ENERGY RESOURCE MANAGEMENT IN JAPAN: GROWTH AND PRICING

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CERTIFICATE

This is to certify that the dissertation entitled **"Energy Resource Management in Japan: Growth and Pricing"**, submitted by me in partial fulfillment of the requirements for the award of the degree of **Master of Philosophy** is my own work and has not been previously submitted for any other degree of this or any other university.

Nabeel Ajmal Mancheri

We recommend that this dissertation be placed before the examiners for evaluation

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Was I Playing God in trying to control the lives of others?
I'm no sentimental humanist, but thoughts like these scared me
And made me actively aware of the limitations. . .. .

Dedicated to my Parents
&
Shohei Imamura

It is torture
To return to a thought
Again and again, and
Better to proceed
Feigning ignorance

CONTENTS

Preface and Acknowledgement

Following are basic five Questions and objectives that have prompted conducting a critical and empirical analysis on this research theme.

1. To analyze the growth and composition of Japanese energy sector in pre and post bubble burst (particularly 1980s and 1990s.)
2. To find out how successful is Japan in its efforts to diversify its energy sector.
3. To analyze the structural changes in the composition of Japanese energy supplies and energy demand and how it may change in days ahead.
4. To trace the relationship between economic growth and energy intensity and energy efficiency during recession and pre recession period of Japanese economy.
5. To study the impact of recession on energy pricing and to analyze the changes in government policies relating to energy sector.

These questions however are not discrete and discontinuous. There is a visible economic link. The energy sector and the economy as a whole have reciprocal relationship and it makes subject under study more complex. Energy security issues are more critical for Japan than for most IEA countries due to its geographical location and limited domestic energy resources. Consequently, Japan is making great efforts to ensure security of supply. Policies to promote nuclear power and renewable energies further contribute to diversification. Despite this effort, however, growing dependency on imported oil from the Middle East is still a concern. Other energy security challenges also prevail. The disruption in gas supply from Arun in Indonesia showed a potential security threat as the share of gas is increasing in the fuel mix. The outage of TEPCO nuclear plants which began in September 2002 is another example. Lastly, increasing summer peak demand for electricity makes it difficult to match supply and demand in the summer season which is usually hot.

Japan, the world's second largest energy importer, is currently facing a number of important policy challenges that could have significant implications on the volume of its energy consumption and the types of fuels it consumes. These policy challenges are many and range from economy wide issues such as economic reform, population aging and the achievement of greenhouse gas emission targets under the Kyoto Protocol to sector specific issues such as the implementation of changes to its energy tax regime and community concerns about the safety of nuclear power.

In addition to these policy challenges (which form the basis for the scenarios undertaken in this study), some more qualitative changes taking place in Japan's energy sector are highlighted in this analysis. These are energy security concerns that appear likely to broaden beyond oil and remain a key driver of Japan's energy policy. The progressive decentralisation of energy purchasing decisions in Japan is likely to continue to change the nature of Japan's energy market. These developments imply that Japan will become a more complex and competitive energy market in which participants will need to place greater effort on energy marketing but one that could offer significant opportunities for reliable energy suppliers.

The scenarios investigated in this study indicate that developments in the drivers of Japan's energy consumption could lead to substantial differences in the pace and pattern of growth in Japan's energy consumption over the period. Equally importantly, under all scenarios, imported fossil fuels continue to supply the majority of Japan's energy needs in to coming years and that by virtue of Japan's size, this will continue to be a vast amount of energy. Oil will remain Japan's largest energy source despite its slow growth relative to other fuels in all scenarios.

A key result of the study is that the extent to which Japan can successfully reform its economy is potentially the major determinant of its energy consumption growth over the period, particularly for natural gas and coal. Furthermore, the results from this study indicate that, unless Japan can accelerate its economic reform program, its current policy settings are likely to lead to slow growth in energy consumption in coming years.

I also believe in the words like acknowledgement, indebtedness, and gratefulness as the outcome of fervor, revelation of the formless soul, reality of the togetherness and love nurtured by the nature for humanity...So to express my feelings I also depend on these beautiful words.
I am indeed grateful to a number of persons and institutions ....At the very outset, I would like to acknowledge my profound indebtedness to my superviser Prof. H.S. Prabhakar which is registered through the length of this work. His excellent guidance, support and constructive criticism through questions and often incisive discussions on the subject, provided invaluable encouragement and steered me away from making many errors of judgment or fact. I wish to place on this record.
Paving the way for history, making the history and inspire to make history, they the beloved teachers of mine, I indebted to the faculties of the Centre for East Asian Studies for their advice and guidance and leading me into a world of new ideas and principles.
I sincerely place my testimony to the JNU& Indian Council for Cultural Relations (ICCR) for providing me the prestigious OKITA Memorial Fellowship for the year 2005-2006.
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I would also like to acknowledge my parents, my brothers who have always inspired me, and given me the confidence to believe that life is a celebration of relationships, commitmentments and grand ideas. I realise that this dissertation emerges out of this shared dreams.
I prevailed to enjoy my friends as a liberating force, they liberated me from the loneliness, introversion, the seriousness of academics; they opened the door of my body and allowed my soul to step out in to the world of love and friendship, I am grateful to all specially Abhay who kills my leisure time with his spontaneous jokes, Vara left no word to say but still a lot to remember, Nishta sincerity and commitment comes first, Dada (Bera) Hari and all my Mallu Friends.........
Any errors that might have inadvertently crept in are my responsibility.

Glossary and List of Abbreviations

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

AEC	Atomic Energy Commission.
AIST	National Institute of Advanced Industrial Science and Technology.
ANRE	Agency for Natural Resources and Energy.
APEC	Asia-Pacific Economic Co-operation.
ASEAN	Association of South-East Asian Nations.
bcm	Billion cubic metres.
b/d	Barrels a day.
BWR	Boiling water reactor.
CCGT	Combined cycle gas turbine.
CCT	Clean coal technology.
CHP	Combined production of heat and power or "co-generation ".
CO2	Carbon dioxide.
ECCJ	Energy Conservation Centre of Japan.
EPCo	Electric power company.
ESCO	Energy service company.
EU	European Union.
FBR	Fast breeder reactor.
FTC	Fair Trade Commission.
FY	Fiscal year (1 April -3 March).
GDP	Gross domestic product.
GHG	Greenhouse gases.
GW	Gigawatt,or one watt $\times 10^9$.
GWh	Gigawatt-hour =one gigawatt ×one hour.
HFC	Hydrofluorocarbons.
Hz	Hertz.
IEA	International Energy Agency.
IPCC	Intergovernmental Panel on Climate Change.

IPP	Independent power producer.
JAPC	Japan Atomic Power Company.
JNC	Japan Nuclear Fuel Cycle Development Institute.
JNES	Japan Nuclear Energy Safety Organisation.
JNFL	Japanese Nuclear Fuel Company Limited.
JNOC	Japan National Oil Corporation.
Kl	Kilolitre.
Km	Kilometre.
KV	Kilovolt,or one volt $\times 10^3$.
KW	Kilowatt,or one watt $\times 10^3$.
KWh	Kilowatt-hour =one kilowatt ×one hour.
LNG	Liquefied natural gas.
LPG	Liquefied petroleum gas.
M	Metre.
M^2	Square metre.
Mb/d	Million barrels a day.
Mcm	Million cubic metres.
METI	Ministry of Economy,Trade and Industry.
MEXT	Ministry of Education,Culture,Sports,Science and Technology.
MOE	Ministry of Environment.
MOX	Mixed oxide fuel.
Mt	Million tonnes.
Mtoe	Million tonnes of oil equivalent;see toe.
MW	Megawatt,or one watt $\times 10^6$.
MWh	Megawatt-hour =one megawatt ×one hour.
NEDO	New Energy and Industrial Technology Development Organisation.
NGO	Non-governmental organisation.
NISA	Nuclear and Industrial Safety Agency.
N_2O	Nitrous oxide.
NOx	Nitrogen oxide.
NSC	Nuclear Safety Commission.

NUMO	Nuclear Waste Management Organisation of Japan.
OECD	Organisation for Economic Co-operation and Development.
PFC	Perfluorocompounds.
ppm	Parts per million.
PV	Photovoltaic.
PWR	Pressurised water reactor.
R&D	Research and development;may include the demonstration and Dissemination phases as well.
SF6	Sulphur hexafluoride.
SOx	Sulphuroxide.
TEPCO	Tokyo Electric Power Company.
TFC	Total final consumption of energy.
TJ	Terajoule,or one joule x 0 12 .
toe	Tonne of oil equivalent,defined as 0 7 kcal.
TPA	Third-party access.
TPES	Total primary energy supply.
TSO	Transmission System Operator.
TWh	Terawatt-hour =one terawatt x one hour.
UNFCCC	United Nations Framework Convention on Climate Change.

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INTRODUCTION TO ENERGY MANAGEMENT IN JAPAN

Energy plays an important role in economic and social development of any country. The study of issues related to state policies on energy has, therefore, its own significance in studies related to international relations or country specific area studies. Because states' energy policies are determined by sharp global discontinuities in supply and high stakes in the energy resource management. Moreover, the state's responses to global energy supply are shaped by its decision-making systems, resource profiles and values and perceptions. The theme under study attempt to analyze the global and domestic factors that determined the growth and pricing of energy in Japan after the 1979 oil crisis.

The consequences of energy deficiency on the working of the national economy are of vital importance. Surely, a sufficient supply of energy is essential for the proper working of the economy; further, due to the ubiquitous role of this commodity energy policy cannot be defined without taking into account the inter relations between the energy sphere and the economic sphere as whole. Energy resources themselves are not the problem. The problem is the management of the world's vast energy resources, and all the complex political and economic decisions and choices and events that surrounded the management task.

Energy problems however proved far more complicated than originally anticipated. None of the alternative technologies now appear simple or inexpensive with changed world economic conditions brought about by ever rising oil prices, future economic growth and thus growth in energy demand are far more uncertain than had been predicted during the period of rapid economic growth in Japan. Nations must map their future energy policies with much greater uncertainty and insecurity but many key factors of supply and demand lies beyond their control.

In 2005, the population of Japan was 128.08 million, only 3%higher than in 1990.The population density of 340 persons per square kilometer is one of the highest within the OECD countries. The total land area is 378000 km, stretching over 3300 km north to of supply has always been a major issue as Japan is an archipelago with few indigenous energy resources. Two-thirds of the land is mountainous, thus affecting the possibilities to build energy networks. In addition, seismic instability requires high security standards. In 2004, the gross domestic product (GDP), measured using current purchasing power parities, was US$3,788 billion .GDP, measured using current prices and exchange rates, was US$4,666.4 billion making Japan the second largest economy in the world[1]. However, economic growth was very slow through the 1990s.In 1999-2000 there was a modest recovery but in 2001, GDP decreased by 0.3%.The OECD estimates growth to be only 0.5 to 1%per year to the end of 2004 with deflation continuing[2].

Japan is the fourth largest energy consumer in the world. In 2001, total primary energy supply (TPES) was 520.7 Mtoe and fell to 517.10 Mtoe in 2003, up by 19%from 1990 levels. This exceeds the 14%growth of GDP over the same period which is quite exceptional among IEA countries. Japan's dependence on oil has decreased from 58%in 1990 to 49.2%in 2001.In 2000, coal accounted for 19.2%, followed by nuclear (16%),natural gas (12.4%),hydro (1.4%),combustible renewables and wastes (1%),geothermal energy (0.6%)and other renewables (0.2%).There were some changes in the proportions of different fuels in TPES between 1990 and 2006.Oil use was replaced mainly by natural gas whose share increased from 9.9%,nuclear power from 12.1%and coal from 16.9%[3].

Japanese responses to energy problems have encompassed energy conservation, the maximum utilization of domestic sources, the development of energy substitute for oil as well as emphases on efficient and effective energy installations, energy research, close co-operation of energy exporting countries and the stock piling of energy resources. The future can be projected only from the record achieved so far, and the Japanese record meeting the challenges stands as brilliant. This evaluation, however doesn't meet the opinion of most Japanese energy critiques as they have on the contrary tended to be overly pessimistic. For example, most Japanese reviewers would consider Japan's efforts

[1] An International Comparison, Japan 2006, Keizai Koho centre. pp.17)
[2] Energy Policies of IEA countries, Japan 2003 Review IEA.2003 pp.17
[3] Ibid. pp.18

in overseas petroleum development a total failure, as these did not succeed in achieving the projected supply of 30% of Japan's oil needs nor have they proved profitable.

Japan is still 82% dependent on imported energies, and in light of the tremendous degree of vulnerability, the diversification of sources of supply and of the domestic energy mix and pattern of consumption can only been seen as a palliative rather than as a comprehensive solution to continuing dependence. The Japanese response to later condition, given the funding and timing limitation of energy substitution and new technological development, will not allow a quick made in Japan solution. Japan's resource diplomacy has had, therefore, to be innovative in the context of new and complicated economic and geo politic relationship between states. The management of dependence has led to new trading and investment opportunities. Japan's energy diplomacy has had to master an increasingly varied set of international variables, and as such diplomacy has reflected foreign policy choices which have not always been consistant with US strategic positions.

Strategy and Approaches of Japan's Energy Diplomacy

Japan is dependent on foreign sources for over 80% of its primary energy supply. The Ministry of Foreign Affairs is engaged in the following six issues of energy diplomacy to strengthen Japan's energy security.

1. Maintaining and Enhancing Emergency Response Measures

(1) Japan is engaged in the improvement and enhancement of international emergency response systems, focusing on the oil stockpiling system of the International Energy Agency (IEA).

(2) Through the utilization of regional cooperative frameworks such as ASEAN+3 and Asia-Pacific Economic Cooperation (APEC), Japan is making efforts to create the emergency response systems in the Asian region.

(3) As of September 2003, Japan's oil stockpiles amount to 167 days (based on the Petroleum Stockpiling Law).

2. Maintaining and Enhancing Friendly Relations with Middle East Countries, other Energy Producing Countries, and Countries along International Shipping Lanes

(1) Japan is promoting dialogue among oil-producing and oil-consuming countries at the multilateral level (e.g. Based on the decision of the 8th International Energy Forum, which was hosted by the Government of Japan in September 2002, a permanent secretariat was established in Riyadh.

(2) Through dialogue with Organization of Petroleum Exporting Countries (OPEC) Japan is seeking to build strategic partnerships with them.

(3) Japan continues to hold dialogue with energy producing countries and countries along international shipping lanes.

3. Diversification of Sources of Energy Supply

(1) To diversify sources of oil supply Japan is working to strengthen relations with relevant countries and improve the investment environment. (e. g. Japan is strengthening cooperation in the energy sector with the Russian Federation, including the Sakhalin Project).

4. Diversification of Energy Sources

(1) Compared with oil, natural gas is more diversified in geographic terms and environment friendly, Japan is making efforts to create an environment for the further use of natural gas (e.g. the Sakhalin Project).

(2) Considering international cooperation with regard to the use of renewable and new energy, Japan is seeking to build cooperative relations with international community in an appropriate format for Japan.

5. Promoting Energy Saving, Efficient Use of Energy, Development and Use of Alternative Energy and Response to Environmental Issues

(1) Energy issues must be addressed, aiming at the goal of simultaneous achievement of the three "Es": economic growth, energy security and environmental protection. Consequently, Japan is promoting international cooperation to expedite the use of energy

which exerts minimal burden on the environment (e.g. greenhouse gas emissions) and to develop and disseminate its technology.

(2) Through multilateral (international organizations such as IEA) and bilateral consultations (Japan-Russia, Japan-China, Japan-India and Japan-Australia, etc.), Japan is promoting investigation and international cooperation concerning energy saving, the efficient use of energy and the development and use of alternative energy sources.

(3) Japan is making efforts to raise international understanding with regard to Japan's nuclear energy policy.

(4) Japan is engaged in promoting the diffusion of renewable energy to developing countries.

(5) Japan is working to promote international cooperation in achieving the greenhouse gas reduction targets stipulated in the Kyoto Protocol (e.g. joint implementation on a bilateral basis and promotion of the Clean Development Mechanism).

6. Approaches to Creating an Environment for the Enhancement of Global Energy Security

(1) Japan supports reforms based on market principles in the energy sectors of the Commonwealth of Independent States (CIS) members, Central and East European countries and endorses the geographical expansion of legal frameworks through the activities of the Energy Charter Treaty.

(2) Japan is implementing cooperation for development of energy resources and infrastructure improvements in energy producing countries.

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

Achieving the *3 Es* in the short and long terms will require continuation of recent trends in research, development and deployment, in the areas of energy efficiency and renewables, while continuing to give attention to nuclear, particularly waste management and research directed at raising the level of public acceptance of nuclear power. A balance of long-term and short-term research and development is likely to continue to be needed, particularly in light of increased private sector focus on short-term research and development. Consideration could also be given to further research on the effectiveness of market-based mechanisms for achieving the *3 Es* of Japanese energy policy.

Energy Policy Institutions

Responsibility for energy policy rests with the central Government, with the Ministry of International Trade and Industry (MITI) taking the lead role. In January 2001, the Ministry of International Trade and Industry became the Ministry of Economy, Trade and Industry (METI). Hereafter both the METI and the MITI will be referred to only as the METI. Within METI, the Agency of Natural Resources and Energy (ANRE) is responsible for the rational development of mineral resources, the securing of a stable supply of energy, promotion of efficient energy use, and regulation of the electric power and other energy industries. Responsibility for energy research and development is shared between ANRE and METI's Agency of Industrial Science and technology. The Nuclear and Industrial Safety Agency, with its seven sections related to nuclear energy, was added to ANRE as a special institution to take a central role in nuclear safety regulation. Responsibility for promoting and developing nuclear power remains in the Electricity and Gas Industry Division of ANRE[4].

Within METI, energy policy-making is entrusted to the Agency for Natural Resources and Energy (ANRE) with a staff of 463. Many other government departments are involved in energy issues. The Ministry of Education, Culture, Sports, Science and Technology's (MEXT) responsibilities include R&D on nuclear fusion and basic research. The Ministry of Environment (MOE) does not have specific responsibilities in the energy field but because it deals comprehensively with environmental policies, it also needs to address many energy-related issues. The Ministry of Land, Infrastructure and Transport (MLIT) formulates transport policies and makes recommendations for building

[4] Standard review of Japan, 2001, IEACompodium,2001.pp. 165

standards. The Ministry of Foreign Affairs (MOFA) is involved in energy policy by enhancing energy security through international co-operation in the field of energy. Responsibilities for nuclear safety and security are concentrated in the Nuclear and Industrial Safety Agency (NISA) which has worked as a special institution within the METI since 2001. Formerly, some of these tasks were implemented by ANRE and the Science and Technology Agency[5].

Japan's NESO is organised within the Agency of Natural Resources and Energy (ANRE) of the METI. In the case of oil supply disruption, ANRE of METI, including the following divisions, would also be responsible for the implementation and co-ordination of the domestic emergency response measures:

• The International Affairs Division, the Energy Policy Planning Division of the Director-General's Secretariat,

• The Planning Division, the Refining Division and the Petroleum Reserve Division of the Petroleum Department, and

• The Energy Efficiency Division of Coal and the New Energy Department.

Allocation Procedures

Stockholding and Maintenance

Oil stock-building started in 1974 with a stock level of 60 days, which corresponded to pre-IEA/OECD requirements. In addition to industry stocks, the government began to build its own stocks in 1978. In November 1987, the Petroleum Council's Sub-Committee for Stockholding submitted a report on future oil stockholding policy in Japan to the government. Based on the recommendations of the report, the government has implemented the following stockholding policy:

• Private stocks are being reduced to 70 days.

• Government stocks are being increased to 50 million kl, equivalent of 90 days imports.

The government provides companies with low-interest loans. With regard to the funding of purchases of oil except LPG for stockholding, out of the mandatory stockpile for 70 days, 25 days of the volume in excess of the running stocks (45 days) are covered by low-

[5] Energy Policies of IEA countries, Japan 2003 Review, IEA.2003. pp.22

interest loans. As for LPG, out of the required stockpile for 40 days, 90% of the volume in excess of the operating stocks (10 days) is financed by low interest loans. The government also supports the establishment and maintenance of company storage facilities.

Demand Restraint Measures

Policy and Legal Instruments

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

The government and local government organisations will take initiatives to introduce demand restraint measures by persuading the public and industry to make greater efforts to conserve energy and provide them with necessary information on the emergency situation. The measures to be taken will be decided on an *ad hoc* basis and reflect the specific nature of any crisis.

Procedures and Monitoring

Based on past experience of oil crises, the government believes that the general public and industries should co-operate in oil consumption reduction measures in an emergency.

Other Response Measures

Fuel-switching

In the case of an emergency, the METI has authority to make a recommendation to modify the supply plan or issue a supply order to electric power companies in accordance with the Electric Utilities Industry Law, in order to secure an adequate capacity for electric power supply and to shift the energy source to non-oil energy sources such as coal, natural gas and nuclear power[6].

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[6] Oil Supply Security, The emergency Response potential of IEA Countries in 2000.OECD/IEA, 2001.pp. 180

Energy Demand and End Use Efficiency

Total energy consumption in 1998 fell for the first time since the second oil crisis in 1979. The fall was entirely the result of the economic recession and weak energy demand in the industrial sector. While energy demand in the industrial sector was almost stable between 1973 and 1998, it almost doubled in the residential/commercial and transport sectors in the same period.

Japan has set a target to reduce energy demand to 400 million kilolitres of crude oil equivalent by 2010, or 9 million kilolitres of crude oil equivalent lower than in the projected business-as-usual case for that year. This target would require virtually no growth in energy consumption from 1996 to 2010. Two major policies to realise this target are the Voluntary Action Plan of Keidanren (the Japan Federation of Economic Organisations) in the industrial sector and the Top Runner programme in the residential/commercial and transport sectors. Keidanren's Voluntary Action Plan covers 32 industry associations, which are responsible for 75% of total carbon dioxide emissions from the industrial sector.

A joint sub-committee of the relevant advisory bodies of METI annually reviews the plan's progress. The Top Runner programme is a legally binding energy efficiency standard based on the Law Concerning Rational Use of Energy.

It covers 11 products such as passenger vehicles, motor trucks, air-conditioners, etc. The targets are based on a product that has the highest energy efficiency performance of all the products in the same group in the market. This is a substantial change from previous standards, which were based on the average performance of product groups.

Lifestyle changes have caused a rapid increase in energy consumption in passenger transport and the residential sector. As a result, carbon dioxide emissions from the energy sector increased by about 8.9% in 1999 over 1990. Construction of some nuclear power generation plants has been postponed. The share of coal in energy supply has increased rapidly, while the share of nuclear and renewable energy has shown only a slow increase[7].

[7] IEA World Energy Outlook 2002, pp.165-166

Energy-consumption growth in Japan slowed in the 1990s due to economic stagnation. Total primary energy supply (TPES) declined along with GDP in 1998 for the first time in two decades as industrial energy demand fell. The Japanese Government's Advisory Committee for Energy reviewed a long-term energy objectives and policies, in early 2001. Its report seeks more effective development, use and mix of fossil fuels, nuclear and renewables, in order to enable the country to achieve its Kyoto target and to secure stable long-term energy supply.

