocessing plant is under construction at Rokkasho, capable of 800 tonnes per annum (t/a) of heavy metal throughput which is completing its active commissioning procedures. It is designed to co-denitrate uranium and plutonium oxide, increasing proliferation resistance. This facility will be sufficient for around 80% of the current spent fuel that is being produced, and spent fuel in excess of the reprocessing capacity will continue to be stored until it is reprocessed at the plant currently under construction at Rokkasho. The Recyclable Fuel Storage Company, established jointly by the Tokyo Electric Power Company and the Japan Atomic Power Company, is building an interim spent fuel storage facility, due to go into operation by the end of 2010.

In line with its firmly declared policy of transparent use of nuclear technologies only for peaceful purposes, the government produces an annual report on the management status of plutonium in Japan. Electricity companies in Japan intend to start using plutonium as MOX fuel in 16 to 18 reactors by 2010. Domestic MOX fuel fabrication capability will be available in 2012. Progress is being made with the necessary regulatory approvals and with the agreements with the prefectures and local authorities where the reactors to use MOX are located.

WASTE DISPOSAL

The Specified Radioactive Waste Final Disposal Act was passed in June 2000, with a view to ensuring systematic and safe disposal of high-level radioactive waste. The act calls for the establishment of an implementing body responsible for disposal, funding arrangements to cover the costs of disposal and a three-step site selection process. The resulting body, the Nuclear Waste Management Organisation of Japan (NUMO), was established by the electric power companies and authorised by the Minister of International Trade and Industry (now METI) in October 2000.

As is the practice developing in the rest of the world, NUMO intends to construct a deep underground disposal facility in a stable rock formation, at a depth of at least 300 metres. Radioactive waste disposal is a highly sensitive subject with the public, and NUMO's approach is to seek volunteer communities where the geology will be investigated. The act specifies a three-stage process: the selection of preliminary investigation locations from volunteer communities, selection of detailed investigation areas and selection of the final site for repository construction.

Following the Final Disposal Plan based on the Specified Radioactive Waste Final Disposal Law, operation is due to commence in the mid-2030s. Although this time-scale seems long, it is not unusual in comparison with plans elsewhere.

In June 2007, the Diet adopted a law to amend the Specified Radioactive Waste Final Disposal Act. With the amendment, trans-uranium waste, which is covered by the amended Enforcement Order for the Specified Radioactive Waste Final Disposal Act, will be added to those materials subject to disposal.

PUBLIC ACCEPTANCE

In a democratic society, a civil nuclear programme is not supportable if a majority of public opinion strongly opposes it. Over recent years there have been a number of issues in Japan that are likely to have eroded public confidence. The latest of these is the Niigataken Chuetsu-Oki earthquake. Although the seven reactors on the nearby Kashiwazakai Kariwa site responded well, sustaining no extensive damage, and those that were operating shut down effectively, the intensity of the quake was well in excess of the design standard requirements for the plant. While the regulatory body, the Nuclear and Industrial Safety Agency (NISA), had already taken steps to review and reinforce the requirements for seismic acceptability, the event will likely have had a further negative influence on public acceptability of nuclear energy.

Based on METI survey data, Table 30 shows that there are relatively low levels of public appreciation of the greenhouse gas and security of supply benefits of nuclear power, and similarly of the reuse of energetic materials from reprocessing, but in all three cases the public appreciation seems to be growing. Again, international experience shows that this lack of knowledge, while undesirable, is not unusual. As long as the public does not appreciate the benefits of nuclear energy, it is unlikely to be tolerant of the perceived disadvantages, real or otherwise.

Table 30

Degree of Knowledge about Nuclear Power Generation

	FY1998	FY2005
Nuclear energy is a means of generating electric power that does not emit carbon dioxide and therefore contributes to solving the problem of global warming.	26.6%	35.6%
Recovering the uranium and other materials from spent nuclear fuels that can be reused as fuels allows effective use of uranium resources.	22.4%	34.8%
The supply of uranium fuel is more stable than that of petroleum and similar fuels.	20.6%	30.7%

Source: Country submission.

The surveys reveal that the public gets most of its information on energy issues from television or radio (76.6%) or from newspapers and magazines (54.3%); only 27.4% responded that national government or local government publications were relevant sources of information for them. A significant barrier to discussion is the lack of interest in nuclear energy, particularly among women and younger age groups revealed by the surveys (up to 76% for women in their twenties and 69% for men in their twenties). However, survey data also show that national government and local government information is trusted (39.3%), almost as much as broadcast sources (42.5%) and slightly more than the print media (37.3%). The government is adjusting its communication programme in the light of these findings.

A key aspect of public support for nuclear power is the trust in the regulatory bodies; traditionally in many countries these are rather invisible institutions. The regulatory body is the public's guardian in an area where the public is reliant on the regulator's specialist knowledge. The regulator must be seen to have a responsive and balanced voice (both for the public and industry). The body responsible for nuclear safety regulation in Japan is the Nuclear and Industrial Safety Agency. NISA has recently taken steps to enhance its public relations activities. In April 2004 the Nuclear Safety Public Relations and Training Division was established, which has a wide-ranging programme of activities.

The industry has also responded, setting up the Federation of Electric Power Companies' High-Level Trust Restoration Committee (covering nuclear and conventional plant issues) in October 2002 and the Japan Nuclear Technology Institute (JANTI) in April 2005. JANTI membership comprises companies and other bodies in the private sector and the organisation is modelled on the United States' Institute of Nuclear Power Plant Operators, with the objective of sharing best practices and learning from the experience of others. In response to earlier issues of falsification of records and attempts to conceal information, JANTI and the industry have established the Nuclear Information Archives (NUCIA). The website records all incidents, including those of only a minor nature, with the objective of sharing the information across the operating community and making it available to the public. Following the past incidents of under-reporting, there is likely to be a considerable task ahead in ensuring that full and transparent reporting standards are maintained and that the public trust in the generators is rebuilt.

CRITIQUE

As discussed above, the government has been steadfast in its support of a significant nuclear component to the overall energy mix. It has taken a clear-sighted and long-term vision of where it believes it needs to be and has set out a strategy to achieve these objectives that few other countries could match.

Japan undoubtedly also has an extremely powerful nuclear industry. In Mitsubushi, Toshiba and Hitachi it has three of the most prominent nuclear plant vendors in the world. While reactor construction time-scales in some countries of the world have lengthened considerably, this is not true of Japan, where programmes have remained commendably short. All three vendors have recently formed alliances with the vendors of other nations to strengthen their opportunities in what appears to be an international reawakening of interest in new nuclear build. Domestically, Japan's fleet of operating reactors is the third-largest in the world and is continuing to grow. There are, however, still some significant challenges to be faced.

In terms of operational performance as described by the number of automatic shut-downs, Japan excels – it has one of the best operating performances in the world. However, in terms of operational availability, the country's nuclear fleet is not performing at a high calibre. World availabilities have been steadily improving and now average around 85%, with the best reactors in the world achieving 94% to 95%. Japan's performance has not kept pace with this improvement elsewhere. Of the 31 countries in the world that operate nuclear power plants, Japan ranked only twenty-seventh in terms of availability performance in 2006.

In part, this relatively poor availability performance is the consequence of conservative regulatory policies. The 13-month inspection interval for nuclear plants is quite short. Furthermore, the shut-down periods for maintenance inspections are long by world standards and represent the majority of the loss of generating availability.

This length stems from Japan's continuing policy of time-based maintenance, whereas best practice has moved to reliability- and condition-based maintenance and, where appropriate, online maintenance. Improving to the world average from the current availabilities of approximately 70% would add the equivalent of 7.5 GW_e. Achieving world best practice would add the equivalent of 12 GW_e. The electricity sector has a target of a 20% reduction in the CO_2 emissions intensity of power generation. Increasing availabilities could deliver a significant fraction of this target.

Elsewhere in the world, licensees have been re-evaluating the performance of their plants and successfully agreeing with their regulatory bodies on the power uprating of their reactors (increasing their maximum operating capacity), sometimes with associated modifications to the plant. Normally this is a very economic investment given the additional power output. It also clearly brings with it the national benefits of reduced emissions and less dependence on fossil energy imports. Japanese utilities are mostly inactive in this area and only one Japanese utility is willing to pursue this at present.

Similarly, the nuclear fuel burn-ups (the amount of energy that is extracted from a given quantity of fuel before the fuel needs replacing) that are achieved in Japan are understood to be significantly below those of world best practice, increasing the demand for uranium and fuel services and potentially increasing down time for refuelling. There is also the challenge of life extension as the current fleet begins to reach 40 years of age, which is critical to the increase or indeed the maintenance of the percentage of nuclear generation. All of these issues should result in the need for regulatory assessment and approval in the medium term, together with a workload for new generation and new fuel-cycle facilities. This will present quite a challenge.

Public support for nuclear power is an important issue for maintaining and possibly enhancing the role of nuclear power in Japan. One key to building this support is active engagement with the public and an open dialogue regarding the benefits and challenges of nuclear power. Furthermore, public perception and confidence in the regulator is also critical – the public must be assured of its objectivity and vigilance in protecting their safety and investors must see the regulator as providing a sufficiently stable and predictable regulatory framework. NISA is currently part of METI, but it is separate from the part responsible for the promotion of nuclear energy. Furthermore, it is also supervised and audited by the Nuclear Safety Commission, which is part of the Cabinet Office. The IEA does not doubt the independence of NISA, but it is important that the public and investors are convinced as well. In short, perception is important and more needs to be done to clarify this independence.

In practice, the lack of irrefutable clarity on regulator independence may lead regulators to be overly conservative as a means to counter the public's perception. This could ultimately undermine the economics of nuclear power, while conversely, the regulator may be perceived by the public as part of the nuclear establishment.

The government is interested in maintaining or increasing nuclear energy production for the societal benefit reasons of reducing CO_2 emissions and contributing to security of energy supply. While the government has started implementing voluntary measures that begin to value emissions reductions in some parts of the economy, a systematic procedure is not in place that would reflect the climate benefits of nuclear power. Further, investors may only see a very limited part of the societal energy security benefit in their own portfolio diversity.

The government policy of rotation of civil servants means that NISA has a higher rotation of staff than that of regulatory bodies in other countries, which makes development of the necessary in-depth expertise an ongoing challenge. A regulator in this position will be rightly forced to conservative judgements in order to appropriately protect the public well-being.

The Japanese retail electricity market is partially liberalised. It appears that utilities see economic advantages from the construction of new nuclear plants and that, therefore, the intended further construction programme is not at risk. However, experience elsewhere has shown that investors in liberalised markets regard nuclear plant construction as presenting additional financial risks and have changed their preferences to the construction of the significantly cheaper (in capital-cost terms) gas-fired plants. This puts even more pressure to increase the scope for profitable operation, to ensure regulatory certainty and prompt response, and to appropriately reward nuclear power for its benefit credentials, such as by placing a value on greenhouse gas emissions in the economy. While there are many ways to internalise the costs of climate change, creating an explicit value for emissions in the economy is one of the best options available in that it internalises the costs of climate change in a transparent, cost-effective manner without exceedingly rewarding some technologies or hampering others. Other options also value emissions, but may do so in an opaque manner that risks leading to higher overall costs than necessary and to inefficient outcomes.

Liberalisation also raises a further issue relating to the assurance of provisions for long-term liabilities (decommissioning, spent fuel treatment and waste disposal). Historically, the utilities have carried their own provisions for these liabilities on their balance sheets. In October 2005, the Reprocessing Reserve Law and taxation system came into operation, designed to put in place a substantial financial reserve to cover expenses involved in the construction of the Rokkasho reprocessing plant and other facilities. As liberalisation proceeds, it may be appropriate to review provisioning arrangements more generally and consider the implementation of fully segregated funds for those liabilities that remain with the utilities.

RECOMMENDATIONS

The government of Japan should:

- *Continue its valuable contributions to the international efforts in the development of advanced nuclear technologies, which are consistent with nuclear non-proliferation.*
- *Encourage periodic inspections and mandatory maintenance requirements to move to match world best practice – while ensuring no erosion of the appropriate safety standards – as this can enhance security of supply.*
- *Consider the possibility of raising the maximum operating capacity of reactors and increasing the maximum energy that can be extracted from fuel (burn-ups) to match best practice in other established nuclear countries.*
- *Ensure that public attitudes are monitored on a regular basis and that the public receives balanced information on the risks and benefits of nuclear energy from sources in which it will place trust.*
- *Make efforts to maintain public trust in the regulatory body, NISA.*
- *Make efforts to ensure that the expertise and experience in and available to NISA are maintained.*
- *Monitor investment sentiment in the electricity production sector and maintain appropriate incentives, to ensure that the climate change and other benefits of nuclear power are recognised in investment decisions.*
- *Review the adequacy of the current arrangements for long-term liability provisions to cover the costs of decommissioning, spent fuel treatment and waste disposal.*

PART III

ENERGY TECHNOLOGY

ENERGY RESEARCH & DEVELOPMENT

Japan has long been a world leader in energy research and development (R&D), and now looks to technology development to further advance its energy and environment objectives. Government R&D spending as a percentage of its GDP is the largest in the IEA, and the government is committed to technology transfer, particularly within the Asia-Pacific region. The majority of energy R&D funding goes to nuclear research.

OVERVIEW

R&D PRIORITIES

A nation that is poor in domestic resources, Japan places a very high priority on energy R&D. In March 2006, the government adopted its *3rd Science and Technology Basic Plan*, which selected eight sectors, including energy, as targets for R&D promotion. In March 2007, the government revised its Basic Energy Plan, which was adopted in October 2003, and specifically itemises the following six categories of energy-related technologies and programmes for which R&D should be promoted:

- *Technologies that will help to improve total energy efficiency*. The government will conduct R&D of technologies likely to produce widespread spin-off effects. In addition, it will promote R&D programmes that will contribute to effective implementation of the Top Runner programme.
- *Technologies that will help to promote the peaceful use of nuclear energy and ensure its necessary safety*. The government will prioritise the implementation of R&D programmes concerning safety-related issues, the fast-breeder reactor cycle, the nuclear fuel cycle, light water reactors and disposal of radioactive waste, according to the Framework for Nuclear Energy Policy and its action plan, the Nuclear Energy National Plan.
- *Technologies that will contribute to the diversification of energy sources in the transport sector*. The government will promote the development of next-generation low-pollution vehicles, such as electric and fuel-cell vehicles, and technologies for enhancing the performance of storage batteries. It will also promote technologies related to a safe, simple and low-cost hydrogen system; highly efficient production of bioethanol; and next-generation liquid fuels such as gas-to-liquids (GTL), biomass to liquids (BTL) and coal-to-liquids (CTL).

- *Technologies related to new energy*. The government will implement R&D programmes related to technologies for reducing the costs and improving performance and user convenience of equipment and systems related to new energy sources such as hydrogen use and fuel cells, photovoltaic power generation and biomass energy.
- *Technologies that will help to ensure stable supply along with the effective and clean use of fossil fuels.*
  - With regard to oil-related technologies, the government will promote the development of technologies related to the dissolution of supercritical water, with a view to enhancing the ability to dissolve heavy oil, such as non-conventional crude oil. It will also develop technologies that will help to reduce drilling costs so as to cut the cost of oil resource development.
  - With regard to coal-related technologies, the government places priority on reducing the environmental impact of coal burning by promoting the development of clean coal technology. In addition, the government will promote the development of technologies related to carbon capture and storage (CCS).
- *R&D programmes that should be considered from a long-term perspective.* The government will promote technologies and programmes, taking a long-term perspective, with due consideration for the degree of maturity of such technologies and their relation to key energy policies. For example, the government will steadily promote the ITER project along with related "broader-approach" activities for fusion.

These six policy areas seek to enhance Japan's progress towards its three objectives under the New National Energy Strategy:

- Improve energy efficiency by at least a further 30% by 2030.
- Reduce oil dependence to 40% of TPES and 80% in the transport sector.
- Maintain a ratio of nuclear power in total generation of 30% to 40%.

ORGANISATIONAL OVERVIEW

The Council for Science and Technology Policy is the top decision-making body in Japan's R&D processes. The members of the council include the Prime Minister, the Minister of Economy, Trade and Industry and other ministers, along with knowledgeable stakeholders. Because of the parliamentary system of government, its mechanism is designed to give sufficient political consideration to funding activities. In addition, there is also the Research and Development Subcommittee under the Industrial Structure Council that serves as an advisory body to the Minister of Economy, Trade and Industry. Japan's energy technology strategy is developed by this subcommittee.

Additional responsibilities lie with particular government ministries, including:

- The Ministry of Economy, Trade and Industry (METI), which has a focus on funding for renewable energy, energy efficiency, the rational use of fossil fuel and power generation (including nuclear power), and technologies relating to climate change.

- The Ministry of Education, Culture, Sports, Science and Technology (MEXT), which has a focus on nuclear R&D and basic research carried out in universities and institutes.

The National Institute of Advanced Industrial Science and Technology (AIST), an affiliate of METI, is one of the largest independent administrative institutions in Japan. In 2001, 16 research laboratories from the former Agency of Industrial Science and Technology were merged. AIST covers six research fields, namely life science and technology; information technology and electronics; nanotechnology, materials and manufacturing; environment and energy; geological survey and applied geosciences; and metrology and measurement technology. In the field of environment and energy, AIST conducts R&D on environment-friendly production process technologies, pollution and chemical substance risk management and reduction technologies, energy diversification, and development of integrated assessments of environmental and energy systems.