The discussions reportedly include further diversification of energy sources with greater roles for natural gas and renewables, in recognition of the difficulty in increasing nuclear capacity as fast as planned. Japan is progressively pursuing liberalization of its energy sector. The government now seeks to build a more competitive market, in which private companies will conduct more effective oil exploration. Deregulation of the oil sector is now largely complete, with a goal of full deregulation and institutional reform. Reforms in electricity and gas, launched later than in oil, could contribute significantly to lower energy prices. The partial liberalization of the electricity market, which started in 2000, allows independent producers to enter the market.

Energy Liberalisation and Prices

Japan continues to liberalise its energy sector with the aim of improving efficiency and lowering pre-tax prices, which are among the highest in the world:

•The deregulation of the oil sector, now largely complete, has unleashed fierce competition in oil product marketing. The resulting pressure on margins is forcing firms to rationalize their operations and cut costs. Several companies have merged since 2000, and a large part of the country's refining capacity has been shut down.

•The Japanese Diet passed a bill in May 1999 amending the Electric Utilities Industry Law to allow a partial opening of the power sector to competition. About 8,000 large industrial and commercial consumers —accounting for about a third of the total power market —may now choose their electricity suppliers. Regional utilities are obliged to allow power from other suppliers to pass through their grids to eligible consumers. Independent power producers have already entered the market. The government plans to fully open the power market to competition by 2007.Japanese electricity prices are currently the highest among the OECD countries.

Gas reforms, which have partially opened up the market to competition, were launched in 1999.Suppliers can now compete for eligible customers outside their traditional service areas. The electric utilities and oil companies are considering selling gas in competition with the city-gas distribution companies.

While energy security and environmental issues have been well addressed in Japan, more needs to be done to improve economic efficiency, including efficiency in the energy markets and cost-effectiveness of government policies. Japanese energy policy includes a complex web of financial and fiscal incentives to encourage certain energy supplies and end-use technology choices. It is not clear how well these mechanisms are working individually or collectively. Japan should develop a comprehensive map of all the various financial incentives and disincentives, regulatory taxes, R&D, etc, to determine the cost-effectiveness of these measures and rationalize these policy options for maximum impact and leverage. Despite some recent reductions, energy prices in Japan are still among the highest within IEA member countries. To increase market efficiency, the government has launched market reform. This process is most advanced in the oil sector which has been fully liberalized. However, the implications have not yet been fully ascertained because the industry is still in the middle of restructuring which involves closing excess refining capacities and rationalizing retailing.

Natural gas market liberalization started in 1995 and 39% of the market is now opened. If measured in terms of the market share by new entrants, *i.e.*2% of the liberalized market segment in March 2002, little competition has emerged. The government has recognized the need for further action to fully capture the potential benefits of market reform and announced new measures such as the introduction of regulated third-party access (TPA) to the pipelines and the promotion of negotiated TPA to the LNG terminals. These appear helpful but their effectiveness needs to be closely monitored and corrective measures need to be introduced promptly if competition does not develop. Expansion of the domestic gas network is also a challenge to further introduction of natural gas, enhancing security of supply and competition.

Electricity market reform was initiated in March 2000.At present, 30% of the market has been opened for competition and regulated TPA has been introduced. Some price reductions have taken place for both liberalised and captive consumers, mainly because of low interest costs, but price positioning due to market liberalisation may also have had an impact. Because new entrants are having difficulties in entering the market and there is little revealed competition between the incumbents, the government has announced further steps. Many of the proposed measures, including clearer criteria for TPA tariffs, removal of pancaking[8], establishment of national power exchange and relaxation of balancing power rules, can help make market access easier, fairer and more transparent. However, the proposal does little to address the fact that the incumbents are very large and powerful companies with significant market powers compared to new entrants. Given the slow entry rate, competition between the incumbents has to be fostered.

Security of Energy Supply.

Japan is making great efforts to ensure security of energy supply. Despite many measures already in place, growing oil import dependence from a single area is still a concern. While Japan's oil emergency measures such as oil stockpiling are very solid, efforts should continue to reduce oil dependence and diversify supply sources. However, Japan is encountering new issues of energy security other than oil supply security. Recent disruption in gas supply from Arun LNG plants is a typical example. Gas supply security is becoming more crucial in Japan because the gas share in TPES is increasing. Concerns are emerging in the electricity sector following recent events at TEPCO nuclear plants. Energy security does not stop at national boundaries but is moving down to the final consumer. Gas and electricity have to be considered as well as oil –both in the short and longer term. These issues are more critical in Japan than in most IEA countries owing to its isolated location without gas and electricity interconnection with neighboring countries and lack of indigenous energy resources. In particular, development, integration and strengthening of natural gas and electricity networks warrant more effort.

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[8] Pancaking means that two or more access charges are collected in electricity transactions when two or more transmission systems are used.

Japan's energy security is also very much affected by the energy security in the Asian region as a whole. Rapidly growing energy demand in the Asian region raises concerns about Asian energy stability. Despite Japan's concrete energy security measures, serious turbulence in the Asian energy market caused by a supply disruption could have a negative impact on Japanese energy security and the economy as it is heavily linked with the Asian economy[9]. Therefore, it is sensible that the government has a keen interest in enhancing emergency preparedness in Asian energy-consuming countries through bilateral and multilateral frameworks.

While ensuring energy security is of the utmost importance, Japan has adopted a wide-ranging programme for the promotion of more energy-efficient equipment –the so-called Top-Runner Programme .Efforts are also undertaken to reduce stand-by power waste and to implement energy management systems for homes and buildings. In 1999, voluntary standards for homes and buildings were upgraded. Subsidies, in the form of low- interest loans, are available for the purchase of more efficient homes. The government estimates that these measures altogether could achieve a 2% reduction in emissions from 1990 levels in the residential and commercial sector. This means a decline from the 2001 emission levels that were 25.5%above 1990.

The original plan for the development of nuclear power is a 30% increase in power generated from nuclear by 2010 (equivalent to 10-13 new plants under current operating conditions).The problems encountered in Japan's nuclear power sector over the last few years may make it difficult to achieve the plan. However, nuclear plants currently have an availability ratio that is lower than the practice in other countries, and improvements on that front could help make up the shortfall, if only 7-8 plants were to start operation in the Kyoto time frame.

The government aims for a rapid development of renewable energy by 2010, although Japan's starting point is relatively low. The indicative target include an increase from 209 MW to 4.8 GW of installed capacity for photovoltaic, from 83 MW to 3 GW for wind,

[9] Ibid. pp.28

and from 900 MW to 4.2 GW for wastes by 2010.It is supported by a set of instruments, including a renewables portfolio standard introduced under the "Law Concerning the Use of New Energy by Electric Utilities" of June 2002.By 2010, utilities must use new renewable sources amounting to 1.35%of their total output[10].

The government also introduced a subsidy to encourage the closure of old coal-fired plants and the shift to natural gas-based generation. Under this system, the government would subsidise 10% of the construction cost of a natural gas plant if a coal plant of more than 35 years of age were closed. The annual budget of this policy is ¥2.5 billion, and it is planned to run for the next ten years[11].The Federation of Electric Power Companies (FEPC) has adopted a goal to reduce the CO2 intensity of end-use electricity by 20%from the 1990 level (to 0.34 tCO2 per MWh against 0.379 in 2001)by 2010.But it also projects a 16%increase (corresponding to a 1.5 %annual growth rate)in the total output of the ten electric power companies between 2001 and 2011,less than the 24%growth in the 1990s.On the whole, the FEPC projects that utilities 'emissions will rise by about 14%from FY1990 by FY2010[12].

Because of its heavy dependence on imported fuels, Japan has always placed a great importance on measures to enhance the security of energy supply. Though market operators are free to choose their supply sources and negotiate their contracts, the government has had an important role in creating favourable conditions to support the development and procurement of oil and natural gas, and, more recently, procurement of coal from new sources. Coal and gas are purchased from well-diversified sources. However, a new challenge following market liberalisation will be to ensure adequate diversification of gas sources. It is of great concern that the dependence on Middle East oil has been increasing since the mid-1980s and has reached 89%–much higher than the

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[10] Ibid. pp. 40
[11] According to the Platts, UDI Products Group's (UDI) database, Japan's coal-based capacity amounts to more than 50 GW, with about 4 GW of capacity in operation for more than 35 years

[12] Principles and Measures 2002-2003 .The Federation of Electric Power Companies (FEPC), page 4.

level at the time of the first oil crisis. However, diversification of oil supply sources is not an easy task. The development of oil supplies via a pipeline from Russia –a long-term strategic project discussed between the Japanese and Russian governments –could help to reduce dependence on the Middle East. As dependence on the Middle East cannot be reduced in the short term, it is essential to enhance relations with Middle East producer countries and promote a producer-consumer dialogue.

JNOC has played an active role in implementing policies to address security of supply. As effective stockpile management is a necessity in ensuring energy security, a smooth transition should be ensured when JNOC is dissolved and its successor established. The Japanese policy to support overseas exploration of gas and oil by Japanese companies has made some contribution to energy security as crude oil supplies from these sources account for 11.5% of the total. Therefore, exploration activities, and associated R&D efforts, should not be jeopardized by the dissolution of JNOC. In addition, cost-effectiveness of such activities should be maximized[13].

Oil Security

Oil remains a critically important energy source for Japan. The supply structure remains weak, since Japan's dependency on the Middle East is higher than that of other IEA countries. Securing oil is the most important issue in the context of energy security. Japan has, therefore, adopted measures, such as stockpiling, self development of crude oil abroad and co-operation with oil-producing countries. Alongside direct government involvement (principally through JNOC), Japan has started to introduce policies to ensure that the operation of the domestic market in petroleum products is comparable with international standards of performance. The intention is to reduce or abolish government interference in non-emergency periods. The downside of Japan's oil exploration policies has been their high cost. Output volumes of oil from Japanese overseas projects are considerable but comprise less than half of the targets set for 2000.

Over the years, JNOC has given numerous loans to Japanese exploration firms. However, some of them have proved to be bad ones owing to poorer-than-expected results. Generous subsidies for exploration may have discouraged exploration firms from seeking high rates of return for their investments. In this context, it is positive that the

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[13] Energy Policies of IEA Countries, Japan Review.IEA.Paris.2003.pp.87

government has taken the initiative to evaluate and streamline its various support schemes with a view to maximizing their cost-effectiveness. However, the government considers what measures it could take to ensure that oil found abroad is supplied to Japan during emergency periods. It is commendable that oil markets have been fully liberalized. As a consequence, competition has started to develop as reflected in the changes in industry structure and in some oil product price reductions. However, there is still considerable room to increase the efficiency of the oil sector through competition both at the wholesale and retail levels. The relatively lower operational ratio of refining capacities, low sales volume per service station and the low number of self-service stations are examples.

The government encourages the refining industry to further rationalise its operations as compared to the development of demand. The tightening environmental regulations will also affect industry's decision as to which facilities are to be closed, and which facilities are to be upgraded with necessary investments. At the moment, the government is considering the establishment of tighter environmental requirements for transport fuels. Given the investments needed to implement these, and the reorganization process in the foreseeable future well beyond 2010 will be met by coal. Therefore, a widespread introduction of clean coal technologies (CCTs) would be necessary to achieve energy efficiency savings, to avoid air pollution problems caused by conventional coal plants and even to contribute to the GHG emissions target. The cost of CCTs is higher than that of conventional alternatives. Therefore, measures may be needed to encourage the market deployment of this technology. This could be addressed by similar market-based incentives such as those given to the development and commercialization of renewable energy technologies, *i.e.* accelerated depreciation or tax rebates. Long-term investment in CCTs also requires stability in the environmental and other regulatory framework.

Gas: Achieving the *3 Es* through Market Mechanisms

Natural gas is considered to be one of Japan's more important energy sources on energy diversity and security grounds, since dependency on the Middle East is smaller than that for oil, and on environmental grounds, because of lower greenhouse gas emissions than from coal-fired power natural gas is principally LNG, the pipeline network is limited and consumption is largely for electricity generated at plants located near terminal facilities. Industrial use of gas is low compared with other industrialized countries because of its cost and the cost of pipeline development, which would be needed to support a rapid growth in consumption in the industrial or the commercial and residential sectors. Given the high dependence on Middle East oil, natural gas might be considered as a means of meeting energy demand with an acceptable environmental outcome. To develop gas further would require overcoming two major barriers: developing the network and lowering the cost of supplying LNG. The more immediate options for developing gas involve lowering the cost of LNG and/or making it more attractive against oil through taxation to reflect its diversity and environmental values. According to the Japan Gas Association, construction costs of terminals have been reduced by about 25% and operating costs by about 50% since 1970. Cost reductions are attributed to technological developments such as doubling the size of terminal berths and LNG tank capacity, and to a five-fold increase in labour productivity. Over-riding considerations in reducing costs within the terminals are safety, reliability and security of supply.

The Japanese gas market is unique compared with other IEA countries. It can be seen as a developing market which has not reached full maturity in some of its segments. Most of the gas used is imported LNG and there are no natural gas import pipelines. The gas networks are not interconnected and they cover only a fraction of the urban areas. Also the large, though decreasing, share of LPG in total gas supply is unique within IEA member countries. Another exceptional feature is the extremely high gas prices, explained in part by the high supply cost of LNG and high costs of building pipelines due to geographical and safety considerations. The government expects natural gas to play a greater role in the future energy mix for three reasons. First, natural gas can contribute to energy security because there are abundant natural gas reserves in the Asia-Pacific and Russian Far East. Expansion of gas imports from these regions could contribute to a reduction of Japan's dependence on Middle East supplies. Second, it can contribute to environmental protection goals because of its lower emissions of CO2 NOx and SOx compared to other fuels. Third, natural gas can be used in new technologies such as micro-gas turbines and fuel cells, which would substantially expand the scope of natural gas usage and also contribute to energy security and environmental protection.

However, there are many challenges in expanding natural gas use. The first is the very high price of natural gas. One factor is the price link to crude oil prices which is a characteristic of Asian countries, including Japan. While long-term take-or-pay contracts of LNG imports ha e been contributing to security of supply, they reduce the liquidity and possibilities to seek cheaper gas sources (*e.g.* purchases from spot markets), should they emerge. Gas and electricity utilities are finding it more difficult to enter into rigid long-term take-or-pay contracts partly because of the uncertainty of future gas demand and, therefore, future contracts are likely to be more flexible and somewhat shorter[14].

However, in order to reduce natural gas prices, Japan will need to have more bargaining power. Reduction of construction and maintenance costs of natural gas infrastructure is also essential to ensure competitive prices. The Sakhalin projects present an interesting opportunity to diversify gas sources in the long term. However, uncertainties exist about the cost of pipeline gas and the future development of gas demand. Some of the expiring long-term contracts have already been renewed while others are in the process of being renewed. Nearly all regional LNG suppliers have unused export capacity or expansion plans and they have better possibilities to enter into shorter contracts owing to depreciation of their assets. Under these circumstances it is not certain that there will be adequate demand for the new pipeline gas. On the other hand, uncertainties in the implementation of the nuclear programme could have an impact on gas demand for power generation in the future.

The second challenge is the development of the gas infrastructure, in particular pipeline networks. Pipeline infrastructure has been developed only around LNG power plants close to import bases and urban areas, thus limiting the use of gas. A domestic gas trunk network is also essential to link the widespread existing and potential new consumers to create aggregate demand necessary for the introduction of pipeline gas. An interconnected network could also enhance security of supply by providing more flexibility and help competition to develop. While the construction and management of a natural gas pipeline is primarily the responsibility of the private sector, the government

[14] ibid- pp. 90

could also play a role in improving the investment climate to reduce business risks, *i.e.* uncertain demand in the early stages of pipeline construction.

Coal: Security of Supply

Japan has few natural energy resources and heavy dependence on imported coal has historically been an important issue. Forecasts of coal demand in Asia have led some commentators in the past to question the continuing security of supply of coal, and raised the possibility of a rising price trend being necessary to stimulate investment and to ensure supply. In Japan, where steam coal is used primarily for base load power generation, security of physical supplies of steam coal supply is essential. The question arises whether pressure to reduce fuel costs for electricity generation will conflict with Japan's energy security objective.
Traditionally, the price paid in Japan for coal is higher than elsewhere in Asia. Other Asian markets have historically followed the Japanese price in settling contracts but there are growing differentials, for example, sales to Korea have been settled independently of Japanese prices. The relatively high coal price paid historically in Japan reflects the value placed by Japanese buyers on securing upstream investment and not the negotiating strength of suppliers. The Japanese coal market may be becoming more sensitive to movements in the spot market[15].

Coal was one of the few indigenous energy sources in Japan. However, its high production cost prevents it from competing with imported coal. Japan is highly commended for its success in phasing out its uneconomic domestic coal industry without major social consequences. This has been possible thanks to considerable restructuring and business diversification efforts by the government. The phase-out didn't raise any security of supply concerns as the international market in hard coal is well established and offers secure and reliable sources of fuel at prices that Japanese national production cannot match. The electricity market liberalisation is also changing the nature of coal trade because generators need to reduce fuel costs to remain competitive. The share of

[15] World Energy Outlook, IEA Paris.1999 .pp. 126

China as a supply source has been increasing rapidly owing to its competitive prices resulting from low production and transportation costs[16].

Other Energy and Environmental Policies

Japan is making great efforts to ensure security of supply by diversifying its energy mix away from oil. Furthermore, oil stocks exceed the IEA stockholding obligation, many flexibility tools (such as supply diversity and possibilities for fuel- switching) are used for natural gas, and policies to promote nuclear power and renewables help towards diversification. However, growing oil import dependence from a single area is still a concern. Japan is also encountering new issues of energy security. The disruption in gas supply from Arun (Indonesia) shows a potential security threat as the share of gas is increasing in the fuel mix. The outage of TEPCO nuclear plants is another example. In addition, sharpening summer peak demand for electricity may cause a risk in matching demand and supply. Energy security issues are more critical in Japan than in most IEA countries owing to its isolated location and limited domestic energy resources.

Nuclear power has a central role in Japanese energy policy both in terms of security of supply and climate change mitigation. Nuclear power is also broadly competitive with other electricity generation forms in Japan. The government's target is to increase nuclear generation by 30 %(equivalent to 10-13 new nuclear plants)between 2000 and 2010.This target, however, has become more difficult to reach because of safety-related incidents in recent years, undermining public confidence and jeopardizing energy security after significant plant outages. The first challenge is to restore public confidence. Secondly, since the load factor of Japanese nuclear power plants is much lower than the best performers in the world, more attention should be given to shortening the statutory and other outage periods and reducing their frequency. A third challenge is to ensure the role of nuclear power in liberalized electricity markets, a subject that has not been addressed in the recent debate on further market reform in the electricity sector.

In June 2002, Japan ratified the Kyoto Protocol with a commitment to achieve a 6% greenhouse gas emissions reduction from 1990 levels by 2008-2012. This is a challenging target since in 1999; emissions were 6.8%above the target year levels. The

[16] World Energy Outlook, IEA.Paris. 2002.pp 201

path towards the target has been laid down by the government in the "New Guideline for Measures to Prevent Global Warming" of March 2002. Japan's CO2 emissions per capita and per unit of GDP are good compared with the IEA average and the country has developed an impressive range of policies to address its rising CO2 emissions from the energy sector. These include the innovative Top-Runner Programme to encourage manufacturers to develop more efficient technologies, energy efficiency labeling, new technologies (*e.g.* the Home and Business Energy Management Systems), voluntary energy performance standards for buildings and portfolio standards for renewable energies. However, some of the measures could be strengthened with energy efficiency labeling extended to a wider range of appliances and energy performance standards made mandatory for new buildings and extended to refurbishment of existing buildings. One of the key measures is Keidanren's (Japan Business Federation) Voluntary Action Plan for stabilising industry's emissions by 2010.A major question will be whether the objective will be met if industrial output recovers from the current recession.

Following chapters unfold through a modest research attempt, the primary energy sector in Japan from demand –supply management to pricing of energy and related issues.

Chapter One the introduction traces the evolution of Japanese energy resources management and introduces the basic theme of the dissertation and also highlights its linkages with the arguments set forth in the different chapters of the study. It presents a brief overview of the Japanese energy sector and the major policies of the government, public and private institutions concerning energy sector.

Chapter Two deals with the supply side of energy sector and analyses the structural change in supply of various form of energy from oil to new energy source after the second oil crisis. Study shows remarkable growth in the diversification of energy sector form oil to other source energy and rising importance of nuclear, LNG and new energies like geo thermal, wind, solar etc. Each section has dealt with separately and also tried to analyse changing policies of the government. Finally the chapter traces to identify the impacts of ever rising oil prices in international market on diversification of energy in Japan and finding a very sturdy relationship between the oil prices and diversification.

Chapter Tree basically examines the demand side of energy sector in Japan and traces to prove the link between economic growth and energy growth. It also analyses how the economic growth influences various development in energy sector, since Japan confronted a very different kind economic experience during 1980s and 1990s. And more the chapter also deals with the changes final energy consumption, energy intensity and energy efficiency in Japan.

Chapter Four looks at the pricing mechanisms of energy; a little economic theory deals with the methods of pricing and also examines the liberalization process of Japanese energy sector. It has seen that, Japan's extensive deregulation of energy sector and withdrawal of the government control, restructuring the various forms of energy tax and subsidies during the time of recession also analysed in this chapter.

The final chapter gives an over all idea about the whole dissertation and concluded with the major findings.

Chapter: II

STRUCTURAL CHANGES IN THE COMPOSITION OF ENERGY SUPPLY

Japan's energy supply is one of the most vulnerable among IEA countries. More than 80% of its energy needs are met by imports and it has one of the highest shares of oil in energy consumption. Virtually all of its oil imported, about 70% of it from the Middle East. After the United States, Japan is the world's most significant importer of oil, and it is the largest importer of energy in general including LNG and Coal[1]. Japan's energy consumption, the fourth highest in the world, thus has a particular influence on international energy markets, and international developments have a strong impact on Japan. The same applies to global environmental issues; Japan is the world's fourth largest producer of Co2 from fossil fuels.