The New Energy and Industrial Technology Development Organisation (NEDO) was established in 1980 as a semi-governmental organisation under METI. NEDO's activities include development and promotion of new energy and energy conservation technologies, management of industrial technology R&D projects, and international co-operation involving joint R&D and information exchange.

In FY2006, the Japan Atomic Energy Agency (JAEA), formerly the Nuclear Fuel Cycle Development Institute (JNC) commenced the fast-breeder reactor (FBR) cycle technology development project (FaCT). FaCT is intended to move the FBR commercialisation programme from the feasibility study phase to the R&D phase. To ensure a smooth transition to the next demonstration phase, a council was organised to share the common vision of the road-map for FBR commercialisation, including representatives from METI, MEXT, utilities, manufacturers and JAEA.

FUNDING

Japan's government budget for energy R&D was over USD 3.6 billion in 2006 (see Figure 42), a decrease of 3% from 2000 and a decrease of 18% from the high in 2002. The largest share, 62%, went to nuclear in 2006. The second-

Table 31

Energy RD&D Funding, 1996 to 2006*

Unit: million USD	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006**	*Share of 2006 subtotal*
Total nuclear	**2 992**	**2 837**	**2 696**	**2 669**	**2 660**	**2 624**	**2 878**	**2 773**	**2 369**	**2 380**	**2 261**	
Light water reactors	*185*	*174*	*161*	*145*	*120*	*105*	*44*	*38*	*32*	*43*	*51*	*2%*
Other converted reactors	*165*	*155*	*56*	*59*	*99*	*72*	*26*	*45*	*59*	*53*	*0*	*0%*
Fuel cycle	*899*	*929*	*873*	*951*	*796*	*832*	*930*	*856*	*778*	*723*	*647*	*29%*
Supporting technologies	*1 071*	*974*	*1 100*	*1 039*	*1 034*	*1 109*	*1 617*	*1 580*	*1 271*	*1 324*	*1 200*	*53%*
Breeder reactors	*326*	*281*	*243*	*221*	*370*	*301*	*134*	*135*	*123*	*134*	*214*	*9%*
Other fission	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*6*	*0%*
Total fission	*2 646*	*2 514*	*2 434*	*2 415*	*2 419*	*2 419*	*2 751*	*2 654*	*2 262*	*2 276*	*2 118*	*94%*
Fusion	*346*	*324*	*262*	*255*	*241*	*205*	*126*	*119*	*107*	*104*	*143*	*6%*
Total conservation and efficiency	**293**	**286**	**462**	**555**	**592**	**621**	**634**	**467**	**425**	**441**	**450**	
Industry	*166*	*179*	*381*	*447*	*515*	*533*	*430*	*327*	*N.A.*	*N.A.*	*90*	*20%*
Residential & commercial	*52*	*44*	*38*	*46*	*28*	*32*	*7*	*13*	*N.A.*	*N.A.*	*166*	*37%*
Transportation	*57*	*47*	*16*	*32*	*33*	*35*	*41*	*29*	*N.A.*	*N.A.*	*53*	*12%*
Other conservation	*18*	*17*	*27*	*30*	*17*	*21*	*156*	*99*	*N.A.*	*N.A.*	*140*	*31%*
Total fossil fuels	**359**	**331**	**279**	**168**	**110**	**77**	**344**	**289**	**319**	**331**	**338**	

Table 31

Energy RD&D Funding, 1996 to 2006*

Unit: million USD	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006**	*Share of 2006 subtotal*
Enhanced oil & gas	*5*	*4*	*27*	*25*	*18*	*26*	*0*	*0*	*0*	*0*	*32*	*9%*
Refining, transportation & storage	*130*	*127*	*70*	*3*	*3*	*2*	*85*	*56*	*153*	*168*	*75*	*22%*
Other oil & shale	*6*	*6*	*7*	*7*	*6*	*6*	*196*	*175*	*58*	*34*	*123*	*36%*
Total oil & gas	*141*	*137*	*103*	*34*	*27*	*34*	*281*	*231*	*210*	*203*	*230*	*68%*
Coal production, preparation & transportation	*14*	*16*	*16*	*12*	*9*	*6*	*0*	*0*	*3*	*2*	*9*	*3%*
Coal combustion	*61*	*62*	*55*	*37*	*13*	*10*	*20*	*14*	*41*	*71*	*64*	*19%*
Coal conversion	*143*	*116*	*105*	*83*	*59*	*26*	*37*	*39*	*65*	*55*	*35*	*10%*
Other coal	*0*	*0*	*0*	*1*	*2*	*1*	*6*	*5*	*0*	*0*	*1*	*0%*
Total coal	*218*	*194*	*176*	*134*	*83*	*43*	*62*	*58*	*109*	*128*	*108*	*32%*
Total renewable energy	**114**	**114**	**126**	**132**	**156**	**140**	**174**	**140**	**244**	**220**	**239**	
Solar heating & cooling	*3*	*2*	*1*	*1*	*1*	*1*	*0*	*0*	*0*	*4*	*11*	*5%*
Solar photo-electric	*67*	*68*	*77*	*94*	*123*	*86*	*110*	*96*	*170*	*134*	*153*	*64%*
Total solar	*70*	*70*	*79*	*95*	*123*	*87*	*110*	*96*	*170*	*138*	*164*	*69%*

Table 31

Energy RD&D Funding, 1996 to 2006*

Unit: million USD	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006**	*Share of 2006 subtotal*
Wind	*5*	*5*	*4*	*5*	*5*	*8*	*6*	*13*	*12*	*11*	*9*	*4%*
Ocean	*1*	*2*	*10*	*5*	*4*	*7*	*0*	*0*	*0*	*0*	*0*	*0%*
Biomass	*5*	*5*	*5*	*0*	*0*	*17*	*34*	*31*	*62*	*71*	*65*	*27%*
Geothermal	*33*	*32*	*28*	*28*	*23*	*20*	*15*	*0*	*0*	*0*	*0*	*0%*
Small hydro (<10 MW)	*0*	*0*	*0*	*0*	*0*	*0*	*9*	*1*	*0*	*0*	*0*	*0%*
Other renewables	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1%*
Total power & storage technologies	**76**	**78**	**134**	**138**	**168**	**190**	**76**	**39**	**54**	**48**	**109**	
Electric power conversion	*29*	*19*	*77*	*57*	*84*	*117*	*9*	*3*	*0*	*0*	*4*	*4%*
Electricity transmission & distribution	*29*	*26*	*26*	*44*	*48*	*50*	*34*	*22*	*54*	*48*	*89*	*81%*
Energy storage	*17*	*32*	*31*	*37*	*35*	*23*	*33*	*14*	*0*	*0*	*16*	*15%*
Total other technologies/ research	**123**	**127**	**112**	**72**	**76**	**85**	**349**	**299**	**227**	**235**	**235**	
Total energy RD&D	**3 958**	**3 773**	**3 809**	**3 734**	**3 761**	**3 737**	**4 454**	**4 007**	**3 638**	**3 655**	**3 633**	

* estimated.

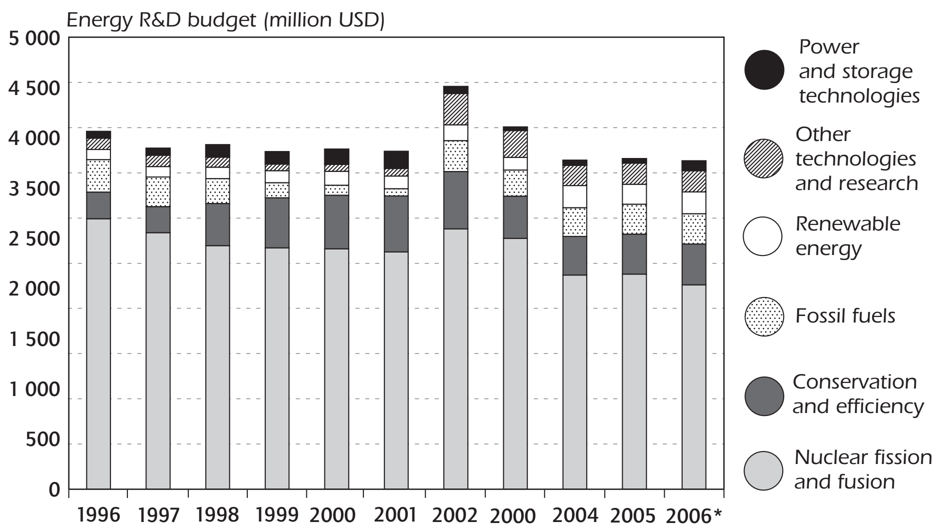
Source: Country submission.

largest category, energy conservation and efficiency, receives 12%, a share that has been increasing. Fossil fuels receive 9%, renewables 7% and power and storage technologies 3%.

More detailed funding allocations are shown in Table 31. Within conservation and efficiency, funding is relatively evenly split, though residential and commercial applications receive the largest total share. In fossil fuels, funding is focused on oil and gas, particularly oil and shale. In renewables, the lion's share of funding goes to solar, with biomass receiving about a quarter of renewables funding. Wind receives negligible funding.

Figure 42

Government Spending on Energy R&D, 1996 to 2006



* estimated.

Source: Country submission.

The share of GDP that goes to public funding of energy R&D is very high in Japan (see Figure 43).

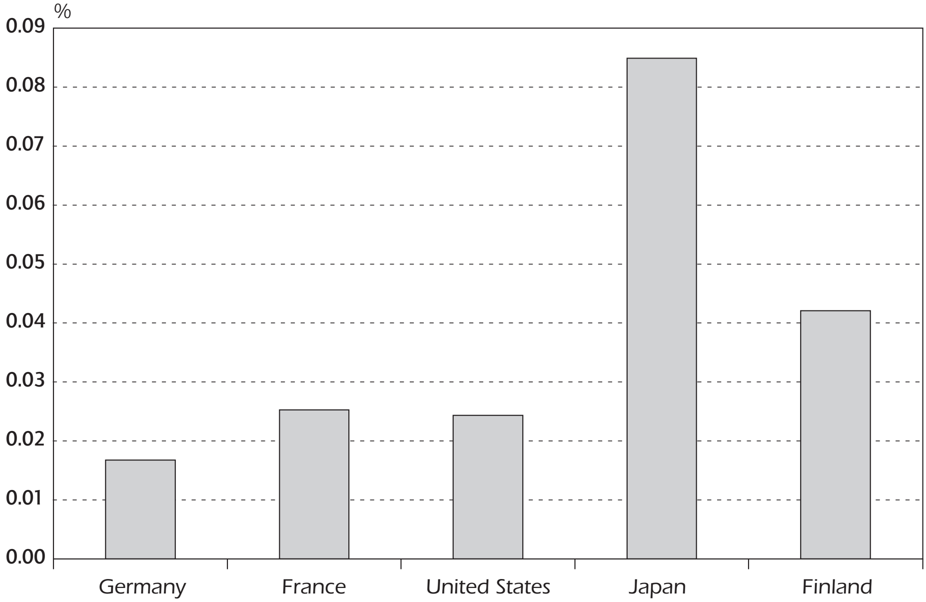
R&D PROGRAMMES AND PROJECTS

TECHNOLOGY PROGRAMMES

Japan's annual budget of USD 3.6 billion is divided between five programmes, along with separate funding for fusion research. These five programme areas are described below and include funding for both basic and applied research.

Figure 43

Expenditure on Public Energy Research as a Share of GDP in Selected IEA Countries, 2004



Note: Excluding nuclear research, the highest energy research spending as a share of GDP is in Finland, followed by Sweden and Switzerland.

Source: *Energy Policies of Finland – 2007 Review*, IEA/OECD Paris, 2007.

Renewable energy technology programme

Japan's funding for renewables R&D was USD 480 million in 2006 (including a broader spectrum of funding than detailed in Table 31). The programme supports R&D on solar, wind and biomass, among others. Funding for next-generation renewables, such as next-generation biofuels, receives a high priority. The programme has a particular focus on fuel cells, including the polymer electrolyte fuel cell (PEFC) and the solid oxide fuel cell (SOFC), as well as on fundamental research on hydrogen science. Currently, the programme is funding demonstration and dissemination of a large-scale project for fuel cell systems. This programme also provides funding for technologies related to the renewable portfolio standard and international renewables standard setting. An overview of NEDO's solar R&D activities is provided in Box 7.

Energy conservation technology programme

The government provided USD 450 million to this programme in 2006. The government supplied funds for the development of basic technology for new environment-conscious ultrafine-grained steel production, the development of high-speed and low-power-consuming network systems using superconducting single-flux quantum (SFQ) device technology, the carbon nanotube capacitor development project, and the development of basic technology for inverter systems for power electronics. NEDO is also achieving results in developing other energy conservation technologies, such as the high-performance industrial furnace, high-performance vacuum heat-insulating material, and a high-efficiency hot-water supply system based on a compact heat pump that uses CO_2 as a refrigerant.

Box 7

NEDO Solar Programme

R&D on solar photovoltaic (PV) technology in Japan started in 1974 as part of the Sunshine Project. The aim of the project was to reduce the cost of PV by a factor of one hundred from the cost at the time. At the early stage of the project, low-cost production technologies of poly-crystalline silicon, such as ribbon silicon, were intensively studied. NEDO was established in 1980 to play a central role in promoting the project. In the 1980s, research on amorphous silicon thin-film cells began in earnest. Production technologies for low-cost silicon cells were also developed, which led to the rapid growth of Japan's PV industries.

Technology developments on thin-film solar cells, which are expected to reduce the cost of solar PV dramatically, became a large part of the project during the late 1990s. Between 2001 and 2005, amorphous silicon/micro-crystalline silicon tandem thin film and copper indium diselenide thin-film cells/modules were intensively developed. Consequently, these types of modules came onto the Japanese market in 2007.

Research on system technologies was also carried out as part of the Sunshine Project. The research results of the grid-connection technology supported the growth of the Japanese PV market as roof-top applications.

Source: Country submission.

Fossil fuel technology programme

Funded with over USD 330 million in 2006, this programme promotes next-generation oil refinery technologies, oil refinery integration projects, coal gasification technology development, including integrated gasification combined cycle (IGCC) turbines and integrated gasification fuel cells (IGFCs), methane hydrates and GTL. Clean coal technologies, including CCS, are a priority area under this programme.

Nuclear technology programme

With USD 110 million, the nuclear technology programme funds R&D on fast breeder reactor cycles, the fuel cycle for next-generation light-water reactors and research on innovative projects for nuclear technology. The programme also funds education and training. (Fusion research receives a substantially larger amount of annual funding than the nuclear technology programme, though the exact amount varies from year to year.)

Electric power technology programme

The government funds R&D on electric power systems with USD 60 million per year, targeting superconducting power networks and fundamental research on superconducting applications.

FUNDING ALLOCATION

Funding is generally directed to projects by NEDO. The process for funding particular projects or programmes varies by entity. Most funding is guaranteed for terms under five years, and must be reallocated on a regular basis according to the evaluation by each funding agency and the Council for Science and Technology Policy.

INTERNATIONAL COLLABORATION

Japan is an active member in ongoing international projects such as the FutureGen project, which is working to develop advanced coal-fired power plant technology, along with ITER, the Global Nuclear Energy Partnership (GNEP) scheme and the Generation IV International Forum (GIF) project, all of which concern nuclear energy. The government is also part of the International Partnership for the Hydrogen Economy (IPHE). Japan is a party to 29 implementing agreements. It is also a leader in efforts to enhance technology transfer and collaboration in Asia (see Box 8).

Box 8

Technology Transfer and Collaboration in Asia

With the full understanding that the level of energy technology development of its neighbours directly affects Japan, the government places a strong focus on international collaboration. In particular, the government focuses technology transfer and partnerships on Asia, partly owing to the rising demands for energy from its neighbours.

Japan is an active member in the Asia-Pacific Partnership on Clean Development and Climate (APP). This programme aims to promote regional co-operation for the development, dissemination and transfer of clean and efficient energy technologies. Japan, the United States, Australia, Canada, South Korea, China and India are members. Eight sectors are currently targeted, including power generation and steel and cement production.

Japan has also been conducting international model projects for increasing the efficient use of energy. Through these projects, highly energy-efficient technologies already commercialised in Japan are to be demonstrated and disseminated in developing countries. The technologies to be disseminated are used mainly in energy-intensive industry, including coke dry quenching (CDQ) equipment and top-pressure recovery turbines (TRT) in the iron and steel sector and power generation systems using waste heat in cement production. Depending on the results of demonstrations of the effectiveness of technologies introduced through model projects, Japanese technical experts are dispatched to relevant firms for seminars, offering education and technical training. By the end of 2007, 38 projects had been conducted in China, Indonesia, Thailand, Vietnam, Myanmar, Malaysia, India and Kazakhstan, contributing to technology transfer. For example, the CDQ model project was implemented in a Chinese steel facility, creating the necessary first step to disseminate the CDQ technology throughout China.

Japan supports capacity building of Asian countries in the energy efficiency and conservation field by dispatching experts and accepting trainees. Experts from Japan provide guidance on energy management systems to factories through on-the-job training, or provide advice and information on legal systems (such as energy conservation law) to countries that are in the process of laying the framework for promoting energy efficiency and conservation. In the training courses, trainees learn about Japan's efforts and experiences on energy efficiency and conservation in the public and private sectors, and visit energy-efficient facilities. Between 2004 and January 2007, Japan had dispatched 303 experts overseas and had accepted 820 trainees from overseas. At the second East Asia Summit held in January 2007, Japan committed to dispatching 500 experts and accepting 1 000 trainees from East Asian countries over the next five years.

Source: Country submission.