Since the 1970s Japan has successfully carried out energy policies designed to increase efficiency, achieve a more balanced mix and secure reliable supplies. Consistent efforts in conservation and efficiency, especially in industry, have made Japan one of the world's most energy efficient economies, with one of the lowest ratios of TPES per unit of GDP. Diversification of energy sources, especially the introduction of natural gas and determined programme to expand nuclear energy, have decreased oil dependence from 77% of total energy consumed and more than 70% of electricity generation in 1973 to 58%and 29% respectively in 1989.Yet the 1990 revision of official long-term out look for energy supply and demand shows that Japan must continue to pay special attention to the issue of energy security. The goal of reducing oil dependence to about 51% by 2000 and about 45% by 2010 requires major efforts, especially given the need to assure stable economic development and to allow people in Japan to improve their standard of living[2]. Further improvements in energy efficiency and continuing shift of energy sources

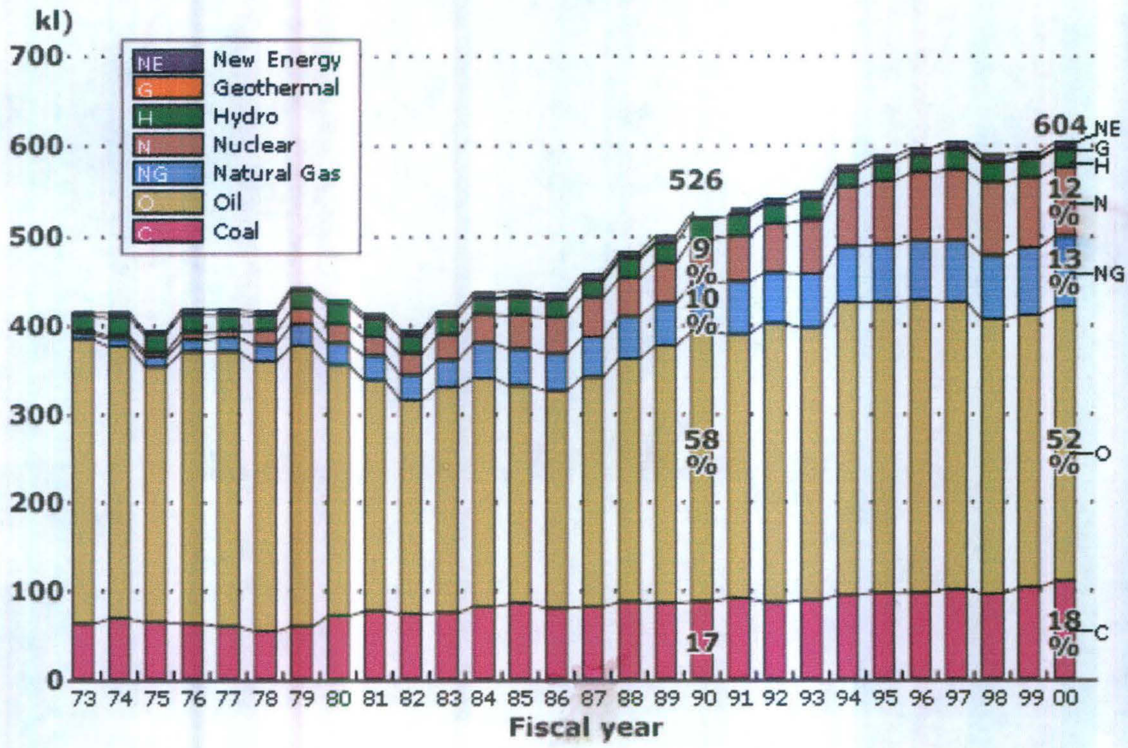
[1] Japan 2005 An International comparison, Keizai Koho centre.pp.100
[2] IEA-World Energy Outlook,1990.pp.293

towards non fossil fuels are necessary for energy security as well as for environmental reasons. In looking for solutions to the challenges posed by increasing energy demand and environmental requirements, Japan puts great emphasis on the development of new efficient and environmentally sound technology.

2.2 Composition of Japanese Primary Energy Supply after Second Oil Crisis.

Japan's level of dependence on oil, its largest source of energy, has decreased drastically since the oil crises (from 77% in 1973 to 52% in 2000). On the other hand, nuclear energy and natural gas have grown in importance in their supply share of energy. Consumption of nuclear energy has increased from 1% in 1973 to 12% in 2000, while natural gas has increased from 2% in 1973 to 13% in 2000.The follwing figure shows the major development that took place in Japanese energy sector over the last thirty years.

Figure 1: Changes in Primary Energy Supply 1973-2000.



(Source: Comprehensive Energy Statistics,ANRE. (preliminary figure for FY2000))

The figure reveals that total supply of primary energy is increasing, with an upward tendency from about 400 million kl of oil equivalent in 1973 to more thgan 600 million kl of oil equivalent in 2000.There had been no much differences in the growth rate of total primary energy supply during the decades of 1980s and 1990s,eventhough the economic growth rate lowered after the bubble burst of 1989.But surely there was a systematic change in the composition and respective shares of different primary energy supply from coal to nuclear.The major changes happened in the sectors like oil, natural gas and nuclear energy.The share of oil to total primary energy supply decreased from 77.4% to 49.7% in 2002[3].Thre were a few number of reasons to this shift from oil to other sources especially to natural gas and nuclear energy.The two big oil crises of 1973 and 1979 and continous increases in the price of crude oil in the international market and the recession of 1990s were the main reasons for these changes.

The gap of decreased oil share has been filled by both natural gas and nuclear,there was tremendous rise in the share of both from 1973 to 2002.The share of natural gas rose from 1.5% in 1973 to 13.5% in 2002 and the incremental growth rate was higher in the first period from 1973 to 1990[4].In the case of nuclear energy the share has incresed from mere 0.6 % in 1973 to 9.5 % in 1990 and 12.6 in 2001.The following sections will discuss each sector elaborately.

2.3 Oil:

Fundamental Concepts Underpinning Japan's Oil Policy - Securing a Stable and Efficient Supply

Since Japan continues to depend heavily on the world oil market, it has adopted various strategies in order to decrease the vulnerability of the Japanese energy economy:

1. Oil accounts for 50% of Japan's total primary energy supply. As an economically efficient and convenient energy source, it is expected to continue to be a major source of energy in the 21st century. Securing a stable supply will therefore continue to be a major issue in Japan's energy policies in the future.

2. Furthermore, Japan imports almost all of its crude oil and relies on the Middle East for 88% of its oil supply. Compared with the supply structure of other

[3] See Appendix 1
[4] ibid.

developed countries, Japan's oil supply structure remains fragile. This is why Japan is effectively and efficiently pursuing measures for stockpiling oil, encouraging independent development of resources, and promoting cooperation with oil producing countries in efforts to put in place a framework that is prepared for emergency situations.

3. On the other hand, in order to promote structural reform of the economy in Japan, it is also necessary to achieve a level of service in the area of energy, which is in no way inferior to other countries on an international scale. Increasing the level of freedom in the management of oil refineries through deregulation and building a strong oil industry with a business base that has been reinforced through the promotion of efficiency and rationalization is also important for the energy security of Japan.

In addition to speeding up the energy conservation and oil substitution, the strategies like increasing oil stock piles and diversifying oil supplies form the traditional oil basin of Middle East has been started since 1980s. In September 1981, the government also decided to expand its stock pile of crude oil through purchase from private Japanese oil companies, thus making advantage of both the present comfortable position of the world oil market and the decrease in domestic demand[5].

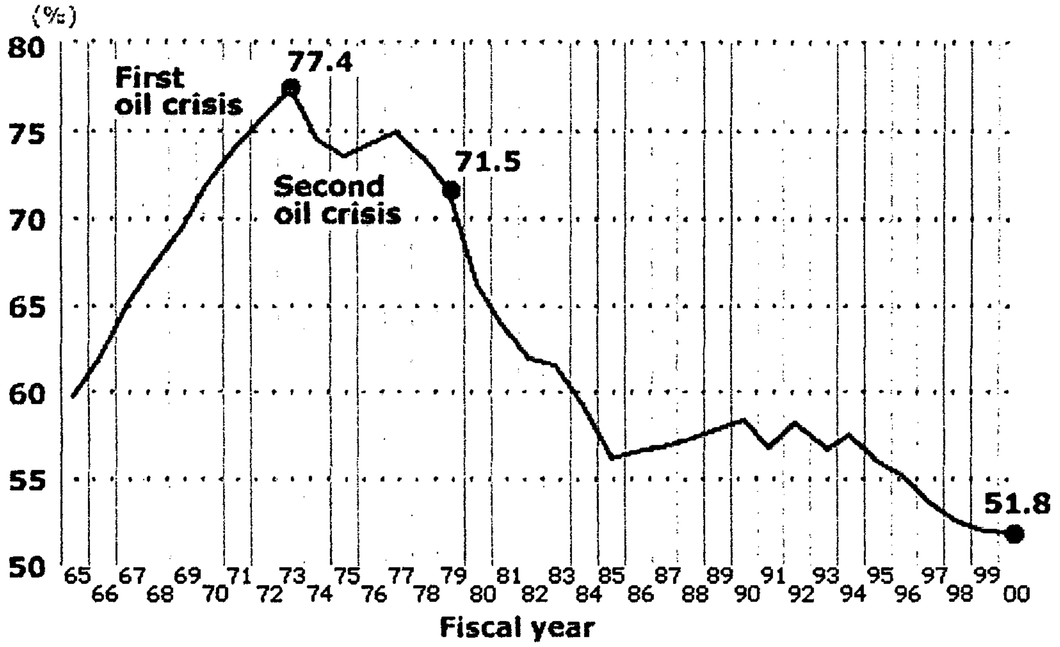
Japan's reliance on oil, which peaked at over 77% of total energy Consumed in 1973 declined to 56% in 1985.Since then, it has tuned slightly upwards again to 58% reflecting continued economic growth and lower oil prices up to the bubble burst of 1990.Demand for oil products has grown for five consecutive years since FY 1986 and is considerably above the IEA average; in 1988 it grew 5.7% and in FY 1989 4.4%,compare with IEA average of 3.2 % in 1988 and 1.1% in 1989[6]. The net oil import decreased from 279.5 Mtoe in 1979 to 255.4 Mtoe in 1980, after the second oil crisis and reached a maximum level of 298.8Mtoe in 1985.

Since 1961, Japan has supported the exploration and development of oil and natural gas abroad by Japanese companies. In FY 1989 oil produced by the 23 Japanese companies

[5] World Energy Outlook IEA.Paris 1981.pp.216-217
[6] World Energy Outlook, IEA. Paris.1990.pp.294

engaged in foreign upstream activities amounted to about 13% of total crude oil imports. This however, still significantly below the target set in 1983 to raise the share of self developed oil to about 30% of imports by FY1995[7].

Figure.2: Changes in Japan's Dependence on Oil



Source: Comprehensive Energy Statistics,ANRE.

The above figure shows that Japan has dramatically reduced its dependence on oil over the last three decades after double oil crises of 1970s.During the first oil crisis Japan's dependence on oil was about 78% and reduced to 51.2% in 2000.Japan achived this through different strategies and methods form diversification energy supply to continous improvement in energy efficiency, technology, initiatives in energy conservation and more over the active participation and colloboration of both government and private,corporate entities.

The following table shows the various aspects of oil sector in Japan with a future forcast upto 2010 by International Energy Agency.

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[7] Ibid.pp.295

Table 1: Domestic Production,Import and Total Supply of Oil in Japan (1980-2010)

(Million metric tons oil equivalent)

	1980	1985	1990	1995	1999[1]	2010.[2]
Production	**0.7**	**0.5**	**0.6**	**0.6**	**0.7**	**0.7**
Imports	**249.4**	**252.2**	**212.7**	**262.5**	**271.2**	**255.0**
Exports	**–1.2**	**–0.5**	**–0.6**	**–3.8**	**–5.3**	**–14.5**
Bunkers	**–19.0**	**–11.6**	**–7.1**	**–5.1**	**–5.2**	**–5.0**
Net Imports – NI	**229.1**	**240.2**	**204.9**	**253.6**	**260.6**	**235.5**
Total Supply	**229.8**	**240.7**	**205.5**	**236.2**	**254.2**	**261.3**
Import Dependence (%)	**99.7**	**99.8**	**99.7**	**99.8**	**99.7**	**99.7**

1. Estimated data.

2. Latest available forecast.

Source: Oil supply Security, The emergency response potential of IEA Countries in 2000. IEA.2001.pp.177

Presently Japan depends on imports for about 99.7% of its oil requirements. Current energy supply of 510 Mtoe comprises 51% oil, 12% natural gas, 17% solid fuels, 17% nuclear and 3% other sources. Oil is imported mainly from United Arab Emirates, Saudi Arabia, Iran, Qatar, Kuwait and Indonesia. Oil accounts for over 50% of Japan's primary energy supply. It is supplied largely from the Middle East. Security of oil supply continues to be the overriding consideration in the design of oil policies. The Japan National Oil Corporation (JNOC) is a government organisation established to secure international oil supplies from fields involving Japanese companies. Its functions include supporting overseas and domestic oil exploration and development by providing equity and loans to Japanese oil companies, and by undertaking research and development of oil exploration and production technology. Other than JNOC activities, exploration, development and refining are managed by private companies[8].

JNOC has been criticised because of debts incurred in its operations. JNOC has reviewed the performance of its operations and withdrawn from many projects. Privatisation or abolition of JNOC has been suggested by some critics. In March 1999, a government advisory committee was established to recommend policies to promote petroleum and natural gas development by Japanese companies. The interim report, compiled in August 2000, pointed out the importance of forming core groups of Japanese companies to promote development. It also indicated the need to provide government support for buying assets such as productive oil fields, and to expand the use of natural gas. The government plans to implement elements of the committee's findings during 2001. Japan is highly dependent on oil imports. The share of the Middle East oil supply declined after the 1970s oil crises but increased again since the mid-1980s, reaching 88%in 2001.Oil supply security has received considerable attention. In addition to maintaining large emergency stocks, Japan tries to reduce dependence on oil and to diversify supply sources, enhances relations with oil-producing countries and gives support to oil and gas exploration. The share of oil in total primary energy supply (TPES) decreased between 1973 and 1990 from 77.9%to 58%, and reached 49.2%in 2001.

2.4 Natural Gas: An Alternative to Oil

Together with Coal and nuclear, natural gas is the main alternative to relieve reliance on oil. The share of LNG to total primary energy supply of Japan has tremendously increased after the second oil crisis from 21.9 Mtoe in 1980 to70.95 Mtoe in 2003[9]. In order to achieve its supply, the government has taken several financial measures to support private industries. Investment loans and loan guarantees are provided by the Japan National Oil Corporation for exploration and development. Loans for LNG production facilities are offered by the export import Bank of Japan, and loans for LNG

[8] IEA-energy policies of IEA countries, Japan 2003 Review.pp.24
[9] An international comparison,.Japan, various issues Keizai Koho Centre. Tokyo Japan,

terminals are provided by the Japan Development Bank[10].The emphasis of gas use in electricity generation is based on environmental and economic considerations. In order to promote the introduction of natural gas for industrial use, a system of long –term, low interest loans by Japan Development Bank was established in FY 1980.

As part of its diversification policy, since the 1970s Japan has introduced natural gas for power generation and town gas production. About 95% of the natural gas supply is imported as LNG, with the other 5% coming from indigenous production, and 75% of LNG imports are used in the electricity sector. The use of natural gas has helped to reduce the high dependence on oil in electricity production and equally, to improve environmental conditions in metropolitan areas. Nevertheless, the overall share of natural gas in total energy demand remains just under 10%.

Among the total of 246 town gas companies in Japan only the four biggest (Tokyo gas, Osaka Gas, Toho Gas in Nagoya and Saibu Gas in Kyushu) use imported LNG. Overall natural gas provides about 72% of feed stock in town gas production. Town gas has a relatively small market share in the residential/commercial sector. The distribution network has been constantly expanded and reaches most potential customers in the big metropolitan areas nation wide, however only 50% of house holds are connected to the pipe line grid. In the future greater commercial demand is expected through increased use of cogeneration systems.

The high cost of LNG import tends to weaken the competitive position of gas. Therefore, the Government promotes town gas production from natural gas and has in place various assistance measures for the further expansion of natural gas. These include special interest rates, tax incentives and concessionary loans, and training measures. The development of LNG demand specifically for Electricity generation, however will also largely influenced by the outcome of the environmental debate, in particular the goal of limiting green house gas emissions and the availability of planned nuclear generating capacities which are discussed in the dissertation on separate headings

[10] World Energy Outlook. IEA.Paris. 1981.pp.221

Japan is the world's biggest importer of LNG. Imports by the three largest gas companies and the major electric utilities come from Alaska, Brunei, Abu Dhabi, Indonesia and Malaysia and since 1989 Australia. In view of the project increase of LNG imports from about 33 million metric tones in 1989 to 43 million in 2000 and 54 million in 2010, further sources are needed. Up to 2005, supply is assured basically through expansion of existing projects[11]. A number of projects are being examined that can secure supply beyond that date, though details still have to be worked out.

Natural gas is one of Japan's most important energy sources in terms of energy security since dependency on the Middle East is smaller than that for oil, and on environmental grounds because of lower greenhouse gas emissions from gas-fired power than from coal-fired power. Electricity and gas issues are consequently closely related since natural gas is imported as liquefied natural gas (LNG) and the gas pipeline network is not highly developed. Given the uncertainty of achieving the nuclear target, natural gas might be considered as an alternative means of meeting energy demand with an acceptable environmental outcome. To develop gas further would require overcoming two major barriers: developing the network and lowering the cost of supplying LNG. Only 5% of the land area (but 50% of the population) is covered by the gas grid. Some small LPG retailers have a high degree of market power[12]. The ability of individual companies to operate flexibly is limited by the present organisation of the gas market within Japan. Third party access to LNG terminals may be one way of introducing competition and lowering costs but would, of course, require consideration of the terms of access and/or compensation to the owners. The development of the gas market may also be impeded by the way in which gas prices are formed. The efficient functioning of the gas market would be improved substantially if market players could operate with more flexibility, for example by encouraging trade in gas between large consumers.

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[11] World Energy Outlook, IEA.Paris. 1990.pp.295

[12] Energy Policies of IEA Countries, Japan, 1999 Review, IEA.Paris. pp.9-10
13 Ibid. 111

Because of its high import dependence, Japan has been seeking a secure and diverse supply. LNG comes from ten liquefaction plants in eight countries. Japan imports natural gas in the form of liquefied natural gas (LNG) from, in order of importance, Indonesia (about 40% of imports in 1996), Malaysia, Australia, Brunei, the United Arab Emirates (Abu Dhabi), the United States (Alaska) and Qatar. LNG imports began in 1969. Imports from Qatar commenced in January 1997 (2.4 Mt in 1997). Japan is now the largest LNG importer in the world, accounting for 62% of global LNG trade. Demand rose 4.1% in 1996-97, and was met by a corresponding rise in imports. During 1997, total imports of LNG were 48.35 Mt. Liquefied Petroleum Gas (LPG) is also used extensively in Japan. LNG is imported by the electric utilities, by a few large users such as Nippon Steel, and by the major gas companies for distribution to smaller distributors and gas consumers[13].

The private sector has, with assistance from JNOC, carried out domestic and overseas natural gas exploration and development projects. In June 1994, the Japan National Oil Corporation Law was revised to make possible investment and debt guarantees for the development and liquefaction stages of natural gas. Japan has small reserves of natural gas, meeting about 3% of total demand. Development on-shore and off-shore is encouraged by measures similar to those for oil. Assistance available from JNOC includes the liquefaction stage. Loans are also available for development and liquefaction of natural gas by the Export-Import Bank of Japan. Loans are available from the Japan Development Bank for the construction of LNG tankers. Assistance is also made available at the receiving and supplying stages. Low interest loans by the Japan Development Bank and an optional special repayment system or tax deductions are extended for LNG receiving terminals and LNG carriers. Assistance is also available for promoting the introduction of natural gas by local town gas companies to replace manufactured gas.

In Japan most of natural gas is used in power plants and by consumers in other sectors close to the major LNG terminals in Tokyo, Nagoya and Osaka, which have only limited pipeline networks. Japan has the smallest gas transmission network of any major gas-using countries. There are many vertically-integrated regional companies, most of which produce or import their own gas. Three companies, Tokyo Gas, Osaka Gas and Toho Gas, account for over 75% of the market of the gas utilities. Natural gas accounts for over 85% of all gas sold in Japan and LPG for the remaining 15%. The Gas Utility Industry Law was amended in 1994 to allow the following:

Gas prices for larger consumers to be negotiated freely between the parties involved. Entities other than general gas suppliers to supply gas in areas outside their supply areas and in areas supplied by other companies.

Further amendments effective from November 1999 implemented the following reforms aimed at further stepping up competition in this sector.

The definition of large consumers was lowered from two million cubic meters and over to one million cubic meters and over.

Rules on gas transmission by pipeline were established, the Regional Gas Industry Co-ordination Council was abolished, and the criteria for entering the household gas market were clarified.

Reforms in the electricity and gas sectors will be reviewed every three years to determine if further measures are necessary.

Japan's special gas market structure determines its approach to gas security. Underground storage, interruptible contracts, pipeline links and other approaches that are common in other regional markets play no significant role in Japan. Reliance is placed on long-term take-or-pay contracts with several stable suppliers, on modular supply and delivery systems that limit dependence on any single installation, and on fuel substitution and sharing via the electricity generation system. These arrangements have served Japan well and no serious security problems have been encountered, even when the Exxon Mobil's LNG plant in Arun in Sumatra (Indonesia) was closed for seven months in 2000 owing to political unrest.

2.41 Domestic Production and Exploration

Domestic natural gas production amounts to 2.5 bcm and accounts for 3.3% of demand. Proven domestic reserves are 40 bcm and they will be depleted in 16 years with the current rate of use. Like oil, exploration and development of natural gas at home and abroad are mainly subsidised by JNOC and its successor –and carried out by private companies. To promote and facilitate development, JNOC provides funds and debt guarantees for the development and liquefaction stages of the natural gas supply chain. In 2000, the Petroleum Council, a consultative organ to the METI, carried out an assessment of these activities and recommended that they continue the specific support forms in the pre-exploration, exploration, development and production stages, as well as in terms of taxes related to these phases, are the same for natural gas as for oil. There is no import tax on LNG. The Development Bank of Japan provides low-interest loans, and a special repayment system (or tax deductions) for the construction of LNG terminals and transmission pipelines as well as for promoting the use of natural gas by those local gas companies that rely on LPG. According to some rough expert estimates, reserves near Japan could provide 7 400 bcm of methane which is enough to support Japan's natural gas use for a century. The plan to develop methane hydrates took off in 1994, following a report from the Petroleum Council. The report recommended that a basic survey be carried out to investigate the reserves and their future commercial potential. Under the plan, the ANRE and JNOC began test production in 1999 at a point 50 km off the coast of Shizuoka Prefecture, at a depth of 945 meters. The government aims to start commercial production from 2016.There are important obstacles to commercialization because no country has the technology and production experience, the main problem being the effective and safe extraction of methane gas from the solid. To address these obstacles, the government has formed a consortium involving industry, academia and JNOC, and promoted technology co-operation with the United States, Canada and Germany[14].

Natural gas imports are based on long-term take-or-pay contracts signed by gas and electricity industries. The role of spot LNG cargoes in gas supply has so far been very small, but an increasing, though not extensive, number is expected in the future. The gas and electricity industries now consider long-term contracts too risky. Market liberalisation has had little impact on total gas demand but it has made it more difficult for each utility to forecast its own gas demand and market share because the future landscape of Japan's deregulated market is as yet unclear. Therefore, the utilities have

[14] Energy policies of IEA countries. Japan 2003 Review, IEA.Paris.pp.76

been seeking more flexible and shorter contracts. Renewal of old contracts has often been for 10 to 15 years, whereas completely new ones are still mainly long-term contracts of 20 years. The trend for shorter contracts is expected to continue because many current LNG exporters to Japan have amortized their investments and are not required by the financial institutions to have rigid 20 to 25-year contracts. Japan is looking into possibilities for importing natural gas from the Russian Far East.