Cool Earth 50's Innovative Energy Technology Programme

To fulfil the ultimate objective of the UNFCCC, Japan is working to create a globally shared long-term vision, such as to halve global greenhouse gas emissions by 2050, as proposed in its *Cool Earth 50* initiative. At the World Economic Forum in Davos in January 2008, Japan advocated that technological innovation will be a necessary element to achieve this reduction by 2050. In this light, the government will focus its R&D investment on the environmental and energy sectors. At the G8 Summit in Heiligendamm in 2007, leaders agreed that technology is a key to addressing climate change and ensuring energy security. Various international meetings such as APEC and the Major Economics Meeting on Energy Security and Climate Change (MEM) confirm the need for technology to address climate change.

Given the importance of innovative technology, Japan formulated the Innovative Energy Technology Programme under the *Cool Earth 50* initiative, selecting 21 key innovative technologies (see Figure 44) that aim to:

- Identify innovative energy technologies to be given high priority.
- Formulate technology road-maps for these high-priority areas, which will provide R&D direction and set milestones of performance with a time line towards achieving the long-term goal by 2050.
- Strengthen international co-operation to accelerate innovative technology R&D, including through existing international frameworks such as FutureGen; the Carbon Sequestration Leadership Forum (CSLF) and APP on clean coal; GNEP and GIF on nuclear; IPHE on fuel cells; and IEA implementing agreements generally.

PUBLIC-PRIVATE PARTNERSHIPS

The government seeks to ensure that the responsible authorities and the private sector engage consistently in R&D over the long term by setting the direction for future technological progress from a long-term perspective. As part of this effort, in April 2007 the government announced an energy technology strategy, which is a road-map for technologies to be realised by 2030.

Figure 45 provides an example of NEDO's changing level of support for the development of energy conservation technologies. The support level starts at 100% for early-stage leading research, steadily declining to half for demonstration research and finally to one-third for dissemination activities.

Figure 44

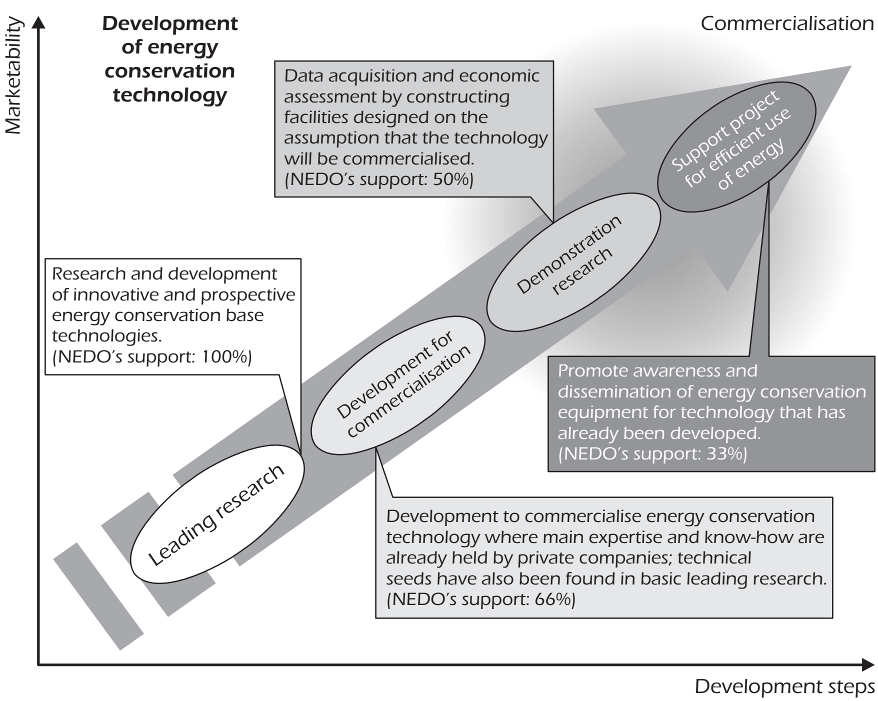
Key Innovative Technologies towards *Cool Earth 50*

		Efficiency improvement		Low carbonisation	
Supply side	**Power generation and transmission**	2. High-efficiency coal-fired power generation	3. Carbon capture and storage (CCS)	5. Advanced nuclear power generation	
		1. High-efficiency natural gas-fired power generation	6. High-efficiency superconducting power transmission	4. Innovative photovoltaic power generation	
	Transportation	7. Intelligent transport systems	8. Fuel cell vehicles	9. Plug-in hybrid vehicles /electric vehicles	10. Production of transport biofuels
Demand side	**Industry**	11. Innovative materials, production/processing		12. Innovative steelmaking processes	
	Commercial	13. High-efficiency housing and buildings	14. Next-generation high-efficiency lighting	15. Stationary fuel cells	
		16. Ultra high-efficiency heat pumps	17. High-efficiency information devices and systems	18. Energy management systems (HEMS/BEMS/local-level EMS)	
	Cross-cutting	19. High-performance power storage	20. Power electronics	21. Hydrogen production, transport and storage	3. CCS (repeated)

Source: Country submission.

Figure 45

Example of NEDO Funding Support Levels for the Development of Energy Conservation Technologies



Source: NEDO.

ROAD-MAPPING AND STRATEGIC ORGANISATION

The government places a high priority on road-mapping in energy R&D, which seeks to lay out a general path for R&D projects, establishing key objectives, setting milestones and clarifying the technological challenges that must be overcome. Road-maps are created for individual projects, as well as general programme areas, which often look to technology objectives in 2030 or beyond. By making road-mapping an important part of all energy R&D funding, the government seeks to:

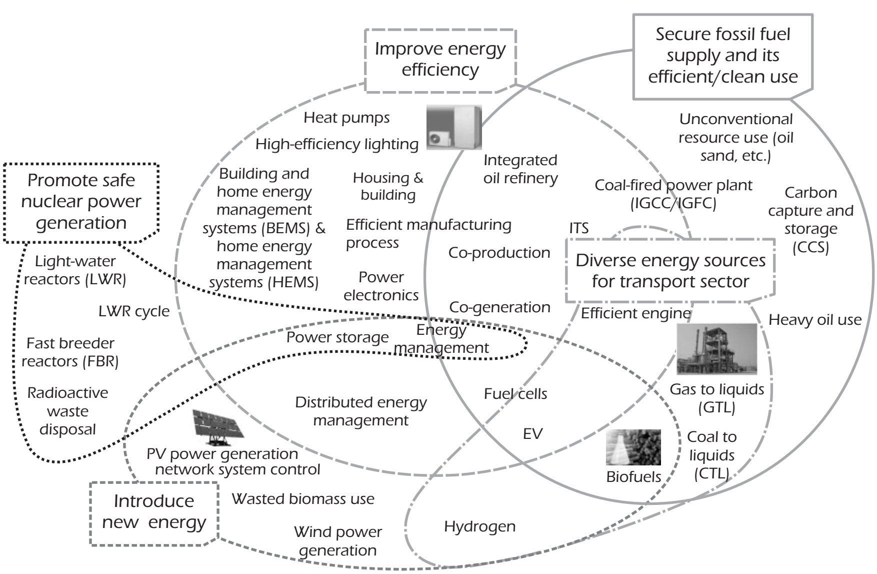
- Establish the basis for effective government R&D management.
- Ensure a successful PDCA (plan, do, check, act) cycle.
- Serve as a communication tool for those who are engaged in R&D.
- Share the long-term technology perspective with the private sector.
- Contribute to accountability.

Road-mapping is conducted and confirmed by the Research and Development Subcommittee of the Industrial Structure Council (an advisory body to the Minister of Economy, Trade and Industry). The members of the subcommittee include experts, industrial representatives and other stakeholders.

In addition to road-mapping particular technology projects, the government has also set out a policy map for its entire energy R&D portfolio. A schematic of this map is laid out in Figure 46.

Figure 46

Energy R&D Technology Map



Source: Country submission.

CRITIQUE

Japan's steady and strong commitment to energy R&D benefits not only Japan, but the global energy sector; the government should be recognised for steadily devoting significant resources to the endeavour. We are also pleased to see that the government is providing R&D funding to a wide variety of technological areas, while still focusing abundant resources on a few key priority areas. Most importantly, we praise Japan's leadership in the global arena in advancing energy R&D and technology transfer to the developing world and collaboration generally – particularly in Asia and on environment and efficiency research areas. The country is well-placed with respect to geography, the political environment and its own strong domestic efforts and success to continue this global leadership, an activity we strongly encourage. Such activities will help spur improvements in global energy efficiency, a key to enhancing energy security internationally and in Japan in particular.

In general, Japan's energy R&D funding appears to be linked to its overall energy policy goals. Environment and efficiency goals rate highly in Japan's energy policy and these areas receive significant government R&D funding. Furthermore, the broad-scale mapping exercise explicitly links the government's policy objectives with its R&D priorities. We encourage the government to expand on this work, in part by creating a longer-term road-map for energy R&D priorities. The R&D funding actors have already established long-term road-mapping as an important part of each project; the government can build on this work to expand it to its overall funding portfolio. This would help improve the overall effectiveness of government funding. Furthermore, a formalised process for allocating funds could both lower the overall cost of R&D administration, and ensure that funding is allocated in a transparent, independent and co-ordinated manner.

Stability of R&D funding underpins its effectiveness. Thus, the government should ensure that the term of R&D investment is well matched to the type of research, in some cases providing long-term funding for research projects or to research fields where results are likely to be attained only after many years. This gives researchers the freedom to undertake the necessary investigations, and avoids stop-start funding that negatively impacts outcomes. The government should ensure appropriate funding stability for R&D research, limiting short-term funding as much as possible.

R&D into new, alternative energy sources is critical to long-term security of supply and achieving long-term energy policy goals. Japan has maintained its commitment to this area, particularly through its support of research technologies in the early stages of R&D.

In addition, the government continues to undertake valuable R&D in the area of clean coal technologies and has a number of demonstration projects under way that have the potential to deliver efficient, low-emission coal generation technology. In order to reduce global CO_2 emissions, we believe it is essential to develop cleaner technologies for coal and praise the government for its research efforts. It should continue to pursue these efforts, including through timely completion of the commercial demonstration phases of the IGCC and IGFC power generation technologies.

RECOMMENDATIONS

The government of Japan should:

- *Continue to play a leading role in advancing and promoting international energy R&D collaboration, both in Asia and more widely.*
- *Develop a more integrated, comprehensive and transparent energy R&D policy framework by:*
  - *Explicitly linking national energy policy goals with energy R&D priorities through a transparent and long-term strategic research funding road-map.*
  - *Ensuring that funding is allocated according to a formalised and streamlined process, developing a standard and transparent protocol where funding for and tendering of research proposals are linked to the R&D priorities.*
- *Continue to support the development of alternative energy sources.*
- *Continue to pursue the development of clean coal technologies, such as through timely completion of the commercial demonstration phases of the IGCC and IGFC power generation technologies.*

PART IV

ANNEXES

ORGANISATION OF THE REVIEW

REVIEW TEAM

The 2008 IEA in-depth review of the energy policies of Japan was undertaken by a team of energy policy specialists drawn from IEA member countries, the Nuclear Energy Agency and the IEA Secretariat. The team visited Tokyo and the Kimitsu Works of the Nippon Steel Corporation from 3 to 7 September 2007 for discussions with energy administration officials, regulators, energy industry groups and non-governmental organisations. This report was drafted on the basis of those meetings and the government's official response to the IEA policy questionnaire, along with other information. The team greatly appreciates the candour and co-operation shown by everyone it met. In particular, the review could not have been possible without the assistance and preparation of Mr. Kiyoshi Mori and Mr. Shinichi Yasuda from the Ministry of Economy, Trade and Industry.

The members of the team were:

Graham White
Department for Business, Enterprise and Regulatory Reform
UK (Team leader)

Éanna Ó Conghaile
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Per Högström
Ministry of Enterprise, Energy and Communications
Sweden

Tim McIntosh
Natural Resources Canada
Canada

Nils Anders Nordlien
Ministry of Petroleum and Energy
Norway

Annemieke Schouten
Ministry of Economic Affairs
The Netherlands

Stan Gordelier
Nuclear Energy Agency
OECD

Nigel Jollands
International Energy Agency
OECD

Ulrik Stridbaek
International Energy Agency
OECD

Jolanka Fisher
International Energy Agency
OECD (Desk officer)

Jolanka Fisher managed the review and wrote the report, with the exception of the section on energy efficiency in Chapter 3, which was drafted by Nigel Jollands from the IEA's Energy and Environment Division, Chapter 6 on electricity, which was drafted by Ulrik Stridbaek from the IEA's Energy Diversification Division and Chapter 8 on nuclear energy, which was drafted by Stan Gordelier from the OECD's Nuclear Energy Agency. Monica Petit prepared the figures and Bertrand Sadin prepared the maps. Sandra Martin and Viviane Consoli provided editorial assistance.

ORGANISATIONS VISITED:

The team held discussions with the following energy and environment stakeholders:

- Central Research Institute of Electric Power Industry (CRIEPI)
- Electric Power System Council of Japan (ESCJ)
- Ennet Corporation
- Federation of Electric Power Companies of Japan (FEPC)
- Institute of Energy Economics, Japan (IEEJ)
- Japan Automobile Manufacturers Association (JAMA)
- Japan Electric Power Exchange (JEPX)
- Japan Electrical Manufacturers' Association (JEMA)
- Japan Fair Trade Commission (JFTC)
- Japan Gas Association
- Japan Iron and Steel Federation (JISF)
- Japan Photovoltaic Energy Association (JPEA)
- Ministry of Economy, Trade and Industry (METI)
- Ministry of Education, Culture, Sports, Science and Technology (MEXT)
- Ministry of Foreign Affairs (MOFA)
- Ministry of Land, Infrastructure and Transport (MLIT)
- Ministry of the Environment (MOE)
- National Institute of Advanced Industrial Science and Technology (AIST)

- New Energy and Industrial Technology Development Organisation (NEDO)
- Nippon Association of Consumer Specialists (NACS)
- Nippon Keidanren
- Nippon Steel Corporation
- Nuclear and Industrial Safety Agency (NISA)
- Petroleum Association of Japan
- Wind Power Developers' Association

REVIEW CRITERIA

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

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY		1973	1990	2005	2006	2010	2020	2030
TOTAL PRODUCTION		**29.5**	**75.2**	**99.9**	**101.1**	**134.8**	**..**	**148.9**
Coal		17.9	4.5	–	–	–	..	–
Peat		–	–	–	–	–	..	–
Oil		0.8	0.7	0.8	0.7	–	..	–
Natural Gas		2.3	1.9	2.9	3.2	..	..	..
Comb. Renewables & Waste[1]		–	5.0	6.5	7.1	21.9	..	24.6
Nuclear		2.5	52.7	79.4	79.1	100.9	..	112.5
Hydro		5.7	7.7	6.6	7.4	9.1	..	8.9
Wind		–	–	0.2	0.2	..	..	..
Geothermal		0.2	1.6	3.0	2.8	2.9	..	2.9
Solar/Other		–	1.2	0.6	0.6	..	..	..
TOTAL NET IMPORTS		**299.1**	**372.1**	**430.9**	**425.3**	**401.1**	**..**	**434.6**
Coal	Exports	0.4	1.4	1.2	1.4	..	..	..
	Imports	41.3	73.9	112.6	113.4	93.4	..	97.8
	Net Imports	40.9	72.6	111.4	112.0	93.4	..	97.8
Oil	Exports	3.1	3.7	9.0	10.1	..	..	..
	Imports	276.2	266.4	266.9	255.0	237.8	..	241.4
	Bunkers	17.7	5.5	6.2	5.8	4.6	..	4.7
	Net Imports	255.4	257.2	251.7	239.1	233.2	..	236.7
Natural Gas	Exports	–	–	–	–	–	..	–
	Imports	2.8	42.3	67.8	74.2	74.5	..	100.2
	Net Imports	2.8	42.3	67.8	74.2	74.5	..	100.2
Electricity	Exports	–	–	–	–	–	..	–
	Imports	–	–	–	–	–	..	–
	Net Imports	–	–	–	–	–	..	–
TOTAL STOCK CHANGES		**-6.5**	**-3.5**	**-2.4**	**1.2**	**–**	**..**	**–**
TOTAL SUPPLY (TPES)		**322.1**	**443.8**	**528.4**	**527.6**	**535.9**	**..**	**583.5**
Coal		57.9	77.2	111.0	112.4	93.4	..	97.8
Peat		–	–	–	–	–	..	–
Oil		250.7	254.3	250.5	240.6	233.2	..	236.7
Natural Gas		5.1	44.2	70.6	77.4	74.5	..	100.2
Comb. Renewables & Waste[1]		–	5.0	6.5	7.1	21.9	..	24.6
Nuclear		2.5	52.7	79.4	79.1	100.9	..	112.5
Hydro		5.7	7.7	6.6	7.4	9.1	..	8.9
Wind		–	–	0.2	0.2	..	..	..
Geothermal		0.2	1.6	3.0	2.8	2.9	..	2.9
Solar/Other		–	1.2	0.6	0.6	..	..	..
Electricity Trade[2]		–	–	–	–	–	..	–
Shares (%)								
Coal		*18.0*	*17.4*	*21.0*	*21.3*	*17.4*	..	*16.8*
Peat		–	–	–	–	–	..	–
Oil		*77.8*	*57.3*	*47.4*	*45.6*	*43.5*	..	*40.6*
Natural Gas		*1.6*	*10.0*	*13.4*	*14.7*	*13.9*	..	*17.2*
Comb. Renewables & Waste		–	*1.1*	*1.2*	*1.3*	*4.1*	..	*4.2*
Nuclear		*0.8*	*11.9*	*15.0*	*15.0*	*18.8*	..	*19.3*
Hydro		*1.8*	*1.7*	*1.2*	*1.4*	*1.7*	..	*1.5*
Wind		–	–	–	–	..	..	..
Geothermal		*0.1*	*0.4*	*0.6*	*0.5*	*0.5*	..	*0.5*
Solar/Other		–	*0.3*	*0.1*	*0.1*	..	..	..
Electricity Trade		–	–	–	–	–	..	–