The two projects under consideration are the Sakhalin I Project importing pipeline gas, and the Sakhalin II Project importing LNG. Technical and economic studies of the Sakhalin I Project show that the pipeline gas project would be feasible. METI considers that imports from Russia will improve energy security through diversification of supply sources. The result of the feasibility of the Sakhalin pipeline project would exert downward pressure on LNG prices. The volume of gas carried by the pipeline project would be equivalent to 6 Mt of natural gas, which is about 11%of current national gas demand. Furthermore, prerequisites for the implementation of Sakhalin I are enough volume of gas demand and improvement of the domestic pipeline network. The volume of Sakhalin II would be 4.8 to 9.6 Mt of LNG. Some gas and electric companies are reported to be planning to purchase LNG from Sakhalin II and exports could start by 2007.

2.42 Supply Security Measures

Japan has developed a series of measures providing insurance against supply interruptions in the gas sector:

Supply diversity: Eight countries supply LNG to Japan. Individual Japanese companies generally have more than one supplier. Osaka Gas, for example, has six suppliers, under nine separate contracts.

Long-term contracts: Suppliers and customers are interdependent and have a common interest in security of supply. They are linked by long-term contracts that have proved a stable basis for managing business in the past.

Modular supply systems: Production and liquefaction plants include a number of separate units; several tankers are involved in each contract; most importing companies have more than one terminal; terminals have more than one jetty.

Supply flexibility .Most supply contracts have from 5%to 10% flexibility either written into the contract or on a "best endeavors" basis.

Gas supply sharing: Although there are few pipeline connections, a number of terminals are shared between gas and electricity companies. Furthermore, there is a high degree of standardization of shipping capacity: extra supply available from a particular source can usually be transferred to another company that might be facing difficulties.

Fuel-switching: 40% of gas-fired power generating capacity is dual-fired, with crude or fuel oil as the main alternative. Fuel-switching would pose few logistical problems as the sites are all coastal and have storage and handling capacity. This flexibility will decline somewhat in the future as new gas- fired generation will be mainly single-fired combined cycle gas turbine (CCGT) plants. For city gas contracts there is less flexibility. There are no interruptible contracts as such. Only about 20%of larger city gas consumers – accounting for a small proportion of total demand –have dual-firing, and that proportion is declining.

SNG manufacture: The capacity for manufacturing synthesised natural gas (SNG) from naphtha is around 1.4 Mt annually for city gas companies as a whole.

Storage: Although Japan has little underground storage capacity, it has a large above ground capacity (7.3 bcm) designed to cope with fluctuations in supply.

2.5 Coal: The Growing Importance

Coal use is increased significantly between 1980 and 2003, from 66 Mtoe to 110 Mtoe according to the alternative energy supply target; this represents 19.5% of TPE in 2002 as compared to 17.8% in 1980[15]. While total domestic Coal production (half coking, half steam coal)has been slowly decreased and lastly stopped in 2002 because the high cost of extraction., Coal imports which reached 53.2Mtoe in 1980 are nearly doubled[16]. In order

[15] See Appendix. 1
[16] See Appendix.2

to promote the development of overseas coal mines, different kinds of assistance are provided, including subsidies for geological surveys, loans for exploration and loan guarantees for development. Some progress has also been made to improve coal infrastructure.

The share of coal in Japan's primary energy supply (19.5 % in 2002) is lower than the majority of IEA countries. Nevertheless, coal has made an important contribution to the reduction oil dependence. Over all coal demand is expected to grow steadily on coming decades, though demand for coking coal is seen decreasing gradually as steel output reduced. Demand for steam coal is set to increase over the medium term with growing electricity demand, but in longer term coal's share in electricity generation is not expected to rise, given higher thermal efficiency in new generating technologies, more over competition from nuclear power and increasing limitations form environmental concern

Under the eighth coal policy plan, in effect since FY 1987, domestic coal production has been reduced in line with the adjustment of Japan's industrial structure. The goal of decreasing domestic coal supply from over 17million metric tons in FY 1986 to 10 million metric tons in FY 1991 had been nearly accomplished by 1989.during this period the work force was reduced from over 20,000 to 8600, and only six of the ten main coal mines remained open. The government provides incentives to reduce production and to facilitate mine closures. As the drastic down scaling of the production has seriously affected local economies and employment.

Between FY 1986 and FY 1989 coal imports rose from 89 million metric tons to 102 million; correspondingly, the share of domestic coal in total coal supplies fell from 13.8% to 11.4%. Generally the development of coal use and handling technologies is promoted to enhance the future possibilities of coal use that is environmentally more benign. An entrained flow coal gasification power plant is at pilot plant status. Other projects including large scale fluidized bed combustion boiler, the development of high performance coal fired power generation technologies, advanced environmental technologies and for coal handling, the coal cartridge system and coal water mixture technologies[17].

Japan is by far the world's largest importer of steam coal for power generation (64.1 Mt in 1997) and of coking coal for steel making (65.3 Mt in 1997). Japan accounts for about 28% of total world coal imports. In Japan, where steam coal is primarily used for base load power generation, security of physical supplies of steam coal is essential. The question arises whether pressure to reduce fuel costs for electricity generation will conflict with Japan's energy security goal. Over time, the Asia-Pacific coal market may develop along lines seen in the European coal market, with the spot market becoming a more prominent point of reference for determining price, but distinguished from the European market by the demand for coal in base load power generation. This latter feature of the market could lead to long-term contracts with prices related to the spot price, but with explicit premiums for security of supply, and thus limit the physical size of the spot market[18].

Japan maintains heavily subsidised domestic coal production, in part on security grounds and as a means of supporting the development of coal technology. Production has declined under competitive pressure from imported coal from about 55 Mt in the early 1960s to its present level of about 4 Mt (FY 1997). Mitsui Coal Mining Co. Ltd closed the Mike mine in Fukuoka Prefecture, southern Japan, at the end of March 1997. The mine was the largest in Japan and employed 1 329 people. Following the closure, only two underground mines remained, the Taiheiyo mine (Hokkaido) and the Ikeshima mine (Nagasaki). There were 11 open cast mines in operation. At the end of FY 1997, 2903 people were employed in the coal mining industry. Following the restructuring of the coal industry owing to its low competitiveness, domestic production decreased by over 60%in the last decade, reaching 3 Mt (1.6 Mtoe) in 2001 and accounting for 1.6%of domestic demand. Following the closure of Ikeshima and the reorganization of the Taiheiyo mine in 2001, the amount was further reduced to 0.7 Mt in 2002.At present, Taiheiyo continues to operate, but at a reduced scale, under the name Kushiro, and is the only coal mine in

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17 World Energy Outlook. IEA.1990.pp.296.

18 Energy Policies of IEA Countries, Japan, 1999 Review, IEA. pp.10.

operation. Competition in the electricity market is also placing pressure on subsidies for Japanese coal production. The future of domestic production is currently under review. To date, policies have been very effective in reducing the level of domestic production. The real need of coal mining regions in Japan appears to be creation of employment opportunities for the remaining mining workforce, rather than energy security or supporting the development of coal technology.

This decade is regarded as the last stage of structural adjustment in the domestic coal mining industry in accordance with the New Coal Policy, which has been implemented since 1992. Domestic coal production is to be phased down, while diversification of the business and development of new activities for coal mining companies is promoted, to the point where the industry's role in the national economy and its burden are "balanced". Coal subsidies were planned to end in FY 2001.

Coal contributes to the diversification of the country's energy mix and is also one of the few domestic energy resources. However, because of high mining costs, domestic production has almost ceased. More than half of steam and coking coal comes from Australia. Following a very stable pattern established over the last 20 years, steam coal imports are primarily sourced from Australia (36.5 Mt in 1997), South Africa (2.8 Mt), and the United States (2.6 Mt). Steam coal imports from China have risen sharply (from 2.7 Mt in 1990 to 6.7 Mt in 1997), and from Indonesia (0.7 Mt in 1990 to 7.5 Mt in 1997). Coking coal imports follow a similar pattern, with stable supplies from Australia (33.1 Mt in 1997), Canada (16 Mt), the United States (5 Mt) and Russia (2.4 Mt), while imports from China (3.1 Mt in 1997) and Indonesia (2.8 Mt) have grown sharply[19]. Imports from Australia have been at approximately the same level for several years; whereas imports from China and Indonesia are increasing and those from Canada are decreasing. Increased imports from China can be seen as part of the expanding trend of Chinese trade into the Asian markets, including Japan. In 2001, steam coal was imported mainly from Australia (58%), China (17%) and Indonesia (11%), and coking coal mainly from Australia (61%), China (15%), Indonesia (11%) and Canada (7%). Coal imports have been free from government intervention since 1992 and coal supply sources and

[19] Energy Policies of IEA Countries, Japan, 1999 Review, IEA. pp.119

contracts are negotiated by individual importing companies: 50%of steam coal imports are based on long-term contracts (3-5 years),30%on one-year contracts and 20%are purchased from spot markets; 20%of coking coal imports are based on longer-term contracts and 80%on one-year contracts.

Until recently, Japan maintained a small but heavily subsidised coal production industry mainly on the grounds of security of supply. The main form of subsidy was directed at coal consumption by the electric utilities, where coal producers received subsidies to cover the differences between the market prices and those established under domestic agreements. This cost premium (about ¥39 billion in 1999-2000) was paid by all electric utilities in Japan even though only three utilities actually used domestic coal. The power industry voluntarily bought the domestic coal.

In FY1992 to FY2001,Japan followed a restructuring programme –sometimes referred to as the "post eighth coal policy ".The programme addressed mining damages and provided support to structural adjustment (*e.g.* .business diversification),former miners, land restoration and the development of mining areas. When the programme expired in FY2001, public subsidies ceased. During the final programme year, the subsidy was ¥12 110 per tonne sold totaling ¥32.4 billion for current production. The only remaining coal mine, Kushiro, will supply coal to the electric utilities until 2006 without any public subsidies, regardless of the higher cost compared to market prices[20].

2.6 Diversification –Nuclear as an Option.

The tightening of access to adequate, assured energy supplies because of heightened competition among energy consumers and more important, the imposition of politically motivated producer controls over pricing and supply, moreover, with demand for petroleum is going up sharply, policy planners every where have turned their attention increasingly to the quest for alternatives to petroleum, and in particular for nuclear energy. Japan has been accelerating its long – standing programme of resource supply diversification. As an initiative in 1967 The Power Reactor and Nuclear Fuel Development Corporation was created. Heavily dependent on fuel imports, Japan has been promoting the development of nuclear power as a domestically generated energy

[20] Energy policies of IEA Countries. Japan 2003 Review.IEA.pp.74

source. Japan's first commercial nuclear power station started operation in 1966, and as of February 2004 there were 52 atomic power reactors in operation and 5 under construction. After 14 years of preparation, at cost of some $170 million, and assorted, complex political problems, Japan's nuclear reprocessing plant in Tokaimura was ready for its test run in the spring of 1977. Today major Japanese heavy equipment manufactures are in a position to offer complete nuclear plants, both pressurized –and boiling water reactors to domestic and as yet not to be foreign customers with license agreement with US firms.

The energy outlook of Japan has reinforced Japan's diverging approaches to nuclear development issues. Since Japan is virtually dependent on energy imports, it is highly vulnerable to the economic and political decisions of its suppliers. Japanese nuclear policy focuses on the breeder as a major future energy source capable of increasing Japan's national self sufficiency in energy. During the 1950s and 1960s, there were great hopes that nuclear- generated electricity – first from fission, later from fast breeder reactors, and eventually from fusion –would surpass fossil fueled generation before the year 2000 and that it would dominate global energy supply during the first half of the twenty first century. Economic realities and concerns about catastrophic accidents and nuclear weapons proliferation combined to abort these bold plans. Nuclear energy did become important (it supplies nearly 20% of the world's electricity) but chances for its future vigorous expansion appear modest at best[21].

2.61 The Growth of Nuclear Energy.

In July 1966, the Japan Atomic Power Company's Tokai Power Station started the operation as the first commercial nuclear power plant in Japan. Since then, the construction of other nuclear power plants has been continued by each electric power companies. As of the end of January 2003, a total of 53 commercial nuclear power plants were in operation, providing about 1/3 of the country's electricity. The development of nuclear power is a major element of Japanese energy policy. With its poor energy resource base, Japan regards nuclear energy as essential to further reduce the oil share, to

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[21] Smill Vaclav, "Energy resources and uses: A global premier for the twenty first century", Current history, Vol, 101, March, 2002.pp.128

meet the projected electricity demand increase of about 60% by FY2010 and to cope with growing CO2 emissions. The government is focusing attention on maintaining the safe and stable operation of the nuclear power plants now in service as well as on proper siting of new installations. On the assumption that the new nuclear plants are each to be built in the 1,000MW category, 40 additional nuclear units are expected to start operation by FY2010,of these some will be constructed on the existing 16 nuclear plant sites, but new sites will also have to found. Since a large section of the Japanese society still reluctant to any development of nuclear as a energy option the Government begun an intensive public relations campaign and a regional development policy that includes subsidies for areas where new sites will be located to increase the acceptance of new plants,. Efforts also include further development of safety technology and an expansion of governmental nuclear safety review and control.

The Government's goal is to establish a self sufficient, closed nuclear fuel cycle as a basis for its nuclear expansion programme, with three facilities (enrichment, reprocessing and final storage for low level radio active waste.) to be located at Rokkasho- Mura in Aomori prefecture. The development of nuclear technology for 21st century is in progress, including improvements in existing light water reactors and development of an advanced thermal reactor, a fast breeder reactor and technology for disposal of high level waste and efficient reactor decommissioning. Japan also seeking international cooperation and co-ordination on ensuring the safety of nuclear power, including R&D efforts and actively participating towards future technology, such as nuclear fusion.

Nuclear power is highly regarded in Japan on the grounds of the stability of fuel supply and fuel price, economical performance and the environment. On the supply side, nuclear power is seen as the best option for meeting both energy security and climate policy objectives. Standardized advanced boiling water reactors are being developed as the mainstay of Japanese nuclear power generation in the future. As of December 1981 nuclear power plants with a total output of 15.5GW were operating, while 10.1 GW were construction and 6.1 GW authorized[22]. At the end of 1985, 33 nuclear units were operating in Japan with capacity of about 24.68 GW, seventeen units (16.45GW) were

[22] World Energy Outlook, IEA.Paris. 1981.pp.223

under construction and three units were planned. At present, there are 23 pressurized water reactors, 26 boiling water reactors, and three advanced boiling water reactors. The average plant availability was around 80%over recent years, but for 2002, availability is estimated at 72%because of closures of some units for safety inspections. The commercial water-cooled reactors are owned by 9 private utility companies and one other company, which is a producer and wholesaler of nuclear-generated electricity. In addition, two prototype reactors, one advanced thermal reactor (ATR) and one fast breeder reactor (FBR), have been built. They are owned and operated by Japan Nuclear Fuel Cycle Development Institute (JNC).The ATR, however, terminated its operations in March 2003. The following table depicts the development of nuclear energy over the last twenty years in Japan.

Table 2: Nuclear Power Generation in Japan from 1985-2004*

Year	<u>In operation</u> Number reactors	(1000 KW)	<u>Under construction and planned.</u> Number of reactors	(1,000KW)
1985	**33**	**24,686**	**17**	**16,453**
1988	**36**	**28,046**	**19**	**18,307**
1998	**52**	**45,100**	**6**	**5,800**
2002	**53**	**45,900**	**12**	**14,400**
2004	**52**	**45,700**	**11**	**13,600**

**Data is compiled from various issues of "An International Comparison" Keizai Koho Center, Tokyo, Japan.*

Total installed nuclear capacity is 45.70 GW, producing over one-third of Japan's power requirements. In 1998, the government planned to increase the proportion of electricity generated by nuclear to 42% by 2010. This would have required the construction of 16-20 reactors. The government's initial budget for nuclear development in fiscal 2004 was about ¥471 billion. Recently, however, public concern about the safety of nuclear power generation has been heightened by such accidents as a sodium leak at the Monju fast-breeder reactor in December 1995 and criticality at the JOC Co, Tokaimura uranium-reconversion plant in September 1999, which led to the first fatality in the history of Japan's nuclear development.

In November 2000, the Atomic Energy Commission prepared a new long-term programme for the systematic implementation of research, development and utilisation of nuclear energy in Japan. The programme has two parts. Part I includes commitments to the Japanese people and the international community on nuclear energy. Part II includes specific proposals for promoting nuclear research, development and utilisation, including research and development on innovative nuclear reactors with high economic efficiency and safety, suitable for diversified energy supply applications such as heat utilisation. The programme was released to the Japanese people, the international community, and all those employed in the nuclear power industry in Japan to raise understanding of these issues.

Accidents at the Tokaimura reprocessing plant in 1997 and the nuclear fuel conversion plant in 1999 have adversely affected public attitudes to nuclear power in Japan. Quality problems with mixed oxide fuel rods prepared by British Nuclear Fuels Limited have also affected public confidence in the government's policy to use mixed oxide fuels in Japanese reactors. The government has taken steps to improve public confidence in nuclear power, including promulgation of the Special Law for Nuclear Disaster Measures, and major reinforcement of nuclear safety regulation. In addition, the Specified Radioactive Waste Final Disposal Act was announced in June 2000, which creates the legislative framework for the final disposal system of high- level radioactive waste in Japan. Based on the legislation, the Nuclear Waste Management Organization of Japan (NUMO) was established in October 2000.

The Nuclear share of electricity was 16% in 1980 and expected to increase more than 30% in 1990.while it reached maximum of 34.6% in 2001[23].whether oil will be displaced on a large scale in electricity generation will depend critically on whether the nuclear programme can proceed as scheduled. The Government plans to increase the proportion

[23] See Appendix. vi

of electricity generated from nuclear to 42% by 2010. To achieve this goal, the private electricity utilities are expected to build additional capacity, requiring about 16 to 20 new nuclear power reactors. Of these, five are in the existing Electric Power Development Coordination Council plan, and three of these are to be built at existing nuclear sites. A further six units, not yet authorized in the EPDCC plans, are also planned for existing sites. Of the new sites, Higashidori, in the north of Honshu, has been given the go-ahead by the Governor of the local Aomori prefecture; construction of the first of four reactors is under review by METI. By early 2008, nine new reactors are planned to be operating, providing an additional 11.3 GW capacity. By the end of FY 2010, a further 12 reactors are planned to be operating, with an additional 14.6 GW capacity[24].

The Japanese government strongly supports nuclear energy on the basis of stability of fuel supply, zero greenhouse gas emissions, fuel prices and economic performance. In The commercial plants have mainly been supplied by Toshiba, Hitachi and GE (BWRs), and by Mitsubishi and Westinghouse (PWRs).At the end of 2002, the average age of Japanese plants was about 19 years. Plant life will be determined on an economic and safety basis taking into account the costs of maintaining safety standards. Equivalent plants in the United States are currently expected to operate for 60 years. In recent years, nuclear power plant operations in Japan have been marred by safety-related incidents, both at generating and fuel manufacturing plant sites. The most notable of these have been: Since 1995, the operation of the prototype FBR (Monju) was suspended following a sodium leakage. In December 2002, the METI gave JNC permission to build installations preventing sodium leakage. However, in January 2003, the Japanese High Court overruled this decision and METI issued an appeal to the Supreme Court in March 2003[25].

2.62 Administration of Nuclear Power in Japan

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

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[24] Energy Policies of IEA Countries, Japan, 1999 Review, IEA.pp.52

[25] Energy policies of IEA Countries. Japan 2003 Review.IEA.pp.105

The AEC was established in the Prime Minister's office with authority for "planning, deliberation and determination" of nuclear power development and utilisation[26]. Its decisions are reported to the Prime Minister. The Nuclear Safety Commission was established by amendment of the basic law in 1978. It has authority for "planning, deliberation and determination" of safety assurance and regulations related to the work of the AEC. Its decisions are also reported to the Prime Minister.

METI conducts work involving nuclear power research, development and utilisation. The Public Utilities Department is responsible for work related to nuclear power generation and the promotion of power source development. METI, with its eight regional bureaus, is in charge of the whole sequence of work concerning commercial nuclear reactors, from the basic design to detailed design, inspection procedures and operation. The Science and Technology Agency (STA) have two bureaus concerned specifically with nuclear power. The Atomic Energy Bureau is responsible for planning, formulating and promoting basic policy on nuclear power research, development and utilisation. The Nuclear Safety Bureau is responsible for regulating and determining safety measures for nuclear source materials, nuclear fuel materials and reactors (at the stage of research and development) and the use of radioactive isotopes. The Ministry of Transport is responsible for regulating the safe transport of radioactive materials and the development of nuclear-powered ships and nuclear reactors in ships. The Ministry of Foreign Affairs deals with diplomatic issues related to nuclear power, and the Planning Bureau of the Economic Planning Agency formulates basic policy and plans for power source development and takes responsibility for their overall co-ordination[27].

2.63 Achieving the Target for New Nuclear Plants

According to Japan's *Long-term Energy Supply and Demand Outlook* published in 2001, nuclear generation is targeted to increase by approximately 30% (*i.e.* by 97 TWh) between 2000 and 2010, requiring 10 to 13 additional units. If the load factor can be increased, fewer new units will be needed to achieve the target. One new nuclear plant was commissioned in 2002, three plants are currently under construction and nine more

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[26] *Nuclear Power Development in Japan*, Agency of Natural Resources, METI, March 1997.
[27] Energy Policies of IEA Countries, Japan, 1999 Review, IEA.pp.54.

are planned. However, increasing capacity to meet the target is very challenging and may be delayed by the need to restore public confidence. In March 2003 the utilities announced delays in other nuclear projects. However, a large increase of nuclear generating capacity could also raise the prospect of the plants supplying other than base-load. Electric utilities' managers think that the deregulation of the electricity market and the role of nuclear should be addressed simultaneously. In particular, they argue that the demarcation of responsibilities between the public and private sectors should be clarified in such fields as high-level radioactive waste disposal, MOX fuel fabrication and long-term nuclear liabilities.

They believe the government should strongly announce its commitment to promoting these policies and provide appropriate support. To address such issues, the government plans to launch deliberations at its advisory council in the next two years on how to secure nuclear power generation in the liberalised electricity market. Achieving that scale of nuclear power development should at least avoid the need to further review the structure of power sources and to pursue further energy saving in the industry, residential and commercial, and transport sectors. Japan's energy efficiency goals are already extremely ambitious and gas penetration is hampered by its high cost. Although the nuclear production target was set before environmental considerations became prominent, the Japanese Government believes that it is compatible with the goals of economic growth, energy security and environmental protection.