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

Please note: Only partial information is available for 2010 and 2030. Forecast data for combustible renewables & waste include solar, wind, etc. Forecasts are based on the 2005 submission.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2005	2006	2010	2020	2030
TFC	**235.7**	**305.3**	**353.8**	**351.8**	**376.9**	**..**	**400.6**
Coal	20.2	33.3	29.7	31.1	39.8	..	38.0
Peat	–	–	–	–	–	–	–
Oil	172.8	188.2	207.4	201.1	209.4	..	208.6
Natural Gas	7.0	15.2	28.7	31.2	28.7	..	38.4
Comb. Renewables & Waste[1]	–	2.6	2.6	2.7	10.4	..	8.7
Geothermal	–	0.1	0.2	0.2	0.1	..	0.1
Solar/Other	–	1.2	0.6	0.6	..	..	..
Electricity	35.7	64.5	84.0	84.4	87.1	..	105.1
Heat	0.0	0.2	0.6	0.6	1.4	..	1.6
Shares (%)							
Coal	***8.6***	***10.9***	***8.4***	***8.8***	***10.6***	..	***9.5***
Peat	–	–	–	–	–	..	-
Oil	*73.3*	*61.7*	*58.6*	*57.2*	*55.6*	..	52.1
Natural Gas	*3.0*	*5.0*	*8.1*	*8.9*	*7.6*	..	9.6
Comb. Renewables & Waste	–	*0.9*	*0.7*	*0.8*	*2.8*	..	2.2
Geothermal	–	–	*0.1*	*0.1*	–	..	-
Solar/Other	–	*0.4*	*0.2*	*0.2*	..	..	..
Electricity	*15.1*	*21.1*	*23.7*	*24.0*	*23.1*	..	26.2
Heat	–	*0.1*	*0.2*	*0.2*	*0.4*	..	0.4
TOTAL INDUSTRY[3]	**141.8**	**138.1**	**138.6**	**140.3**	**180.5**	**..**	**179.7**
Coal	18.2	32.3	29.1	30.4	..	..	..
Peat	–	–	–	-	-	..	-
Oil	96.4	70.3	72.2	71.9	..	..	..
Natural Gas	2.1	4.0	7.0	7.7	..	..	..
Comb. Renewables & Waste[1]	–	2.5	2.6	2.6	..	..	..
Geothermal	–	–	–	-	-	..	-
Solar/Other	–	–	-	-	-	..	-
Electricity	25.1	29.0	27.8	27.6	..	..	..
Heat	–	–	-	-	-	..	-
Shares (%)							
Coal	*12.9*	*23.4*	*21.0*	*21.7*	..	..	..
Peat	-	-	-	-	-	..	-
Oil	*68.0*	*50.9*	*52.1*	*51.3*	..	..	..
Natural Gas	*1.5*	*2.9*	*5.1*	*5.5*	..	..	..
Comb. Renewables & Waste	-	*1.8*	*1.8*	*1.9*	..	..	..
Geothermal	-	-	-	-	-	..	-
Solar/Other	-	-	-	-	-	..	-
Electricity	*17.7*	*21.0*	*20.0*	*19.7*	..	..	..
Heat	-	-	-	-	-	..	-
TRANSPORT	**42.5**	**76.2**	**92.5**	**91.1**	**89.5**	**..**	**93.4**
TOTAL OTHER SECTORS[4]	**51.5**	**90.9**	**122.7**	**120.4**	**107.0**	**..**	**127.5**
Coal	1.8	1.0	0.6	0.6	..	..	..
Peat	-	-	-	-	-	..	-
Oil	35.2	43.2	44.4	39.7	..	..	..
Natural Gas	5.0	11.2	21.7	23.5	..	..	..
Comb. Renewables & Waste[1]	-	0.1	0.0	0.0	..	..	..
Geothermal	-	0.1	0.2	0.2	0.1	..	0.1
Solar/Other	-	1.2	0.6	0.6	..	..	..
Electricity	9.5	34.0	54.6	55.1	..	..	..
Heat	0.0	0.2	0.6	0.6	1.4	..	1.6
Shares (%)							
Coal	*3.4*	*1.1*	*0.5*	*0.5*	..	..	..
Peat	-	-	-	-	-	..	-
Oil	*68.5*	*47.5*	*36.2*	*33.0*	..	..	..
Natural Gas	*9.6*	*12.4*	*17.7*	*19.6*	..	..	..
Comb. Renewables & Waste	-	*0.1*	-	-	..	..	..
Geothermal	-	*0.1*	*0.2*	*0.2*	*0.1*	..	*0.1*
Solar/Other	-	*1.3*	*0.5*	*0.5*	..	..	..
Electricity	*18.5*	*37.4*	*44.5*	*45.8*	..	..	..
Heat	*0.1*	*0.2*	*0.5*	*0.5*	*1.3*	..	*1.3*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2005	2006	2010	2020	2030
ELECTRICITY GENERATION[5]							
INPUT (Mtoe)	**93.1**	**173.6**	**226.6**	**226.4**	**242.5**	**..**	**283.8**
OUTPUT (Mtoe)	**40.0**	**71.9**	**93.6**	**93.8**	**96.1**	**..**	**115.1**
(TWh gross)	465.4	835.5	1088.4	1090.5	1116.9	..	1337.9
Output Shares (%)							
Coal	*8.0*	*14.0*	*27.9*	*27.4*	*18.3*	*..*	*18.2*
Peat	*–*	*–*	*–*	*–*	*–*	*..*	*–*
Oil	*73.2*	*29.7*	*12.6*	*11.1*	*9.3*	*..*	*8.6*
Natural Gas	*2.3*	*20.0*	*22.2*	*23.3*	*23.3*	*..*	*28.8*
Comb. Renewables & Waste	*–*	*1.3*	*1.8*	*2.1*	*4.6*	*..*	*4.1*
Nuclear	*2.1*	*24.2*	*28.0*	*27.8*	*34.7*	*..*	*32.3*
Hydro	*14.3*	*10.7*	*7.0*	*7.9*	*9.5*	*..*	*7.8*
Wind	*–*	*–*	*0.2*	*0.2*	*..*	*..*	*..*
Geothermal	*0.1*	*0.2*	*0.3*	*0.3*	*0.3*	*..*	*0.2*
Solar/Other	*–*	*–*	*–*	*–*	*..*	*..*	*..*
TOTAL LOSSES	**92.0**	**139.3**	**176.3**	**175.0**	**159.0**	**..**	**182.8**
of which:							
Electricity and Heat Generation[6]	53.0	101.6	132.5	132.1	145.0	..	167.2
Other Transformation	19.6	17.1	21.5	20.6	5.1	..	5.8
Own Use and Losses[7]	19.3	20.6	22.3	22.3	8.9	..	9.9
Statistical Differences	**–5.6**	**–0.8**	**–1.7**	**0.7**	**–**	**..**	**–**

INDICATORS

	1973	1990	2005	2006	2010	2020	2030
GDP (billion 2000 USD)	2219.40	4122.40	4978.30	5087.10	5506.44	..	7343.20
Population (millions)	108.67	123.48	127.77	127.76	127.47	..	117.58
TPES/GDP[8]	0.15	0.11	0.11	0.10	0.10	..	0.08
Energy Production/TPES	0.09	0.17	0.19	0.19	0.25	..	0.26
Per Capita TPES[9]	2.96	3.59	4.14	4.13	4.20	..	4.96
Oil Supply/GDP[8]	0.11	0.06	0.05	0.05	0.04	..	0.03
TFC/GDP[8]	0.11	0.07	0.07	0.07	0.07	..	0.06
Per Capita TFC[9]	2.17	2.47	2.77	2.75	2.96	..	3.41
Energy-related CO_2 Emissions (Mt CO_2)[10]	907.6	1071.4	1227.7	1212.7	1105.8	..	1191.2
CO_2 Emissions from Bunkers (Mt CO_2)	61.5	31.0	41.2	38.5	36.3	..	43.7

GROWTH RATES (% per year)

	73–79	79–90	90–05	05–06	06–10	10–30
TPES	1.6	2.1	1.2	–0.2	0.4	0.4
Coal	–2.0	3.8	2.5	1.2	–4.5	0.2
Peat	–	–	–	–	–	–
Oil	0.5	–0.1	–0.1	–4.0	–0.8	0.1
Natural Gas	24.2	8.2	3.2	9.7	–0.9	1.5
Comb. Renewables & Waste	–	–	1.8	8.7	32.5	0.6
Nuclear	39.1	10.1	2.8	–0.4	6.3	0.5
Hydro	3.2	0.9	–1.0	12.2	5.5	–0.1
Wind	–	–	–	–	..	–
Geothermal	22.3	6.7	4.4	–4.7	0.0	–
Solar/Other	–	–	–4.7	–	..	–
TFC	0.9	1.9	1.0	-0.6	1.7	0.3
Electricity Consumption	3.9	3.3	1.8	0.4	0.8	0.9
Energy Production	4.9	6.1	1.9	1.2	7.5	0.5
Net Oil Imports	0.5	-0.2	-0.1	-5.0	-0.6	0.1
GDP	3.5	3.8	1.3	2.2	2.0	1.4
Growth in the TPES/GDP Ratio	-1.8	-1.7	-0.1	-1.9	-1.7	-1.0
Growth in the TFC/GDP Ratio	-2.5	-1.9	-0.3	-2.8	-0.4	-1.1

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

FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Combustible renewables and waste comprises solid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

2. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.

3. Industry includes non-energy use.

4. "Other sectors" includes residential, commercial, public services, agriculture, fishing and other non-specified sectors.

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

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

7. 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.

8. Toe per thousand US dollars at 2000 prices and exchange rates.

9. Toe per person.

10. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2005 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.

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The 27 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 hydropower, 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 27 member countries of the IEA are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, the Slovak Republic (since November 2007), Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

the nuclear option for the 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.

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.)

GLOSSARY AND LIST OF ABBREVIATIONS

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

AAU	assigned amount unit (under the Kyoto Protocol)
ABWR	advanced boiling water reactor
AIST	National Institute of Advanced Industrial Science and Technology
ANRE	Agency for Natural Resources and Energy
APEC	Asia-Pacific Economic Co-operation
APP	Asia-Pacific Partnership on Clean Development and Climate
ASEAN	Association of South-East Asian Nations
bcm	billion cubic metres
BEMS	business energy management system
BOG	boil-off gas
BTL	biomass to liquids
BWR	boiling water reactor
CASBEE	comprehensive assessment system for building environmental efficiency
CCGT	combined-cycle gas turbine
CCS	carbon capture and storage
CDM	clean development mechanism (a flexibility mechanism under the Kyoto Protocol)
CDQ	coke dry quenching
CER	certified emissions reduction (under the clean development mechanism of the Kyoto Protocol)

CHP	combined production of heat and power; sometimes when referring to industrial CHP, the term "co-generation" is used
CNG	compressed natural gas
CO_2	carbon dioxide
CSLF	Carbon Sequestration Leadership Forum
CTL	coal-to-liquids
EAS	East Asia Summit
ECCJ	Energy Conservation Centre, Japan
E&P	exploration and production
ERU	emissions reduction unit (under joint implementation of the Kyoto Protocol)
ESCJ	Electric Power System Council of Japan
ESCO	energy service company
EU	European Union
EU-ETS	European Union Emissions Trading Scheme
EUR	euro (€); EUR 1 = JPY 161 = USD 1.37 (average exchange rate in 2007)
FaCT	Fast Reactor Cycle Technology Development
FBR	fast-breeder reactor
FEPC	Federation of Electric Power Companies of Japan
FY	fiscal year
G8	Group of Eight, an international forum for the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States
GCV	gross calorific value
GDP	gross domestic product
GHG	greenhouse gas
GIF	Generation IV International Forum
GJ	gigajoule, or 1 joule × 10^9

GNEP	Global Nuclear Energy Partnership
GTL	gas-to-liquids
GW	gigawatt, or 1 watt × 10^9
GW_e	gigawatt of electric capacity
GWh	gigawatt-hour = 1 gigawatt × 1 hour
HEMS	home energy management system
HTTR	high-temperature test reactor
Hz	hertz
IEA	International Energy Agency
IEEJ	Institute of Energy Economics, Japan
IGCC	integrated gasification combined cycle
IGFC	integrated gasification fuel cell
IPCC	Intergovernmental Panel on Climate Change
IPHE	International Partnership for the Hydrogen Economy
IPP	independent power producer
ITER	International Thermonuclear Experimental Reactor
JAEA	Japan Atomic Energy Agency
JANTI	Japan Nuclear Technology Institute
JEPX	Japan Electric Power Exchange
JFTC	Japan Fair Trade Commission
JI	joint implementation (a flexibility mechanism under the Kyoto Protocol)
JNC	Nuclear Fuel Cycle Development Institute
JNES	Japan Nuclear Energy Safety Organisation
JNOC	Japan National Oil Corporation
JOGMEC	Japan Oil, Gas and Metals National Corporation
JPY	Japanese yen (¥); JPY 1 = USD 0.0085 = EUR 0.0062 (average exchange rate in 2007)

kcal	kilocalorie, or 1 calorie × 10^3, equivalent to 10^{-7} toe
kg	kilogramme, or 1 gramme × 10^3
kJ	kilojoule
kl	kilolitre, or 1 litre × 10^3
km	kilometre, or 1 metre × 10^3
km^2	square kilometre
kmt	thousand metric tonnes
ktoe	thousand tonnes of oil equivalent; see "toe"
kV	kilovolt
kWh	kilowatt-hour = 1 kilowatt × one hour = 1 watt × 10^3 × one hour
L	litre
LCD	liquid crystal display
LDP	Liberal Democratic Party
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LWR	light-water reactor
m^2	square metre
m^3	cubic metre
MAFF	Ministry of Agriculture, Forestry and Fisheries
mcm	million cubic metres
MEM	Major Economics Meeting on Energy Security and Climate Change
METI	Ministry of Economy, Trade and Industry
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MHLW	Ministry of Health, Labour and Welfare
Mkl	million kilolitres (1.172 Mkl is equivalent to approximately 1 Mtoe on an energy basis)
MLIT	Ministry of Land, Infrastructure and Transport

MOE	Ministry of the Environment
MOFA	Ministry of Foreign Affairs
MOX	mixed oxide
Mt	million tonnes
MtC	million tonnes of carbon
Mt CO_2	million tonnes of carbon dioxide
Mt CO_2-eq	million tonnes of carbon dioxide equivalent
Mtoe	million tonnes of oil equivalent; see "toe"
Mtpa	million tonnes per annum
MW	megawatt, or 1 watt × 10^6
MW_e	megawatt of electric capacity
MWh	megawatt-hour = 1 megawatt × one hour
MW_{th}	megawatt of thermal capacity
NEDO	New Energy and Industrial Technology Development Organisation
NEF	New Energy Foundation
NISA	Nuclear and Industrial Safety Agency
NO_x	nitrous oxides
NUCIA	Nuclear Information Archives
NUMO	Nuclear Waste Management Organisation of Japan
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PPS	power producers and suppliers
PV	photovoltaic
PWR	pressurised water reactor
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well
RPS	renewable portfolio standard

SME	small and medium-sized enterprise
SO_2	sulphur dioxide
t	tonne
t/a	tonnes per annum
TFC	total final consumption of energy
toe	tonne of oil equivalent, defined as 10^7 kcal
TPA	third-party access
TPES	total primary energy supply
TWh	terawatt-hour = 1 terawatt × 1 hour = 1 watt × 10^{12} × 1 hour
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar ($); USD 1 = JPY 118 = EUR 0.73 (average exchange rate in 2007)
VIU	vertically integrated utility

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Energy Policies of IEA Countries

JAPAN 2008 Review

Declaring climate change and environment as a top priority of the 2008 G8 Summit in Hokkaido, host country Japan has demonstrated its commitment to pressing ahead in these domains. Already a world leader in advancing energy technology transfer and environmental policy, the country is determined to further improve its domestic policies, moving it towards a more sustainable and secure energy pathway for the long term. Along with other accomplishments, government support for energy R&D is very strong and policies to enhance the efficiency of appliances – both for domestic consumption and export – are models for other countries.

Yet there is still room for progress. Most importantly, a greater reliance on market forces throughout the system could lead customers to choices that enhance security, raise economic efficiency and promote environmental protection. Particularly with respect to climate change goals – Japan is the world's fifth-largest greenhouse gas emitter – strengthening the value on greenhouse gas emissions would help give consumers the appropriate signals they need to make the right choices. Enhancing energy savings through efforts aimed at particular sectors (sectoral approaches) could be a part of the overall policy mix, along with ongoing leadership in promoting energy efficiency. The government should continue to work to complement existing voluntary instruments with stronger ones, including ones that rely more on market incentives, and standards and requirements.

This review takes an in-depth look at the energy challenges facing Japan today and provides critiques and recommendations for policy improvements to help guide the country towards a more sustainable energy future.

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