2.64 Economics of Nuclear Power

According to the latest METI estimates, fossil-fuel plants and nuclear plants have similar levelised costs, with a small advantage for nuclear in Japan. If a value were attached to emitting carbon dioxide, nuclear power could gain an economic advantage. Japan has the highest investment costs for nuclear, gas and coal-fired power in the OECD countries based on the generic assumptions used in a recent OECD NEA/IEA study[28]. Japan is seeking to reduce the capital costs of nuclear plant by standardisation of plant design. There is scope for reducing the per unit capital costs of nuclear plants. Increasing the

[28] A comparison of the costs of generating electricity from different sources is provided in a series of reports entitled *Projected Costs of Generating Electricity*, OECD NEA/IEA, 1998.

capacity utilisation factor of generating plant decreases the levelised cost of electricity generation. Options which are more capital intensive are more sensitive to load factor variation than less capital intensive options. Hence, according to the OECD NEA/IEA study, increasing the capacity utilisation factor for nuclear plants from 65% to 80% decreases costs by some 15%; for coal-fired plants the effect is lower, about 10%, since fuel costs represent a larger share of the overall levelised electricity cost.

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

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

2.65 Investments in Nuclear Plants

The Government of Japan has identified increased investment in nuclear power as important to meeting its energy security goals and greenhouse gas emission objectives. Utilities will continue to require assurances that they will be able to recover costs from investments in new nuclear plants. A cost recovery mechanism will continue to be required for any excess costs associated with renewable energy and, possibly, with nuclear power. If economic incentives are insufficient in promoting investment, one option would be to guarantee that a share of the demand is met by nuclear-generated electricity. This could be accomplished by requiring all customers to purchase a portion of their supplies from nuclear-generated power. The nuclear share would be set by the Government. It could be made consistent with the expected contribution by nuclear power to meeting the Kyoto target. In effect, this would create two markets, a market for non-nuclear power generation and a separate market for nuclear-generated power.

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

Japan has clear medium-and long-term objectives to support nuclear energy. It has successfully and progressively pursued the construction of nuclear power plants over several decades in response to its lack of domestic energy resources. More recently, Japan has regarded the use of nuclear energy as a central measure in achieving its very challenging Kyoto target. In the *Long- Term Energy Supply and Demand Outlook of 2001*, nuclear power generation is expected to increase by 30%between 2000 and 2010 to simultaneously address energy security and climate change mitigation. However, the government and electric utilities are facing significant, fundamental challenges in meeting this ambitious target. The most significant challenge is improving the level of public acceptance. Nuclear power operations in Japan have been marred by safety-related incidents in recent years, either at generating plant sites or at fuel manufacturing plants. In particular, the recent data falsification by TEPCO has seriously undermined public confidence in nuclear energy. Public opinion has a serious impact on the political processes involved in the establishment, operation and decommissioning of nuclear plants by different constituents of local governments.

While METI's cost assessment in 1999 shows that nuclear power is more competitive than any other energy source in Japan, most other countries find combined cycle gas turbines the most attractive alternative given their low capital cost, high efficiency and short construction period. Noting the critical role of nuclear in terms of energy security and climate change mitigation, the government should promptly clarify the role of nuclear power in liberalised markets as well as demarcation of responsibilities between the public and private sectors in high- level radioactive waste disposal, MOX fuel fabrication and long-term nuclear liabilities. Currently, competition in the supply of nuclear fuel fabrication services to Japanese plants is minimal. The fuel is another factor that could improve the economics of plant operations similar to other measures such as increased irradiation levels, increased plant rating and extended plant operating cycles.

2.7 Trends in Alternative and New Energy

"New energy" sources are defined in Japan as oil-alternative energy sources which have not yet been used widely, mainly because of economic constraints and instability of supply, but whose introduction is necessary in order to reduce Japan's oil dependence and to assist in environmental protection. The Government's target for the share of new energies in total primary energy supply has been set at 3.1% in financial year 2010. *The Law Concerning Promotion of the Use of New Energies* was enacted in June 1997, as a framework for encouraging the introduction of renewable and non-conventional fuels. The law includes financial assistance measures for businesses which use new energy sources. The 1998 Budget allocated ¥74.8 billion (up from ¥56 billion in 1997) for new energy promotion. National and local tax incentives, subsidies for approved enterprises and loan guarantees by the New Energy and Industrial Technology Development Organisation (NEDO) are available. Details of the measures for the promotion of photovoltaic power generation for residences, for diffusing clean energy vehicles, and for the introduction of new energy in local areas are set out in 1998.

The new energies consist of the following technologies:

- Photovoltaic power generation
- Wind power generation

- Solar heat utilization
- Temperature difference energy
- Waste power generation
- Thermal utilization of waste
- Production of fuel from waste
- Biomass power generation (*)
- Thermal utilization of biomass (*)
- Biomass fuel production (*)
- Snow ice heat utilization (*)
- Clean-energy motor vehicles
- Natural gas cogeneration
- Fuel cells

(*) New addition by ordinance revision (issued and became effective on Jan. 25, 2002)

There had been different level of concern for the development of new energies since the oil crisis,but more importance has given to this sector only after 1996.In the Special Measures for Promotion of New Energy Use brought to effect in 1997, New Energy utilization, "is defined as" the technology essential for the introduction of alternative energy to petroleum, which is technically well on its way to practical use, but is not widely used due to the restriction of economic aspects" Therefore, for energy technologies that have already reached the practical use stage, such as hydroelectric power generation and geothermal power generation, as well as technologies that are still in the R&D stage, such as wave power generation and ocean thermal power generation, are categorized as natural energy, not new energies.

The transition from coal and conventional oil will rely not only on increased consumption of non conventional liquids and vigorous expansion of natural gas extraction but on steadily rising contributions of renewable energies. These sources fall into two basic categories, solar and terrestrial. Solar energy can be harnessed directly by converting radiation to heat and electricity, and indirectly by tapping solar powered energy flows, especially those of water and wind and using biomass fuels. Geo-Thermal energy, radiating from the earth's core and mantle, is the only non solar renewable flow that has a significant commercial potential, but less than 0.5% of the world's electricity generating capacity has been installed in geo thermal power plants[29].

In October 1990, the cabinet decided on new FY 2010 supply targets for alternative energy, which comprises hydro power, geo thermal energy, other renewable sources and other non-oil sources. Hydropower is to be increased from the present 37GW of stalled capacity to 53 GW by 2010, though there are some siting limitations caused environmental constraints. Many old plants will be retrofitted to increase their output. Geo-thermal energy was expected to be increased about fourth fold by 2000.The share of energy supplied by other renewable sources, such as solar energy, alcohol fuels, petroleum waste and firewood, is to increase from the current 1.3% to 5.3% by 2010.To achieve this goal, the government plans the active introduction of photovoltaic solar power generation, increased use of solar water heaters and introduction of methanol[30].

The government considers hydropower and geothermal energy as mature technologies which do not need government support. It has been formulating policy and legislative frameworks to support "new energies "where cost competitiveness is still low, but the promotion of which will enhance energy security and climate change mitigation. Prior to the introduction of new legislation in June 2002, the policy and legislative framework for new and renewable energies evolved through the following stages:

In 1994, Japan adopted the "Basic Guideline for New Energy Introduction" as a Cabinet decision, setting out the government's position on new and renewable energy for the first time. The guideline called for government-wide efforts to introduce new and renewable energy at the national level, local efforts by local governments, and co-operation by private businesses and the general public. In May 1997, the Cabinet adopted an "Action Plan for the Reform and Creation of Economic Structures" to initiate structural reform of

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[29] Smill Vaclav, Energy resources and uses: A global premier for the twenty first century, Current history, Vol, 101, March, 2002.pp.128.

[30] Energy Policies of IEA Countries, Japan, 1999 Review, IEA. pp.22

the Japanese economy. The Action Plan positioned new energy as one of the new industrial sectors with future growth potential, and described programmes for encouraging development and growth in this sector.

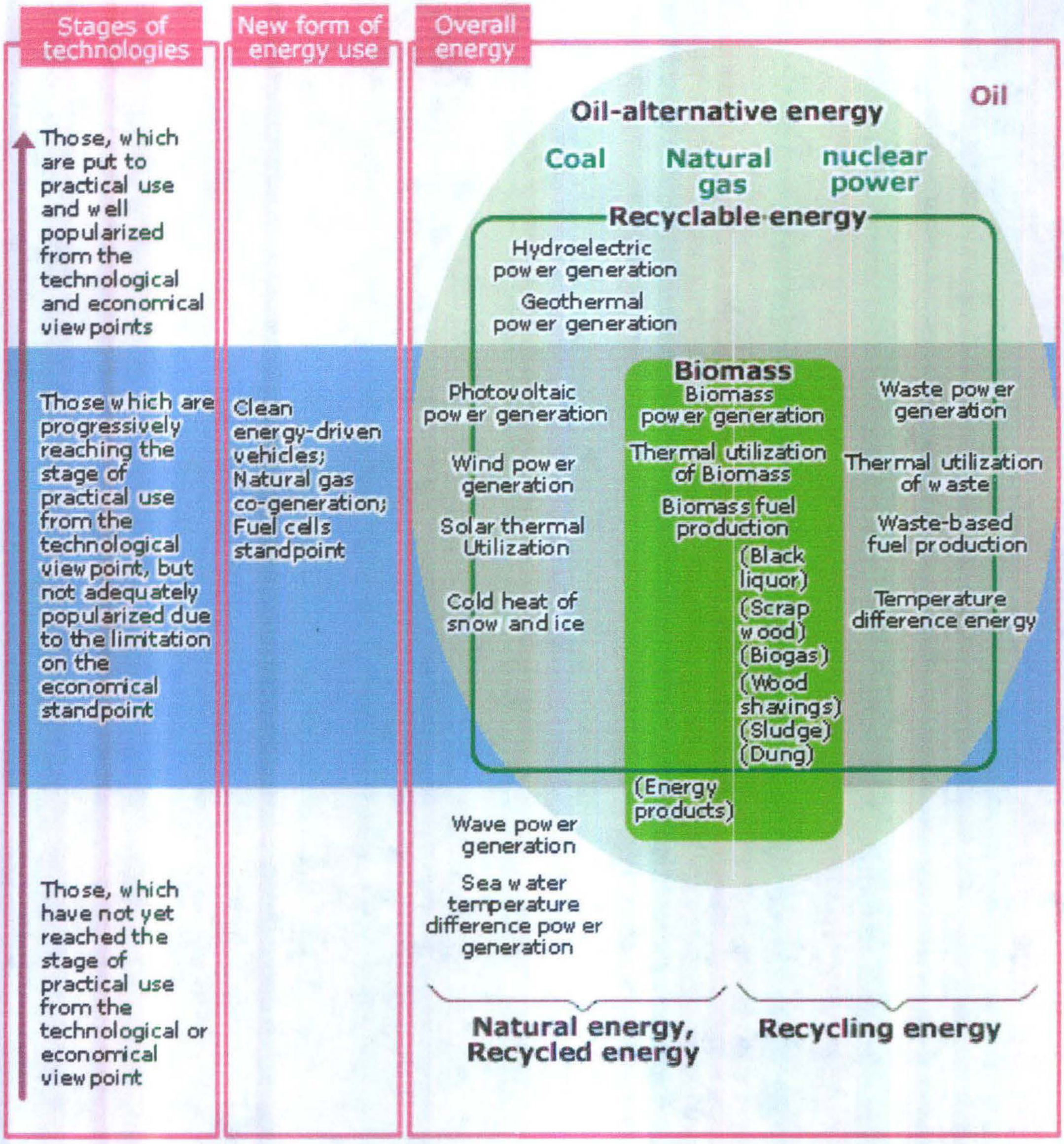
As a consequence, the Law Concerning the Promotion of the Use of New Energies was enacted in June 1997 to provide a framework encouraging the introduction of new and renewable energy. The law clarified the role of various entities such as end-users and the government, and incorporated financial assistance measures. Under this law, such renewable energies as PV, wind power, solar heat, thermal energy conversion, waste power, and waste heat were defined as "new energy". This law also covered new forms of energy utilisation such as fuel cells, natural gas vehicles and natural gas co-generation. In June 2001, the New and Renewable Energy Subcommittee (set up under the Advisory Committee for Natural Resources and Energy) projected a potential increase in the use of renewable energy up to 2010 under two case scenarios. The Base Case assumes the continuation of the suite of policies in place in 2001, leading to an increase in the share of new energies in TPES from 1.2%in 2000 to only 1.4%in 2010.The Policy Case assumes that new aggressive policies will be put in place and the share of new energies would climb to 3%of TPES in 2010.

The most significant additional policy was the introduction of a portfolio standard for renewable generation in the electricity market. In June 2002, the Diet adopted the Law Concerning the Promotion of the Use of New Energy by Electric Power Suppliers. The law introduced a portfolio standard, *i.e.* electric power retailers are required to obtain a certain percentage of their sales from new energy sources. The law aims at promoting capital investment in new energy sources through mandatory expansion of their market with a view to climate change mitigation and fuel diversification. According to the portfolio standard, retailers are obliged to acquire around 1.35%of their sales volume from new energy sources in 2010.The specified sources are solar power, wind power, small and medium-sized hydropower(less than 1 MW and without a dam),geothermal energy using vapour recycling technologies, biomass and organic waste. The scheme is estimated to increase generation from such sources from 3.28 TWh in FY2003 to 12.2 TWh in FY2010.

The budget for the promotion of new energy (¥144.9 billion for FY2002) has more than doubled over the past five years. This was ¥34.3 billion greater than the previous fiscal year (See Table2.4), to boost existing programmes and measures to reduce costs through the process of technology learning. In addition, fiscal measures are in place to promote investment in renewable energy. Tax deductions or special depreciation allowances apply to the acquisition cost of new energy facilities. Local property taxes are also lower for new energy projects. The government is implementing the measures outlined in Table: 2.3 after the portfolio standard system is implemented. Investment subsidies for new energy are not given to hydropower and geothermal power plants because they are considered to be competitive. Other technologies, such as PV and wind power, have received a significant amount of investment subsidies[31].Investment subsidies for PV for household installations, however, been reduced from ¥23.2 billion in FY2002 to ¥10.5 billion in FY2003.In addition to subsidies given by the government, prefectures, cities, towns and villages have implemented their own subsidy systems to complement national subsidies. The general power utilities have been voluntarily buying electricity from renewables, such as PV and wind power at premium prices. For example, households with renewable systems that generate more electricity than they consume sell the surplus electricity to power companies at the same price as they buy electricity from the power companies. Together with government support, this voluntary purchase has made a large contribution to the penetration of renewable energies, in particular solar and wind. The government expects the introduction of the portfolio standard to encourage retailers to purchase all surplus electricity from renewables in the future.

[31] In FY2002, the subsidies paid to PV plants for residential use (output under 10 kW) were ¥0.1 million per kW which is equivalent to one-seventh of the installation cost. For larger PV plants with output above 50 kW, subsidies were one-third of the installation costs for enterprises and 50%for municipal entities. Subsidies for electricity generation from waste were 10%of the installation cost for plants with less than 15%efficiency and for more efficient plants, one-third of installation cost for enterprises and 50%for municipal entities. Subsidies paid to renewables plants such as wind and biomass were, in principle, one-third of installation cost for enterprises and 50%for municipal entities. (Energy policies of IEA Countries. Japan 2003 Review.IEA.pp.100)

Figure 3: Where Does the New Energy Stand?



2.71 Benefits from the new energy

The new energies are contributing to constructing sustainable economic structure as they are environmentally friendly, emit little CO_2, and provide us with alternatives for relying less on petroleum . As domestic energy resources that are almost limitless in Japan, the new energies give the opportunity to secure a stable supply of energy, and to deal with global environmental issues. In addition, introduction of new Energy technologies can bring further advantages such as creating new industry and chance of employment, etc.

- As a domestic energy source, new Energy contributes to the diversification of the energy supply structure for Japan which relies on imports for most of its energy supply.
- Natural energy, such as photovoltaic power generation or wind power generation, is inexhaustible, and does not increase CO_2, the cause of global warming.
- We can realize cleaner and more efficient ways of using conventional energy, such as clean-energy motor vehicles, which still burn the fossil fuels, but in a cleaner, more efficient way.
- As most of the new energies are distributed and available near their place of usage, there is no energy loss due to transportation.
- Photovoltaic power generation can provide electricity during the day when power consumption is at its highest; therefore it will contribute to easing demand for energy at peak hours.

Table:2.3. Introduction of Various New Energies.

Type of new Energy	Condition of introduction
Photovoltaic power generation	Application has increased by 3.5 times during the last 3 years. Generating cost is still high, even though the price of the system has come down over the last six years to one fourth of what it had been.
Wind power generation	Application increased by about 7 times during the last 3 years, and its commercial viability has been recognized depending on local conditions. Future issues are economic efficiency and stability.
Waste power generation	Local communities are mainly promoting the installation of facilities. A future issue is the problem of location, etc.
Biomass power generation	Wooden chips, biogases (sugar cane husks) and sludge are used mainly. In recent years, there have been trials using methane gas

	from the food waste, but still economic viability is still an issue.
Solar thermal utilization	Level of application has decreased in recent years. The main issue is economy.
Thermal utilization of waste	While there are some cases where it is introduced as a heat supply project, the number of applications is in low.
Temperature difference energy	
Thermal utilization of biomass	Black liquor waste accounts for a substantial amount of the new Energy in this area, such as biomass heat utilization.
Clean energy motor vehicles	Hybrid automobiles and natural gas automobiles are steadily increasing, and the level of application amounted about 4-fold during the last 3 years. Future issues are economic efficiency, performance and infrastructure availability.
Natural gas cogeneration	The application increased by about 1.4 times during the last 3 years. High efficiency facilities are still expensive.
Fuel cell	Phosphoric acid type has decreased. Competition to develop solid high polymer types is already noticeable in domestic and overseas companies to develop cells for practical use and dissemination. Large-scale application is anticipated in future.

Note: For implementation amount refer to "4. Application objectives for new energies" for number of application.

Source: Agency for Natural Resources and Energy (ANRE), METI.

Table4: Measures for Promoting New Energy, Financial Years 1997 and 1998.

(Billion ¥)

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

Source: Energy Policies of IEA Countries, Japan, 1999 Review, IEA. pp.58

In 1996, new energies (as defined earlier) accounted for only 1.1% of primary energy supply and are expected to account for 3.1% in 2010. Black liquor used for in-plant power generation in the pulp and paper industry accounted for 70% of new energies in 1996 and is expected to account for 30% in 2010. The only carbon-free new energies are solar and wind energy, which together accounted for only 15.5% of new energies in

1996. The capacity of solar energy is expected to increase nearly ten-fold by 2010, but would still account for less than 30% of new energies. Total carbon-free renewable energies (hydro, geothermal, photovoltaic, solar heat and wind power) accounted for 2.3% of primary energy supply in 1996 and are forecast by METI to increase their contribution to 3.7% in 2010, but forecast by the Institute of Energy Economics, Japan (IEEJ) to *fall* to 2.1%. Whatever the forecast, the new energies should be viewed as part of the energy research, development and demonstration programme with a very long-term goal. Moreover strong government support will be needed besides corporate and popular understanding and co operation on the basis of positive judgments about a long term prospects for new energies. Assessment of the long-term prospects should take into account the economics of the new energies. The prospects for achieving the targeted increase in photovoltaic power generation by 88 times, for example, look over-ambitious on economic grounds. The IEEJ considers that photovoltaic might increase their contribution to power generation by perhaps 11 times in the period 1996 to 2010[32].

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

In 2001, energy from new and renewable sources (including large-scale hydro) amounted to 16.3 Mtoe and accounted for 3.2%of TPES. Some 7.2 Mtoe came from hydropower, 5.2 Mtoe from combustible renewables and wastes, 3 Mtoe from geothermal energy and 0.9 Mtoe from solar and wind power. Use of renewables increased by about 20%in absolute terms but their share in TPES remained at roughly the 1990 level. Electricity generation from renewables declined by 6.6%in 1990-2001, the main reason being an annual variation in hydropower generation. Gross electricity generation (excluding pumped storage) from renewables totaled 101 TWh in 2001, accounting for 10%of total generation. Hydropower is by far the most common source, with 84%share of total generation from renewables , followed by solid biomass (7%),municipal solid waste

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[32] Energy Policies of IEA Countries,Japan,1999 Review,IEA.pp.63

(5%), geothermal energy (3%),industrial waste (0.3%)and wind power and photovoltaic (PV)(0.3%).

At the end of 2001, the total hydropower generation capacity was 46 400 MW (of which pumped storage accounted for 24 300 MW).The generating capacity from solid biomass was 1 600 MW, municipal solid waste 1 500 MW, geothermal 533 MW, PV 452 MW and wind 175 MW. Some 7.5 GW of hydropower capacity is under construction and 5.9 GW is in the planning stage. Most of these plants are pumped storage plants and only 1 GW is conventional hydropower over numerous small sites. Japan has nearly exhausted sites for construction of conventional large-scale hydropower plants. In recent years, special emphasis has been placed on the development of large- scale pumped storage systems to handle peak load, improving the stability of the nation's electric power supply. TEPCO's Kazunogawa plant, which began operation in June 2000, has the highest effective head (714 m) of any pumped storage hydroelectric plant in the world.

Japan produced 52 Mt of municipal solid waste and 406 Mt of industrial solid waste in FY2000;77%of municipal solid waste and 3.4%of industrial solid waste was incinerated;93%(incineration capacity base)of the incineration facilities for municipal solid waste have heat recovery and power generation capability. Low-temperature combustion during waste incineration is the cause of over 90%of all dioxin emissions. The government is addressing this issue by developing high-temperature combustion incineration plants[33].

Since the beginning of the Heisei Era (1988), about 310,000 kW of geothermal energy has been developed, entering into the stage of full-scale introduction at long last, providing the source of electric power exceeding about 530,000 kW, when added to 220,000 kW developed earlier. Although the geothermal energy development is reasonably expected to compete with fossil fuel resources in terms of economics on the medium- and long-term basis due to the increase in prices of crude oil etc. The total capacity of Japan's 15 geothermal power plants was 533 MW at the end of FY2000.A

[33] Energy Policies of IEA Countries. Japan 2003 Review .IEA. pp.95

number of electric power companies (EPCos) operate 12 plants with a total capacity of 497 MW. The capacity factor of geothermal power plants was 72%in FY2000.

Ministry of Economy, Trade and Industry, have carried out technical development of wind generating system with Sunshine Scheme from 1976 to 2000 (from 1993, it was new Sunshine Scheme), and carried out activities like the study of 100kW class wind generation plant in Miyake Island from 1981 to 1986, development of large-size generating system from 1990 to 1998, and development of small island wind generating system from 1999. Wind power plants have been developed in over 100 locations. Number of wind generator installation in Japan exceeded 260 cases as of end of March 2001, with the output of app. 144MW(see appendix 3). Low wind speeds in many easily accessible areas limit the possibilities to expand the use of wind power. The seasonal variation in wind speed is counter-cyclical with peak demand. The strongest winds are in winter while peak demand is in summer. The seabed generally shelves quite steeply, limiting the possibilities for offshore wind power. Onshore wind power generation is limited for a variety of reasons, including intermittency, high cost and difficulties in achieving planning permission because of visual intrusion. However, the Ministry of Environment has recently announced plans to permit construction of wind power facilities in national parks. Power distribution grids, into which wind capacity needs to be supplied, are in many cases not strong, particularly on the northern island of Hokkaido which has the greatest potential for wind applications. Weaker grids are limited in their ability to accept the intermittence of wind energy because of its impact on the fluctuation of voltage and frequency. Therefore, the Hokkaido Electric Power Company has announced that it will limit the access of wind power to its networks at 250MW and the Tohoku Electric Power Company at 470 MW.

Japan is the second-largest producer of solar power in the world and the largest of PV power. Situated between latitudes of 24o N and 46o S, Japan has a moderate to good solar resource. For power generation, the peak supply from PV correlates with peak demand. In 2002 Japan's manufacturing capacity for PV systems was 250 MW. Major house builders are working closely with PV manufacturers to better integrate PV systems into building designs. At the end of FY2001, about 81 000 homes had solar cell panels installed and the number was expected to increase to 100 000 by the end of FY2002.The use of solar heat soared in the 1980s following the second oil crisis.

As a result of the national government's new-energy policy and private businesses' voluntary efforts, electricity derived from renewable energies in particular accounts for 2.5% ('2002) of the total power generation in Japan – a level that can be favorably compared with those of European nations and the U.S. (2% on average among IEA participants). Further, additional policies and measures aimed at accomplishing policy targets such as global-warming have recently come under review.

Japan is ranked third behind the U.S. and France in amounts of renewable energies introduced, according to the 2000 statistics of the IEA (International Energy Agency), but the percentage of such energies in primary energy supply is slightly lower than in other nations. As far as power generation is concerned, however, Japan tops all other developed nations with the exception of the U.S., and is roughly average among developed countries in terms of the percentage of renewable energies used in power generation.

In Japan, the report of the New Energy Division of the Advisory Committee for Natural Resources and Energy released in June 2001 called for a further expansion in the introduction of renewable energy in a bid to address global warming, and it was decided to introduce the RPS System as a means of achieving this goal, as the system holds the promise of improving economic efficiency through the use of the market principle, while taking renewable energy promotion targets as energy security.

2.8 Crude Oil Prices and Diversification.

Following points may be taken in to consideration for concluding the chapter as below and finding the result of remaining questions, what was the impact of ever rising crude oil prices on diversification of energy supply in Japan, how much influential was it in the government policies related to energy diversification? And is there a coherent relationship between the total amount that Japan paid each year for the crude oil imports and the degree of diversification[34].Naturally few questions arise from here like, how we define the "degree of diversification" and can we statistically prove the relationship.

Since 1973, the world has faced many episodes where crude oil prices suddenly increased. In most economies, these fluctuations in energy prices also affect the price of other goods and services, and disturb the well functioning of the economy.

This subject has come under close scrutiny since the energy crisis of the 1970s, when economic research led to an improved understanding of the potential adverse economic consequences of rising real energy costs. The changes caused by the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand and diversify the energy from oil to other sources including nuclear .Oil prices shot up in the wake of the embargo in 1973-4 and were further exacerbated by supply disruptions induced by the Iran-Iraq war in 1979.

Again since 1986, the Crude Oil price has fluctuated dramatically, reflecting developments in the international Crude Oil market. In FY 1990, the import price soared because of the Gulf crisis. It began to rise in September 1990 and reached $34.16/bbl in November. The average price for FY 1990 was $23.34. Crude oil price continued soaring in FY 1999 from about $10/bbl level mainly by OPEC/non-OPEC cooperative production restrain and the average crude oil price in FY 2000 recorded $28.37/bbl, the highest price since FY 1986 because of high gasoline price caused by low gasoline inventory in the US and speculative investment by speculators in NYMEX (New York Mercantile Exchange).In the first half of FY 2003, the crude oil price rose due to the observation that the Iraqi unstable situation would last longer than expectation. The average price for FY 2003 was $29.42/bbl (See Appendix.viii)

These developments in international crude oil price have any effects in the Japanese energy sector? Is there any relationship between the increasing crude oil price and consequent rise in real cost of oil import and increased share of nuclear and other energies over the years in Japan. The given table in *appendix viii* shows a positive relationship between these variables mentioned above. By using the statistical formula of

[34] The term diversification often used in this dissertation implies, shifting the dependence of energy from oil to nuclear energy and other new energy sources.

"*Karl Pearson's*" coefficient of correlation we can prove the degree of relationship in the following way.

Of the several mathematical methods of measuring correlation, the Karl Pearson's method, popularly known as Pearson's coefficient of correlation, is mostly used in practice. Pearson's coefficient of correlation is denoted by the symbol r.

Karl Pearson's coefficient of correlation ($r = \frac{1}{n}\frac{\sum(x-\bar{x})(y-\bar{y})}{\sum x^2 \sum y^2}$).Taking the variable X as the total price, Japan paid each year for oil imports and variable Y as the combined quantity of nuclear and other new energy sources in primary energy supply in Japan from 1987 to 2003 for proving the relation empirically. By solving the equation we get the value R equal to *0.568* which meant there is a positive relation between the amount paid for the crude oil imports and the quantity of nuclear and other new energy in the primary energy supply in Japan from 1987 to 2003.Form the analysis we can conclude that the developments in the international crude oil market particularly the fluctuating prices have a significant impacts on the diversification of energy sources, to be precise, shifting from oil to nuclear and other forms of new energies.

Chapter: III

CHANGES IN THE COMPOSITION OF JAPANESE ENERGY DEMAND

Favourable international conditions helped Japan's post war economic growth. Japan benefited from market globalisation and a movement towards a free trade regime. Japan, moreover, was able to enjoy an abundant oil supply from Middle East and other parts of the world at prices that were cheaper than for domestic coal. With an annual growth rate of over 10% through the later half of the 1960s, the Japanese economy continued to expand until the oil crisis of 1973. Indeed, the national income doubled in less than ten years. And later Japanese economy had been experiencing a moderate rate of growth until the so called bubble burst of 1989. Energy is fundamental to most production and consumption activities and as a result energy consumption is typically viewed as an indicator of economic activities and living standards. Between 1970 and 2001 the pattern of final energy consumption in Japan changed significantly as energy demand in the transport and residential sectors grew more rapidly than energy demand by industry .The reasons for these changes are many and include increased electricity demand by households, rapid growth in the number of freight and passenger vehicles in the transport sector and increased energy efficiency of Japanese industry. It should also be noted that Japan's economic slowdown since 1992 has had a larger effect on industrial energy consumption than energy consumption in the transport or residential sectors[1].

This chapter analyses the Japanese economic growth during pre and post bubble and its impact on the changes that took place in the spheres of energy demand, efficiency and intensity in the same period.

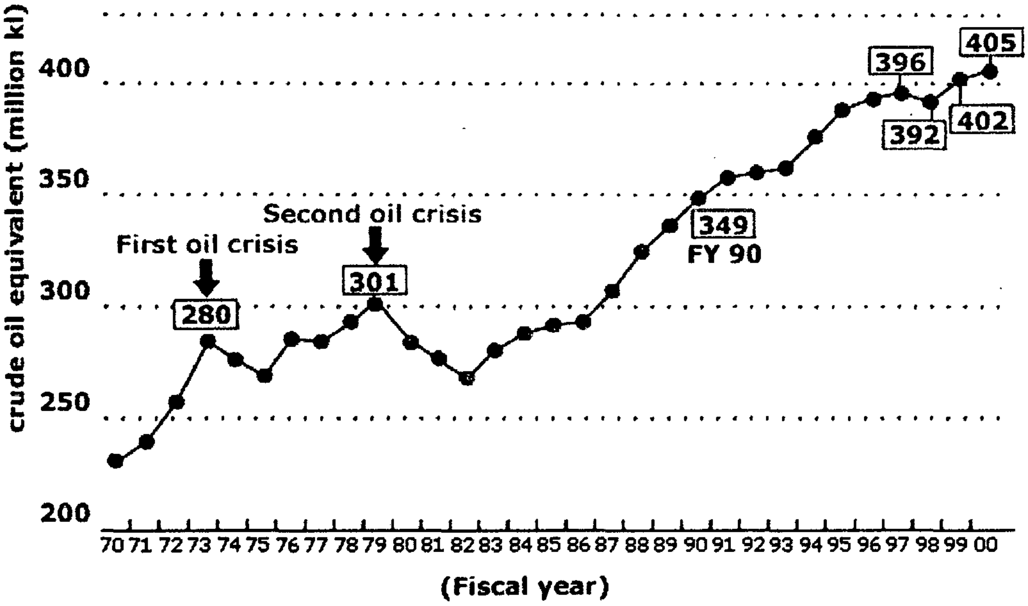
3.1 Trends in Energy Demand

Energy consumption in Japan has been following a consistent rising trend except for periods during the two oil crises. A look at consumption by sector shows that while

1 Sam Hester, "Japan's energy future, economic imperatives and environmental challenges", Department of Industry, Tourism and Resources, Australian Government, 2004.pp.11

consumption by the industrial sector leveled off after the oil crises, consumption by the residential/transportation sector has consistently increased irrespective of economic trends, reflecting changes in lifestyle and desire for comfort. Following investments in energy efficiency after the oil crises of 1973-75 and 1979-82, Japan's final energy consumption had generally stabilised until 1982.

Figure 4: Changes in Final Energy Consumption



Source:ANRE, Comprehensive Energy Statistics (preliminary figure for FY2000)

Energy consumption then started to increase, and continued to rise steadily through the 1990s pace with the economic growth, except in 1992 and 1993, which were years of economic adjustment. The rate of growth of energy consumption (mostly for electricity because of the increased use of air-conditioning) has been faster in the residential, commercial and the transport sectors. From 1990 to 1996, energy demand grew by 1% per year in the industry sector, by 3% per year in the residential and commercial sectors, and by 3% per year in the transport sector. The share of the industry sector is decreasing, dropping to a level of below 50% of total energy consumption for the first time in 1995, while the shares of the residential, commercial and transport sectors are rising[2].

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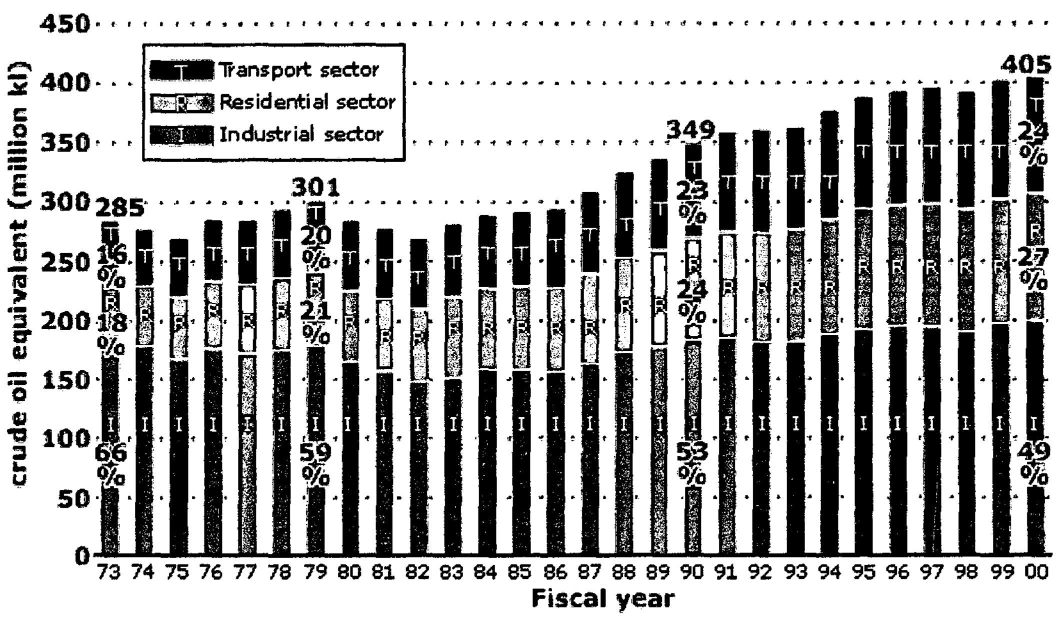
[2] Energy Policies of IEA Countries, Japan, 1999 Review, OECD. pp.35

3.12 Industrial Sector

Energy consumption in the industrial sector decreased from 1982 as a shift occurred away from basic material industries (many being re-established offshore) and towards less energy-intensive industries, such as processing and assembling, electronics and information. The trend slowed as businesses responded to market demand for a wide variety of production activities requiring small quantities of output and the production of high value-added products, coupled with the general expansion of business encouraged by a government policy to expand domestic demand. However the general trend in the energy consumption by industry continued to decrease almost one percent in every year, both in the period of economic growth as well as during the recession. Compare to eighties, there has been a sharp decrease in the consumption during recession and the trend continued till 2001.It can be noted that the slow down in the industrial production because of the recession, shifting of the manufacturing sector in to abroad and using high efficient technologies in the industrial production might be the reasons for the less energy use by industries.

Figure 5: Changes in Final Energy Consumption by Sector



Source:ANRE, Comprehensive Energy Statistics (preliminary figure for FY2000)

The industrial consumption of energy decreased from 47.7% in 1983 to 44.4% in 1992 and further 38.4% in 2001.The volume of diminution has almost doubled between these two decades, possibly showing the impacts of economic recession on industrial production. Again there was slight raise in energy consumption in coming years reaching to 41.5% in 2003[3].

3.13 Residential Sector

Energy consumption in the residential sector is closely related to the social structure, such as the number of households and the proportion of senior citizens in the population. As disposable income increased, the demand for a level of comfort, comparable with that of other IEA countries, continued to push up energy use in households. The share of residential sector in energy consumption increased from 21% in 1980 to 27% in 2000. This trend has been particularly evident for electricity demand. The number of electrical appliances has increased significantly, even as the appliances have become more efficient in their use of energy. Principal areas of end-use growth have been in domestic electrical appliances and for heating and cooling. On the other hand, the shares of hot water supply and kitchen use are decreasing.

3.14 Commercial Sector

Energy consumption in the commercial sector, which is closely related to the level of economic activity, had flattened from the mid-1970s with the decrease in energy intensity per unit of floor space. However, consumption has been rising steadily since 1985 largely because of increases in office automation and the trend towards continuous 24 hour use of electricity, and an increase in the frequency of equipment use. The development of a service and information-oriented society has been the main driver behind consumption increases in the sector. The share of energy consumption by office automation equipment has risen from 23.9% in 1981 to 38.2% in 1996[4]. As in the residential sector, demand for heating and hot water in the commercial sector has decreased dramatically. Hence, as for the residential sector, demand growth has been principally for electric power. Government policy aims to improve energy efficiency in electrical appliances and lighting. Energy consumption for air-conditioning and heating is also being targeted for improvement through application of energy efficient technology.

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[3] See Appendix:ix

[4] Energy Policies of IEA Countries, Japan, 1999 Review, OECD. pp.36

3.15 Passenger Transport

The increase of energy consumption for passenger transport is attributable to the growth in the number of private cars and to the increasing share of cars with engines of 2000 cc or larger. The number of cars increased at an average annual growth rate of 4% from 1990 to 1996, while fuel efficiency decreased. At the same time, the size of cars increased, raising energy consumption in this sector. There has been little change in actual on-road fuel economy, according to the Japanese Government, but in 1990 the Government reduced the tax on the largest new cars, and their market share grew significantly. The share of private passenger cars as a proportion of total passenger transport was about 60% in 1973, growing to about 70% in 1996[5]. Issues related to energy consumption by cars are the frequency of car use; the demand for higher-performance, bigger, and safer cars; and the control of exhaust gases. These factors have accelerated the increase of energy consumption in the transportation sector.

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

3.16 Freight Transport

Energy consumption in the freight sector decreased until 1982, the end of the second oil crisis. However, it increased steadily in the 1980s, except during the years of economic adjustment after the collapse of the so-called "bubble economy". Demand grew at an annual average rate of 1.5% from 1990 to 1996. The increase of energy consumption in the freight sector mainly reflected the growth in the number of trucks. The share of trucks in total freight transport increased from about 70% in 1973 to about 90% in 1996[6]. The fuel intensity of Japanese trucking is one of the highest in the IEA countries, consequence of a relatively low maximum permitted gross weight and traffic congestion. The number of cargo flights has also risen, but the absolute quantity is still small.

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[5] Ibid.pp.36
[6] Ibid.pp.37

Total energy consumption by transport sector continuously increased from 22.9%in 1983 to 28.13% in 2001 and decreased to 26.42 in 2003. TFC growth was quite strong in the transport sector –29%between 1990 and 2001 –with an average annual growth rate of 2.4%.In particular, energy use by passenger cars increased sharply and accounted for 80%of the transport sector's energy demand in the 1990s. (See Appendix: ix).

3.17 Oil Consumption.

In 2001, oil accounted for nearly half of Japan's primary energy consumption while nuclear power and natural gas represented 16 per cent and 12 per cent of the total respectively (figure A; IEA 2003a). These shares are substantially different from 1970, when oil accounted for more than 70 per cent of Japan's primary energy consumption and nuclear power and natural gas combined accounted for less than 2 per cent of the total consumption.

Electricity generation accounts for nearly one-quarter of oil consumption in Japan transport 31.2% and industry 27.6%. Oil's share of electricity generation in Japan fell from 73% in 1973 to 21% in 1996, under the influence of government policy. Oil demand grew by only 1.2% between 1990-2001 reaching 256.1 Mtoe, from 1990 to 2001, total final consumption (TFC) of oil increased to 218.5 Mtoe, *i.e.* by 16 %.(see Figure 16 of IEA-energy policies of IEA countries. Japan 2003 review pp.67).Because of stagnant economic growth, oil consumption ceased to increase, and a downward trend emerged. The transport sector is the largest oil user (43%), followed by industry (31%), and household and other sectors (26%).Kerosene is the most typical heating oil used in Japan.

By 2001 Japan's final consumption of petroleum products was around 217 million tonnes

Of oil equivalent, significantly above its 1970 level of 130 million tonnes. Much of this increased consumption stemmed from growth in the transport sector, in which petroleum consumption almost tripled from 32.0 million tonnes of oil equivalent in 1970 to 95 million tonnes in 2001. A factor contributing to the increased petroleum consumption in the transport sector was growth in the number of passenger motor vehicles in Japan. Between 1990 and 1996 the number of passenger motor vehicles increased at an average rate of 4 per cent a year; at the same time, average vehicle fuel efficiency decreased (IEA 1999). This decrease occurred after taxes on large new cars were reduced in 1990, resulting in these vehicles taking an increasing share of Japan's car fleet over the period[7].

METI has established long-term targets for oil-fired generation but large investments in oil-fired capacity have been preserved, with only a few plants converted to other fuels. Japan has few economic alternatives to oil for meeting seasonal demand and none for meeting peak demand other than pumped storage, which is often oil-fuelled. Hydro capacity is limited and coal and natural gas expensive, leaving oil as the least costly means of meeting peak summer demand, which is largely driven by air-conditioning.

3.18 Gas Consumption.

Japan is the seventh biggest gas consumer in the world. Natural gas demand reached 64.8 Mtoe (80 bcm) in 2001 which is 50%higher than in 1990.Some 44.4 Mtoe (69%) of natural gas is used for power generation. TFC of gas has grown by 39%since 1990 reaching 20.4 Mtoe in 2001. The industry accounts for 41%of TFC of gas and the rest is used in the household, services and other sectors. Despite its rapid growth, natural gas is still available only in about 5%of the whole country and 21%in city areas. The number of gas users has been gradually increasing from 22 million in 1990 to over 26 million (about 55%of all households) in 2001[8]. Natural gas use in the transport sector is still limited but growing fast. In 2001, the number of natural gas vehicles exceeded 12 000 and the number of filling stations was about 180.However, little change is expected in the sectoral breakdown of gas demand by 2010.

In addition to natural gas, other types of gas (coal-type gas and LPG) are distributed via the networks by the gas utilities. In the past, the share of other gases was larger but since the end of the 1970s, natural gas has had the major share. Today, about 88%of all city gas is natural gas whereas the share of LPG is 11%and the share of gas derived from coal is

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7 Sam Hester, "Japan's energy future, economic imperatives and environmental challenges", Department of Industry, Tourism and Resources, Australian Government, 2004.pp.12.

8 Energy policies of IEA countries .Japan 2003 review.IEA, Paris. pp.76)

9 Ibid.pp.77

1%;57 utilities distribute only LNG,15 both LNG and indigenous natural gas and the rest distribute only LPG or coal-type gas[9].

3.19 Coal Consumption

The share of coal in Japan's total primary energy consumption declined between 1970 and 2001 but has been rising in recent years. Just over three-quarters (75.7% in 1996) of all steam coal imports are consumed in electricity generation, where coal consumption has been growing at 10.4% per year since 1978. Most of the remainder (20%) is used in industry, principally in cement making. The steel industry uses virtually all coking coal imports (of which 11.1% are steam coal quality used for pulverised coal injection into blast furnaces). Coal demand increased from 74 Mtoe in 1990 to 100.2 Mtoe in 2001, *i.e. by* 35%.The demand for different types of coal has developed differently. Whereas consumption of steam coal increased by 11.1%between 1990 and 2001 mainly led by increasing demand for electricity generation, consumption of coking coal decreased by 6%as a result of economic slow-down and declining demand for steel.

In 2001, 76%of steam coal was used for power generation and most of the remainder was used by the non-metallic minerals industry. All coking coal is used by the steel industry. The government's *Long-Term Energy Supply and Demand Outlook* forecasts an increase in coal demand of 26%between 2000 and 2010 in the Base Case and of 9%in the Policy Case. Final consumption of coal has remained quite steady in the 1990s; it decreased from 22.5 Mtoe in 1990 to 20.8 Mtoe in 2001[10].

In 2001, total final energy consumption (TFC) was 342.1 Mtoe, increasing by 17%from 1990 levels. Industry is the largest energy-consuming sector (38%)[11], followed by residential, services and other sectors (33%) and transport (28%)(See Appendix; viii).In 2001,oil constituted for 63.9% of TFC, electricity 23.1%,coal 6.1%,natural gas 6%,combustible renewables and wastes 0.7%, and other energies 0.3%.In the industrial sector, TFC declined by 2%between 1990 and 2001.The largest energy-consuming industries are chemical and petrochemical (which represent 36%of all industrial

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[10] Energy Policies of IEA Countries. Japan 2003 review pp.72

[11] Including non-energy use of 8.7 Mtoe.

consumption),iron and steel (with a 16% share),paper, pulp and printing (with an 8%share),and non-metallic minerals (with an 8%share).

TFC in the residential sector increased by 17%and in the services sector by 72%(primarily because of an increase in floor space),but declined by 40% in the agricultural sector between 1990 and 2001.Households are seeking to raise living standards by acquiring more air-conditioning units and electrical equipment, and increasing the heated areas in buildings[12].

According to the *Long-Term Energy Supply and Demand Outlook* of 2001, TFC in the industrial sector is expected to decrease by 5.1%in the Base Case and 6.1%in the Policy Case, and in the transport sector by 4%and 6% respectively between FY1999 and FY2010.TFC in the residential and commercial sector is expected to increase by 20%in the Base Case and 14.3%in the Policy Case over the same period. The developments in Japan's energy consumption pattern have been encouraged strongly by government policies aimed at diversifying the fuel mix. The changes in Japan's fuel mix between 1970 and 2001 also reflected the growing importance of electricity in Japan's final energy consumption over this period. Much of the growth in electricity consumption occurred in the residential sector, as electrical appliances such as air conditioners and computing equipment have become increasingly abundant in Japanese households.

3.2 Japan's Economic Growth and Final Energy Consumption.

Historically, energy demand in Japan had risen faster than GDP, particularly during the 1950s and 60s.Between 1965 and 1970 real GDP grew by 11.3% and final energy consumption grew by 14.2% annually. While the trend has changed since the seventies the GDP growth overtaken the energy growth and it continued until 90s. Between 1990 and 1996, when real GDP grew by 1.7% per year, primary energy supply grew by 2.1% per year and final energy consumption by 2% per year. On this basis, the income elasticity of energy demand (the responsiveness of energy demand to a rise in income) was 1.2. The Japanese Government Outlook assumes growth in GDP to be 2.3% per year to 2010, and the income elasticity of energy demand to be 0.47 in the BAU case, and 0.1

[12] Energy Policies of IEA Countries. Japan 2003 Review.IEA,Paris pp.45

in the Policy case. Achieving this outcome would only be possible with a dramatic turn around in historic trends in energy consumption.

In absolute term both GDP and energy consumption increased continuously over the decades. The GDP grew from 312.70(trillion Yen) in 1980 to 546.2 (trillion yen) in 2003.As discussed earlier, both the growth rates of GDP and energy consumption were reduced much in 1990s compared to 1980s because of the recession. Between 1980 and 1990 GDP grew by an average of 4.1% and energy grew by 2% in the same period. While during the ten year period of 1990 to 2000 GDP grew by 2.2% and energy grew by 2% as1980s.Between 2000 and 2004GDP grew by 1.4% while energy growth was negative equal to -1.4 in the same period. The given table shows a positive relationship between the growth in GDP and energy consumption over the last three decades[13].

Table 5: Japan's Economic Growth and Final Energy Consumption.1965-2000

Year	GDP in real terms (trillion yen in constant 1995 prices)	Final Energy Consumption (mtoe)
1965	123.00	108.50
1970	204.10	211.20
1980	312.70	264.50
1990	469.8	322.90
1997	492.1	340.46
2000	535.7	342.13
2003	546.2	353.53

Source: Energy data and Modeling Center.IEEJ.Tokyo.2002.pp.3

[13] Using the Karl Pearson's coefficient of correlation (R= $\frac{1}{n}\frac{\sum(x-\bar{x})(y-\bar{y})}{\sum x^2 \sum y^2}$) to determine the degree of relationship between the two variables vis-à-vis GDP as variable X and final energy consumption as variable Y, the result shows a positive relationship with a slight difference equal to "0.91& 0.75" of correlation between GDP growth and energy consumption in Japan during the period of growth(1980s) and the period of recession(1990s),implying high intensity during the growth period compare to the time of recession.

Japan aims to reduce growth in energy consumption from about 2% per year (above the rate of economic growth) to 1% per year. Between 2000-2004 growth in energy consumption was less than that rate of economic growth after a long period 10 years. Demand-side policies designed to achieve this. In the past, energy consumption in Japan has been closely related to economic growth, with the only important deviations occurring in the wake of the oil crises of 1973 and 1979. The priority accorded to economic recovery will have an important influence on the outcome. If the link between economic activity and energy consumption cannot be changed, as appears likely from historical trends, then even greater emphasis will have to be placed on the already ambitious supply-side measures.

Table 6: Annual Growth Rate of GDP and Energy Demand

Period	Real GDP	Final Energy Demand
1965-70	11.3	14.2
1970-80	4.4	2.3
1980-90	4.1	2.0
1990-97	1.7	2.0
1997-2000	2.2	2.5
2000-2004	1.4	-1.4

Source: Estimated using the data from Energy data and Modeling Center2002.pp.3

The above table reveals that during 1970s and 1980s the growth rate of final energy consumption was lower than the growth rate of GDP.The two big oil crises of 1972 and 1979 and a moderate level of economic growth compare to 1960s were the two reasons cited by the development experts. But after the bubble burst of 1989 the situation changed again to overhaul the GDP growth by that of energy consumption and in 2000-2004 period energy growth reached at a minus level.

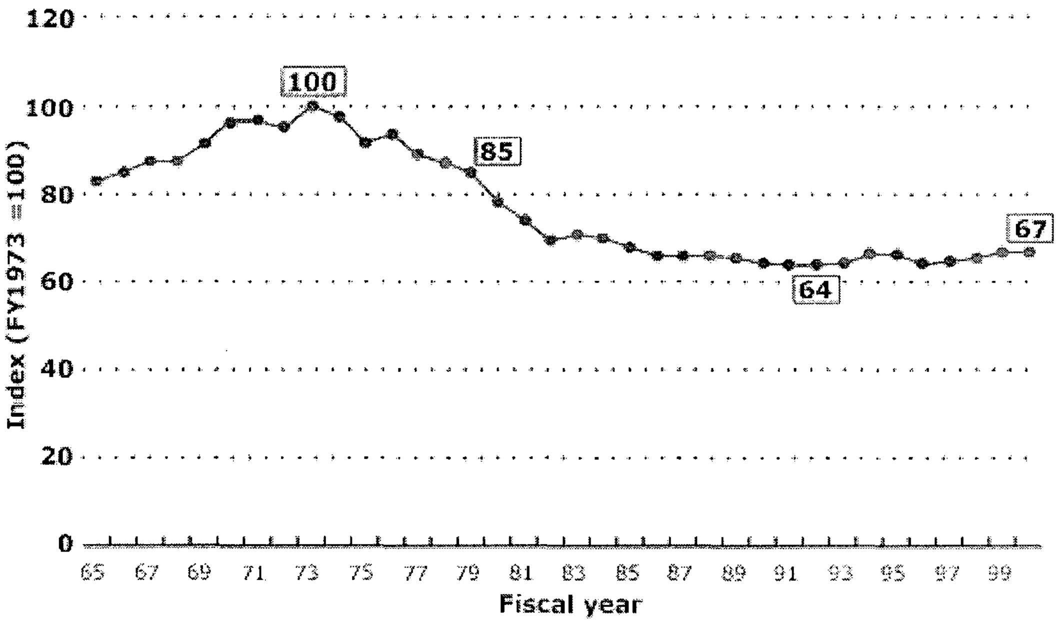
Total final energy consumption in 1997 was 334.9 Mtoe, a rise of only 0.65% from 1996, and in 2003, it rose slightly to 353.53 Mtoe. During this period energy growth rate was more than the growth rate of Gross Domestic Product, which rose by 0.5% in the same

Total final energy consumption in 1997 was 334.9 Mtoe, a rise of only 0.65% from 1996; and in 2003, it rose slightly to 353.53 Mtoe. During this period energy growth rate was more than the growth rate of Gross Domestic Product, which rose by 0.5% in the same period. In 1997, oil accounted for 62.8% of final consumption, electricity 23.4%, coal 6.6%, gas 6%, and renewable energy sources 1.1%. In 1997, industry accounted for about 47% of final consumption and it decreased to 41.54% in 2003, while transport sector accounted for about 26% in 1997 and slightly rose to 26.42 in 2003. Demand for energy in transport has risen by nearly 16% since 1990, and has nearly doubled (growing by over 98%) since 1973. Industrial demand for energy in Japan has risen by 17% since 1990, and just over 12% since 1973.

3.3 Energy Intensities

Energy Intensities, measured as energy requirements per unit of economic activity, also show great differences across nations. They can be expressed in four different ways, depending on whether the numerator includes or excludes non commercial energy, and depending on whether the denominator is GDPmer or GDP ppp. Japan faces an even larger challenge than other IEA countries in reducing growth in energy consumption. Because of high end-use prices, which have encouraged energy conservation, and a strong tradition of promoting energy efficiency, Japan's energy use per unit of GDP is well below the IEA average. Low housing space compared with other IEA Member countries, and fewer kilometers driven per passenger relative to GDP, contribute significantly to this low ratio. Final energy consumption by GDP in Japan decreased at a satisfactory rate following the oil crises and in recent years has leveled off. The ratio of energy use per unit of GDP improved significantly at the time of the two oil shocks (1973-75 and 1979-82) and during the recession and restructuring which followed, partly because of industry relocation offshore. Since 1982, however, energy consumption has been rising, fuelled by economic growth. The following figure explains the trend in final energy consumption per unit of GDP from 1970 to 2000.

Figure 6: Changes in Final Energy Consumption per GDP



Source: Comprehensive Energy Statistics (preliminary figure for FY2000)

In terms of energy consumption per unit of GDP, the general trend in energy intensity in Japan is similar to that seen in other IEA countries: energy intensity fell markedly at the time of the oil crises and the subsequent recessions, i.e., 1973-75 and 1979-82, but almost stabilised in the 1990s. Table: 3.3 show the historical relationship between energy use and GDP in the three main Japanese energy services: electricity, Oil and Gas consumption demand. Changes in energy consumption are directly related to changes in GDP in all three sectors, except for the periods of the two oil shocks (1973-75 and 1979-82) for stationary energy consumptions. Primary energy use has been increasing since 1990 as a result of worsening energy intensities during this period. The decrease prior to 1990 was primarily as a result of changes in manufacturing. Even after correcting for changes in the mix of output (i.e., the effect of relocation of manufacturing industry offshore), Japanese manufacturing had one of the greatest declines in energy intensity among IEA countries from 1973 to 1990.

Table 7: **Oil, Natural Gas and Electricity Consumption/GDP***

Year	**GDP**	**Oil Consumption(Mtoe)**	**Natural Gas Consumption(Mtoe)**	**Electricity Consumption(Mtoe)**
1970	**1050**	**128**	**28**	**30**
1975	**1300**	**140**	**29**	**39**
1980	**1600**	**135**	**30**	**44**
1985	**1900**	**140**	**40**	**50**
1990	**2300**	**158**	**43**	**65**
1995	**2500**	**170**	**47**	**74**
1996	**2550**	**171**	**47**	**78**

* GDP (PPP) in billion 1990 US$

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

It is hard not to attribute part of the decline in manufacturing energy intensities observed before 1986 to higher energy prices. This stimulated the application of energy-saving technologies. Other factors also affected the rate of energy intensity decline. The rate of growth in manufacturing output influences the rate of investment in new technology and the utilisation of production factors, including energy. Thus both prices and the rate of economic growth are important determinants for how manufacturing energy intensities change over time. Shifts in the production processes themselves have also lowered manufacturing energy intensities. Examples include increased use of recycled feed stocks (e.g., scrap metal, recycled paper) and shifts from primary to secondary production, i.e., shifts away from raw steel and aluminium production to secondary and from raw paper to recycled paper production. These shifts represent structural changes within sub-sectors. To isolate the effects of these "micro" structural changes requires more disaggregated data than what are generally avail-able on an internationally consistent basis.

Differences in fuel prices also play a role, although higher intensities, especially in energy-intensive industries, tend to be related to lower prices. Access to cheap energy is often a stimulant for the production of energy-intensive materials. Most sectors in Japan saw a reduction in this share, even though Japanese industries reduced energy intensities at a faster rate than most other countries through the 1980s.According to the study of *Fridtjof Unander,* A closer examination of the data for intermediate production cost and value-added, shows that value-added increased relative to product costs in Japanese industries[14]. This indicates that the use of other production factors also became more efficient in parallel with the energy intensity reductions. Compared to other countries, the somewhat higher share of energy expenditures in Japan in 1998 could thus be related to that the use of other production factors is more efficient, though quantification of this is beyond the scope of this study.

Table 8: Energy intensity in Japan

Year	Real GDP Growth	Energy intensity TPEC/GDP
1970	11.3	1.03
1980	4.4	0.84
1985	5.0	0.84
1990	5.0	0.68
1995	0.6	0.76
1997	1.4	0.69
2003	1.5	0.64

Source: Estimated using the data from Energy data and Modeling Center2002.pp.3

These calculations show that energy intensity of GDP declined by an estimated 1.9% annually in the 1970s. This was a period with rapidly rising energy prices brought about by the first oil crisis of the early 1970s. Rising prices and concerns about fuel embargos produced strong incentives for energy efficiency and structural change. At the same time, Japan's economy grew at 4% annually. In the 1980s the average annual improvement in energy intensity fell to about 1.6% while the economy continued to grow by 4% per year. The second oil shock occurred late in the 1970s and brought about another round of rising energy prices that likely affected energy use at least into the early 1980s. By the middle of the decade world oil prices had fallen considerably from their peak. While energy intensity improvement slowed somewhat in the 1980s, carbon intensity improved

[14] Unander Fridtjof, "Thirty Years of Energy Prices and Savings", *Energy Technology Policy Division* IEA.2004 pp.6

more rapidly in the 1980s (2.5%/yr.) than in the 1970s (2.2%/yr.). The direct reason for this divergence of energy and carbon intensity was the increased share of nuclear and natural gas in primary energy supply.

The 1990s offer a strong contrast from the 1970s and 1980s. Both energy and carbon intensity are nearly flat and not significantly different than zero. The point estimate of the average energy intensity actually increased very slightly. A number of things changed in Japan in the 1990s. For one, it was a period of slow GDP growth with a rate of 1.4% per year. Unlike the 1970s and 1980s, international energy prices were relatively stable and low. The slight improvement in carbon intensity can again be traced to greater use of nuclear and natural gas, as their share of primary energy supply rose from 9 to 12% and 10 to 14%, respectively[15].

The actual data presented in the table 3.4 suggest the slowdown of energy intensity may have had its roots as early as 1980. Removing the transition years in the late 1980s from the earlier decade estimates would likely thus show an even greater difference between the rapid improvements through about 1985 and the negligible improvement since 1990. What can Japan expect in terms of energy and carbon intensity improvement in a reference (*i.e.*, no policy) case through the Kyoto commitment period? Will it return to the rapid improvements of the 1970s and early 1980s, or can it expect performance more like the 1990s? The answer depends in large part on what is behind the change and there are several possible explanations. More detailed statistical analysis that attempt to sort out the effect of energy prices and other factors might help explain the reason for this change, but unfortunately many of the changes occurred together and this high correlation will make it difficult to separate the effect of each factor.

If the differences are mainly due to energy prices, then possibly the recently high oil and gas prices may spur improving energy and carbon efficiency. However, the fuel mix change that led to more rapid increases in carbon than energy intensity is unlikely to continue. Gas could penetrate further but unlike the previous periods when oil prices rise led the way and encouraged a switch to gas, in recent years gas prices have risen rapidly for independent reasons and so there may be less economic incentive to switch from oil

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[15] Ibid.pp.11

to gas even with rising oil prices. As in most other industrial countries, nuclear expansion in Japan has slowed dramatically with few new plants expected to come on line in the near term. Thus, even if rising energy prices spur improvements in energy intensity, these may not be accompanied by an additional improvement. This suggests that energy prices are not the sole explanation for it because energy price changes reflect to a large degree changes in international markets that were felt in all countries.

Another hypothesis is that rapid economic growth stimulates rapid energy efficiency improvement. The argument here is that with rapid growth comes a rapidly expanding capital stock, and perhaps rapid replacement of old capital. If the newer equipment and technology is more energy efficient than the old then improvement in energy efficiency will result.

Another possibility is that Japan has exhausted many of the immediate sources of improvement in energy intensity while other industrial countries have not yet done so. The case to be made here is that Japan has been at the leading edge of intensity change among the industrial countries. With highly efficient processes already widely adopted in Japan, the next set of energy efficient processes may not be yet proven or possess as clear an economic advantage as did the technologies contributing to the rapid decline in intensity in the 1970s and early 1980s[16].

3.4 Energy Efficiency

Japan has a strong tradition of promoting energy efficiency, extending back to the two oil crises of the 1970s. After the first oil crisis in 1973, the initial focus was on R&D. The Ministry of International Trade and Industry (METI) began what was known as the ''Moonlight Project'' in 1978, in collaboration with industry, to develop a high-efficiency gas turbine, waste heat technologies, heat pumps, and early fuel cells. During the second oil crisis in 1979, the Law Concerning the Rational Use of Energy was established. Its main objective was to promote efficient utilization of fuel resources, and

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[16] Satoru Kasahara and others, "Climate Change Taxes and Energy Efficiency in Japan", MIT Joint Program on the Science and Policy of Global Change Report No. 121, May 2005 PP.11

it focused on factories, buildings, facilities, and equipment. The law has been revised several times and to this day plays a central role in energy efficiency policy in Japan.

More recently, Japan adopted new energy efficiency initiatives as part of its strategy to reduce greenhouse gas emissions. In the wake of Third Conference of the Parties under the UN Framework Convention on Climate Change (Kyoto, December 1997), Japan developed a plan for reducing its energy consumption by approximately 2.2 EJ/ year by 2010. This figure is slightly greater than the amount of energy consumed annually by all the nation's households, and is equivalent to about 14% of total national energy consumption as of 2001.

It is commendable that Japan has made energy efficiency one of the priorities for meeting the energy targets in the short and long terms. However, in view of the rising trends in energy consumption in all sectors, the share of the targets to be achieved by energy efficiency measures would require drastic changes in lifestyle, energy infrastructure and the use of efficient technology. If the measures are not successful, then additional contributions would be required from fuel switching (from coal to nuclear, gas or renewables) or from international flexibility mechanisms. Japan has historically achieved high standards of industrial energy efficiency, so further improvement will be a challenging task. Improvements in the residential and commercial sectors are likely to require significant changes to life style, possibly running counter to the trend to higher levels of comfort in residences (for example, space heating and cooling) and in transport (for example, larger cars).

3.41 General Energy Efficiency and Conservation Policy

In April 1997, the National Energy Council of Ministers decided on a programme of *Comprehensive Energy Conservation Measures towards the Year 2000* covering 66 new or enhanced measures for the industry, transport and residential/ commercial sectors[17]. Highlights include:

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

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

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

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

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

In June 1998, the revised *Law Concerning the Rational Use of Energy* established general objectives, policy principles, reporting requirements, financial incentives and sanctions on industry to achieve improved energy efficiency. The law is administered by METI (jointly with the Ministry of Transport, in the case of automobile fuel efficiency), and the Minister for International Trade and Industry (together with the Minister for Transport in the case of automobile fuel efficiency) are responsible for setting targets and monitoring progress[18].

Further improvements in the energy efficiency of cars and electrical devices are promoted by the "top runner" system. Under this system, energy efficiency targets are set higher than those achieved by the most efficient currently commercialised product. Sanctions on failure to comply with the Government's target are negative publicity, orders to comply and fines. Industry is expected to comply by recognising that more efficient products will have market appeal.

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

[18] Energy Policies of IEA Countries, Japan, 1999 Review, IEA.Paris. pp.42

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

In the second category are about 9 000 factories consuming more than 1.5 Ml of crude oil or over 6 GWh of electricity. Measures in the law include an obligation for the first category to: Employ energy management personnel. Prepare and submit energy rationalisation plans covering a three to five year period[19].

3.42 Factors Likely to Influence the Success of Energy Efficiency Policies:

Energy efficiency policies have taken on a new significance in Japan because of the role they are expected to play in meeting Japan's COP 3 commitments. Energy efficiency improvements achieved to date make the achievement of still further improvements extremely difficult. Moreover, higher standards of performance are expected to be achieved at a time when economic performance has declined. Both the Government and Japanese industry can be expected to give primary attention to raising domestic consumption and expanding industrial output. Past trends have shown a close relationship between GDP growth and energy consumption, and there is a high probability that economic recovery and a rise in energy consumption will coincide.

The Government expects the industry sector to reduce energy use by 21 million kilolitres of oil equivalent by 2010, as part of a balanced package of measures which includes energy conservation standards and technical assistance. Industry is free to achieve the target by voluntary means, but failure to do so would eventually result in the application of strict sanctions. Standards and obligations are supported by sanctions such as negative publicity for firms that fail to achieve the standards (regarded as highly punitive in Japanese society), orders for manufacturers to rationalise energy use, and fines.

Tax incentives and low interest loans are also available for industry to introduce energy efficient facilities. Should voluntary measures fail to deliver the results necessary to reduce carbon dioxide emissions, then there will necessarily be a call for more stringent measures on both the demand and supply sides.

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[19] Ibid.43

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

3.43 Developments in Energy Efficiency and Conservation Policies

In 2001, Japan's total primary energy supply (TPES) was 520.7 Mtoe, up by 19%from the 1990 level. Japan has made efforts to use energy more efficiently since the oil crises in the 1970s and, as a result, has managed to achieve a high level of energy conservation. However, Japan's energy intensity (TPES per unit of GDP) has remained stagnant in the last two decades, whereas the IEA average has been steadily declining. Nevertheless, Japan's energy intensity is still among the lowest in IEA countries. In 2001, Japan's TPES per capita increased by 15.8%from 1990 to 4.09 toe. The OECD average increased by 8.2%to 4.68toe over the same period. The Government of Japan has implemented various programmers with the help of private sector since 1970s.The important conservation policies and consequent results in energy efficiency are mentioned below.

3.44 Energy efficiency standards- The top-runner programme and labelling:

The Law Concerning the Rational Use of Energy of 1993 established "energy efficiency standards" as absolute targets for certain electric equipment and vehicles. For example, in the case of computers, energy efficiency performance was supposed to improve by 30%from FY1992 to FY2000.If manufacturers and equipment importers failed to comply with the standards, they were then subject to recommendations given by METI. The 1999 amendment to the Law introduced the Top-Runner Programme, which replaced the "energy efficiency standards".While energy efficiency standards had been set at the level slightly above the average energy efficiency. performance of the product category, in the Top-Runner Programme the best performing items in their category set the minimum standard for a future year. The programme originally covered electric appliances (refrigerators and freezers, air-conditioning, televisions, video players, lamps and computers) as well as cars and light trucks, for both gasoline and diesel engines. The coverage of the programme has been extended to include heating equipment using oil, gas and electricity, vending machines and electric transformers. Each type of equipment is divided into several groups and the energy efficiency target is established for each group. Development is not monitored for each product, but for the whole group. METI can issue recommendations and orders if targets are not reached. If the manufacturer or importer does not comply with the order, penalties are imposed. This is a significant improvement compared with the 1993 law. The government intends to tighten the targets every few years to ensure continued gains in efficiency. Table: 3.5 show the impact of major policy measures introduced by the 1999 law (Base Case) and the new *Guideline* (Policy Case).

Table 8: Energy Conservation Targets for Designated Equipment

Equipment	*Base year*	*Target year*	*Approximate improvement of efficiency*
Air-Conditioning (heating &cooling)	**FY1997**	**FY2004 blower/wall (for most types) type items <4kW FY2007 all other**	**63%**
Space heaters	**FY2000**	**FY2006**	**1.4%(gas), 3.8%(oil)**
Refrigerators and freezers	**FY1998**	**FY2004**	**30%**
Fluorescent lamps	**FY1997**	**FY2005**	**17%**
Televisions	**FY1997**	**FY2003**	**16%**
Video players	**FY1997**	**FY2003**	**59%**
Magnetic disk devices	**FY1997**	**FY2005**	**78%**
Copy machines	**FY1997**	**FY2006**	**30%**
Computers	**FY1997**	**FY2005**	**83%**
Gas cooking appliances	**FY2000**	**FY2006**	**14%**

Water heaters	**FY2000**	**FY2006**	**4.1%(gas) 3.5 %(oil)**
Electric toilet seats	**FY2000**	**FY2006**	**10%**
Vending machines	**FY2000**	**FY2005**	**34%**
Transformers	**FY2000**	**FY2006 (oil-filled)**	**30%**
Passenger vehicles gasoline	**FY1995**	**FY2010**	**23%**
Passenger vehicles, diesel	**FY1995**	**FY2005**	**15%**
Freightvehicles,gasoline	**FY1995**	**FY2010**	**13%**
Freight vehicles, diesel	**FY1995**	**FY2005**	**7%**

Source: METI.

The estimated energy savings to be achieved by the current targets are shown in the above table. Whereas the Top-Runner Programme itself targets manufacturers and importers, it is implemented and made visible to consumers through the energy labeling of products. In July 2000, a voluntary labelling system was introduced for air-conditioning equipment, refrigerators, freezers, televisions and lighting. The label shows relative energy efficiency of these products compared to heir top-runner targets. In addition to informing final consumers, the objective of the labelling system is to encourage manufacturers and importers to satisfy the top-runner standards even ahead of the target year.

3.45 Measures in Industry:

Energy efficiency has long been a priority in the industrial sector due in part to the relatively high cost of energy in Japan. In addition, numerous policies and programs have encouraged and supported efficiency improvements by industrial firms. The Energy Conservation Center initiated free energy audits for smaller firms starting in 1978, as well as audits for a fee for medium and larger companies. In 1979, METI issued efficiency standards for combustion and heating devices, prevention of heat loss, and utilization of waste heat. They applied to 'designated energy management factories', roughly 3500 factories in the manufacturing, mining, and energy supply sectors with energy use above a minimum threshold. The 1979 Energy Conservation Law required these facilities to hire a certified energy manager and to report energy consumption annually. In 1993, these facilities were required to develop energy conservation plans, with the aim of reducing energy consumption at least 1% annually[20]. Industry sector policies are composed of regulatory measures, voluntary actions by industry, subsidised energy audits, expansion of energy service companies (ESCOs) and a complex mix of subsidies, tax exemptions and soft loans for energy efficiency investments.

Large-scale factories (manufacturing, mining, and electricity, gas and heat supply) with an annual fuel consumption of at least 3 000 kilolitres of crude oil equivalent or industries with an annual electricity consumption of at least 12 GWh have been subject to energy efficiency requirements since 1979 under the Law Concerning the Rational Use of Energy. With the 1999 and 2002 amendments to the law, the requirements have been extended to all industry and service sector users of energy as well as to the energy sector operators with an annual fuel consumption of at least 1 500 kilolitres of crude oil equivalent or annual electricity consumption of at least 6 GWh. As a result, currently 5200 large-scale factories and offices and 5 600 mid-size factories and offices are covered under the law. The indicative target of the law is to improve energy intensity by 1%per year.

The Energy Conservation Center of Japan (ECCJ) has conducted about 5600 energy audits of small and medium-sized enterprises. In these audits, concrete lists of priority measures are prepared; including investments required and expected benefits. These audits are free of charge for companies with a capital of less than ¥100 million or less than 300 employees, and with a charge for larger industries. At present, about 100 companies are involved in implementing ESCOs and annual investments are ¥67 billion per year. Combined heat and power (CHP) generation is promoted through a generous taxation and financial support system. Natural gas-fired CHP plants can receive subsidies which are one-third of the installation cost for enterprises and 50% for municipal entities. Furthermore, CHP facilities are allowed a 30% depreciation rate or a tax exemption of

[20] Satoru Kasahara and others, "Climate Change Taxes and Energy Efficiency in Japan", MIT Joint Program on the Science and Policy of Global Change Report No. 121, May 2005 PP.11

7% in the first year of operation. As a result of these policies, about 6.5GW of CHP capacity was installed in Japan as of 2003[21]. However, this is still less than 3% of total electric generating capacity in the country.

Under the 1999 and 2002 amendments to the law, the requirements were extended to medium-size firms. Voluntary commitments also play a role in stimulating industrial energy efficiency improvements in Japan. In 1997, the Japanese Business Federation began a ''Voluntary Action Plan on the Environment,'' which encourages industry associations to establish voluntary energy conservation, waste minimization, and recycling targets. Goals are expressed as either a reduction in absolute energy use or CO2 emissions, energy use or CO2 emissions per unit of output, or as commitments to adopt certain technologies. The steel industry, for example, committed to reduce its energy use 10% below the level in 1990, by 2010 (ECCJ, 2002). Complementing these other policies, the 1993 Energy Conservation Law established tax incentives and low interest loans for industrial energy efficiency measures. In 2003, the law was extended for a further ten years and its scope was extended to cover Clean Development Mechanisms and Joint Implementation projects as well as those aimed at recycling used products and reducing emissions from wastes and residuals.

3.46 Measures in the Residential and Services Sectors

Japan's efforts to increase the efficiency of its buildings compare poorly with its successful efforts on appliances and equipment. Voluntary energy efficiency standards for new residential buildings were first introduced in 1980 and strengthened in 1992 and 1999. The latest insulation standards are estimated to reduce heating and air conditioning energy use by 20%, but remain voluntary in nature. For five major types of commercial buildings (offices, retail, hotels, health care, and schools) standards cover building envelope thermal integrity, air conditioning system efficiency, mechanical ventilation, lighting systems, water heating, and elevators. These standards set thermal performance values and overall efficiency targets but are also voluntary.

Tax incentives and low-interest loans are available to support the construction of buildings with low energy consumption and environmental burden, as well as to

[21] Cogeneration Center Japan (CGC Japan), 2004.

encourage the purchase of certain energy-efficient equipment such as home and business energy management systems (ECCJ, 2002). Financial incentives also are facilitating use of energy service companies (ESCOs) for energy retrofit projects. The ESCO market has grown rapidly in recent years, with total project value increasing from about 170 million yen in 1998 to 665 million yen as of 2001 (Energy Conservation Center, Japan (ECCJ) 2003).Other initiatives include consumer education and promotion campaigns carried out by Japan's Energy Conservation Center.

In addition to the Top-Runner Programme and labelling schemes discussed above, several other measures have been introduced to curb the growth of energy consumption in buildings. These include voluntary standards for insulation, certification systems, individual billing and metering, reduction of stand-by power, better energy management, financial and fiscal incentives and information dissemination.

In March 2000, the Committee on Advanced Demand Side Management was established as an advisory body to the Agency for Natural Resources and Energy (ANRE) to increase the focus on demand-side management, particularly in the residential and services sectors. It investigates how to make consumers better aware of the cost of energy, encourages energy conservation, promotes businesses that provide support for energy conservation activities and formulates policies that encourage users to invest in energy saving.

The government has had two projects in the area of voluntary building certification, namely the "Housing Performance Indication System" (HQAL) and the "Excellent Building Mark System for Environment and Energy". HQAL enables consumers to compare the energy performance of houses by consulting performance evaluation reports published by evaluation bodies designated by the Minister of Land, Infrastructure and Transport. The reports are prepared before the buildings are constructed and they are included into the building contracts to ensure that the buildings will meet their planned energy performance. HQAL has been implemented in approximately 90000 buildings since its creation in October 2000.The "Excellent Building Mark System for Environment and Energy" has been applied in 68 very large buildings since its start in March 1999.Under this scheme, energy efficiency of buildings is evaluated on the basis of criteria set by he Institute for Building Environment and Energy Conservation and the results are made public[22].

Individual billing and metering is largely applied to all buildings, including apartment houses. The next step will be the introduction of computerized Home Energy Management System (HEMS) for residential buildings and Business Energy Management System (BEMS) for offices. Both systems provide real time information on energy consumption and cost, and break down the to al consumption in more de ail, for example by office, and help manage energy consumption of lighting, air-conditioning and hot water supply.

An experiment on HEMS began in 2001.BEMS was introduced o he markets in 2002 and is promoted by subsidies. Japan's consumption of stand-by power is 9.4%of average total consumption of households.

3.47 Measures in the Transport Sector

The 1979 Energy Conservation Law introduced energy efficiency standards and efficiency labeling for gasoline fueled passenger vehicles. The 1979 standards led to a 12% increase in the average fuel efficiency of passenger cars by 1985. In 1993, new standards as well as penalties for noncompliance were introduced. As a result, the average fuel efficiency of new cars increased an additional 8.5% between 1990 and 2000 (IEA, 2002).The use of the Top-Runner Programme in the transport sector is discussed above and its energy efficiency targets for vehicles are given in Table: 3.5.Other transport sector measures are vehicle taxation, promotion of alternative fuels, promotion of public transport and traffic management. The Japanese government is carrying out an Action Plan on Promoting Low- Pollution Vehicles. By 2010, this plan aims to deploy 10 million low-pollution vehicles (natural gas and electric vehicles, hybrid vehicles and vehicles that meet certain fuel efficiency and exhaust gas standards).The plan foresees that the government sector will set the example by replacing all its official vehicles (about 7000)between 2002 and 2005,and by inviting local governments to follow. Low-pollution vehicles are subject to reductions on vehicle purchase taxes for which they have to comply both with fuel efficiency and emission (*e.g.* for NOx and particles) standards.

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[22] Energy policies of IEA countries .Japan 2003 Review.IEA, Paris. Pp.53

In addition, car ownership is taxed and differentiated according to car age and type favoring younger cars and low- emission vehicles. Other measures include subsidies for certain types of buses and trucks, and publicity campaigns. As a result of these efforts, out of a to al 1.8 million vehicles registered in April-September 2002, 57%qualified for tax reductions. Most of them were efficient low-emission gasoline vehicles but the number of hybrid vehicles was 9254 and natural gas and electric vehicles 1401.

The government has few measures to directly discourage the use of private cars but concentrates on promoting the use of public transport. It also takes measures such as improving efficiency of freight services and reducing traffic jams through Intelligent Transport System (ITS).It tries, for example, to control traffic congestion by differing start times of office work. The government is also considering introducing congestion tolls.

3.5 Major R&D Programmes

In 2002, individual R&D projects in energy efficiency were grouped under a research programme called "Innovative Technologies that Cope with Global Warming". This comprises R&D projects for technologies that educe CO2 emissions by drastically diminishing energy consumption. The vast majority (86%)of publicly funded R&D on energy efficiency is used for projects improving energy efficiency in industry, particularly to support the implementation of the Voluntary Action Plan by industries.

In the process industry, particular attention is paid to improving the operational energy efficiency of industrial establishments as a whole rather than developing technologies for individual stages. Other R&D areas are thermal storage systems and heat/power exchangers for industrial complexes. Attention is also given to the spillover of technologies; new energy-saving technologies are first adopted in industry and then spread into individual households to improve the cost-effectiveness of R&D.

The Home Energy Management System is an example of publicly funded R&D activities in the buildings sector .R&D on the Business Energy Management Systems is financed by the private sector. Other publicly funded efforts include technologies for more efficient use of heat (heating, air-conditioning and hot water systems using, for example, micro co-generation), electric and electronic appliances and lighting as well as improving the thermal performance of buildings under renovation.

Energy consumption patterns are shaped by the behaviour of a large number of actors, each of whom has to make many decisions relating to energy-using activities. Thus, the implementation of energy-efficiency improvements involves actors operating at various levels. There is growing appreciation of the role that improvements in energy efficiency can play in bridging the gap between energy supply and demand. The term "energy-efficiency improvements" is used here in this extended sense to include any measure that results in the delivery of an energy service with a reduction of energy consumption. Further, the term "energy-efficiency improvements" is not restricted to "retrofitting", i.e., improving the efficiency of devices and processes already in place and operation, to conventional technologies and to the residential sector. It includes an emphasis on energy efficiency in new plant and equipment, new technology and to the energy-intensive sub-sectors of industry[23].

Though energy efficiency levels in Japan are still good compared to international levels, the difference is narrowing both in terms of energy intensity and energy demand per capita. Whereas the increase in energy consumption in the industrial sector has been moderate, partly reflecting the economic slow-down, people 's lifestyle choices have led to quite a rapid increase of demand in the household and passenger transport sectors. The policies in place in the two latter sectors have not yet proven to be very effective and the government may need to explore new, more effective measures. Japan appears to be relying heavily on a voluntary approach and various financial and fiscal incentives in order to improve the energy efficiency of industrial, residential and commercial buildings and transport, while having some regulatory measures such as the Top-Runner Programme.

Most other IEA countries have recognised the effectiveness of standards in improving energy efficiency and have made them mandatory. Some other IEA member countries – and recently the European Union in its planned standard and certification directive for

23 Amulya K.N. Reddy, "Barriers to Improvements in Energy Efficiency", Department of Management Studies, Indian Institute of Science, Bangalore, India. PP.21

buildings –have sought to raise the awareness of energy consumption in buildings by introducing energy-efficiency certification or labelling systems. Japan has activities in the area of building certification but so far with limited coverage. In energy performance standards and certification for buildings, Japan could benefit from examining the international experience in terms of implementation and monitoring.

The Top-Runner Programme encourages manufacturers to develop more efficient technologies. Its targeted efficiency levels are ambitious for most products, making significant energy savings and CO2 emissions reductions likely. The target levels are clear, firmly set and analytically simple (requiring only a statistical appraisal of the efficiency of products on the current market).The monitoring results show that the programme has had a positive impact on the efficiency of, for example, vehicles and household appliances. Some researchers, however, have found that life cycle engineering-economic analyses may provide both a stronger foundation and a more aggressive rate of improvement.

The key to Japan's energy efficiency gains is that the clear national policy (translated into a coherent package of measures) is firmly administered by a single agency with the authority and influence to ensure that measures are implemented across all sectors. In Japan, the October 1979 Law Concerning the Rational Use of Energy was formulated and implemented by METI (Ministry of Economy, Trade and Industry, an elite ministry on par with Ministry of Finance and the Foreign Office) with a wide sphere of influence across most sectors and Ministries. In summary, Japan is rightfully recognized as a leader in energy efficiency within the OECD, notably in the industrial sector and in appliances and equipment. Like many other OECD countries, however, Japan's energy consumption in its residential, commercial, and road transport sectors continues to rise, economy-wide energy intensity actually increased during 1990–98. It remains to be seen if newly enacted energy efficiency policies will be adequate to reverse this trend, thereby yielding economic benefits and contributing to the achievement of Japan's greenhouse gas emissions reduction.

Chapter: IV

ENERGY PRICING

Pricing is an important mechanism, especially to achieve long term changes. Thus prices should be related to the long term planning horizon. Adequate pricing means establishing consumer prices for energy products that reflect the cost of energy supply, i.e. the long-term marginal cost for electricity, the long-term price of oil products on international markets for fossil fuels. Although most energy planners agree with such objectives, they often face reluctance and opposition from decision-makers outside the energy sector, who fear public opposition and the impact of energy prices corrections on the consumer price index. Pricing structures are distorted by subsidies and do not reflect external negative effects[1].

The objectives of energy pricing are closely related to the general goals of energy policy. First the economic growth objective requires that pricing policy should promote the economically efficient allocation of resources, both within the energy sector and between it and rest of the economy. Second the social objective recognizes every citizen's basic right to be supplied with certain minimum energy needs. Given the existence of significant numbers of poor consumers and also wide disparities of income; this implies subsidized prices, at least for low income consumers. Third the government may be concerned with financial objectives relating to the viability and autonomy of the energy sector. Fourth, energy conservation is also an objective of pricing policy, while prevention of unnecessary waste is an important goal, other reason often underline the desire to conserve certain fuels.

Fifth, the need for price stability to prevent shocks to consumers from large price fluctuations. Sixth, the government may use taxes on energy and petroleum in particular as an important source of fiscal revenue and even for macro-economic policy. Finally, there are other specific objectives such as promoting regional developments (eg: rural

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[1] Ronald Fischer, Pablo Serra "Energy prices in the presence of plant indivisibilities", Energy Economics, vol, 25.2002. pp.303

electrification) or specific sectors like export oriented industries and other socio, political, legal or environmental constraints. This chapter generally looks in to the major development in the dome of the energy pricing in Japan especially during the restructuring period of Japanese economy and analyses the major policy changes and reciprocal impacts on the energy prices.

In discussing the pricing of energy the role of deregulation or liberalization, we must not only turn our eyes to the expanded application of market principles, but also focus on the roles of players who act in the marketplace. The tough players that could emerge from reform in Japan's energy industry, and take on an active role in the international marketplace, are likely to be in such forms as (1) horizontally integrated firms in respective sectors of the upstream and downstream oil sectors; (2) vertically integrated firms engaged in both the upstream and downstream oil sectors; and (3) comprehensive energy firms (or corporate groups) with interests in all of the oil, power and gas industries[2].

4.1 Pricing Policy Instruments.

Governments of course play a pervasive role in the pricing of commercial energy resources and the relative neglect of issues relating to traditional forms of energy. Government exercise direct influence over energy prices, usually through the ownership of energy sources or price controls. Indirect influences occur through such means as taxes, import duties, market quotas, and taxes on energy using equipment and Government in energy resources. In Japan the right of production and distribution is rest with the government. In oil and gas production, refining and distribution as well as in coal mining both public and private organizations operate often side by side. In 1967, METI had established Japan National Oil Corporation for assisting Japanese oil companies in overseas exploration. JNOC has assisted over 300 projects in oil and gas exploration, JNOC also set up the government stockpile of crude oil. Japan largely relies on big corporations and trading companies to develop its purchase and marketing

[2] Takeo Kikava, "Liberalization and Japan's Energy Industry", Institute of Social Science, Tokyo 2005.pp.8

strategies. The electric power generating corporation (EPDC) a quasi-governmental wholesale company established in 1952 to help secure stable supplies of electricity. EPDC is scheduled for privatization within next five years. The power reactor and nuclear fuel development corporation (PNC or DONEN) is also a government owned company works the policy related to nuclear energy.

However irrespective of the form of ownership the government exercise some form of wholesale or retail price control, usually at several levels, including during production, during refining, after transport or transmission and so on. Income and excise taxes are also levied from both public and private energy sector companies. Quite often certain fuels in specific uses tend to be subsidized, cross subsidies exist between different fuels, user groups and geographic regions; import and export duties excise taxes and sales taxes are levied often by several levels of government, from federal to municipal at various stages in production, processing, distribution and retailing chain.

Other policy instruments are often used to reinforce pricing policies, such as quotas on imported or scarce forms of energy, coupled with high prices. Many special policies involving tax holidays and concessions, import subsidies, export bonuses, government loans or grants, high taxes on large luxury goods and automobiles etc are also used to affect energy use. The 2000 report of World Energy Council (WEC) draws upon the three energy goals identified in the World Energy Council's millennium statement, Energy for Tomorrow's World - Acting Now, published in April 2000. These three goals of energy accessibility, availability and acceptability (the "three A's" of sustainable energy systems) are closely interlinked and pointing as the pillars of energy pricing policies[3].

4.2 A Little Economic Theory

The purpose of an economic system is to allocate limited resources for the production and consumption of goods and services to meet the needs of all actors in the economy. Ever since Adam Smith, debate about the virtues of a competitive pricing mechanism to optimise this allocation of resources has centered the “laissez-faire" approach[4].

[3] Pricing Energy in developing countries,WEC,London,June 2001.pp.1
[4] Ibid

The failure of the price system to allocate resources efficiently, in all situations and for all actors, is of interest for various reasons. It implies that market prices do not necessarily reflect marginal social benefits or costs, and that market profitability does not necessarily reflect net social benefits and costs. Also, the failure of markets to allocate resources efficiently provides reasons to consider supplementary mechanisms, interventions or corrective devices to induce markets to function more efficiently. The two best known and commonly used intervention devices are taxes and subsidies, which consequently makes them of major interest in the context of energy markets, where market reform must go hand in hand with appropriate regulation.

This recognition of the need for appropriate regulation is not, however, a clarion call favoring government interventionism in energy systems at all times and in all places. What is needed in most cases to achieve appropriate regulation is a stable energy policy, which sets long-term goals and fosters clear rules for the assessment of each particular case of market failure and possible solutions for it. In many cases government intervention may improve the allocation of resources, but in others it may not. Japanese government has been adopting the same strategy for the energy sector till the liberalisation and extreme deregulation process started late 1990s.But still government play a pervasive role in any major policy decision making.

4.3 Approaches to Pricing.

Energy resources must be produced and used in a manner that protects and preserves the local and global environment now and in the future. Pricing, as a major driver of energy demand and also as a determinant of consumption patterns and choices, is the key to energy efficiency improvements, the transfer of technologies and the pace of innovation. These are instrumental in moving both producers and users of energy services towards a more sustainable path. Thus, certain types of externalities related to environmental goals or to the depletion of resources are often linked to pricing through energy policy.

4.31 Historical Cost Recovery Pricing & Cost of Service Ratemaking

In broad outline, cost of service ratemaking (price setting) involves the determination of a valid rate base for each service provider, which reflects the allowable investment cost of plant and equipment, and a fair return on that investment. Such determinations require many different issues regarding the continued economic significance of the original costs of plant and equipment over time to be resolved. There are many different economic and regulatory theories with regard to the various aspects of rate base determination. Prices are adjusted to allow the service provider to recover full operating expenses and depreciation, and earn a fixed rate of return on investment in the rate base. This approach to price setting is widespread, and provides a sustainable way to set tariffs.

This approach is often used when there is no possibility to introduce competitive market pricing (for example, in electricity distribution), and where the level of assets is very significant compared to the additional investments required each year. It allows for recovery of oil exploration expenditures or the cost of building a pipeline, for instance. The pipeline example, where the cost recovery approach makes more sense than a marginal cost approach, is based on the premise that the capacity of a pipeline is fixed and the marginal cost of an additional consumer would be a new pipeline. At the same time, the short-run marginal cost of operating a pipeline is so low compared to the investment required that it would not make sense to use this cost in pricing, since for each customer it would be next to zero.

4.32 Marginal Cost Pricing

According to economic theory, the optimal allocation of resources is reached when marginal price is equal to marginal cost. In the short term, one is better off running a power plant if the short-term marginal cost is lower that the price paid for the energy. The short-run marginal cost covers all variable costs of energy production, including fuel, labour and maintenance. Marginal cost pricing is used in countries where there are still vertically integrated government-owned utilities. In theory, prices will tend to converge towards a point where short-term marginal revenue is equal to short-term marginal cost in the market. In this situation, competitive market pricing will be optimal, from a short-term point of view.

4.33 Opportunity Cost Pricing

Opportunity cost pricing is based on the value the energy would have if it could be offered and purchased outside the country rather than consumed within. This approach allows the setting of a standard on which policymakers can rely. In Mexico, for example, in the determination of the internal price of oil, a calculation is made to determine what would be the net income if the barrels of oil were sold in the United States, taking into account transportation and quality.

4.34 Market Pricing

More and more countries including Japan are moving towards the design and creation of electricity markets, especially at the wholesale level. Although WEC recognises markets as the most efficient way to allocate resources, it also calls for appropriate regulation to address specific market flaws, including those which might emerge between wholesale and retail sectors. Externalities, barriers to entry, oligopolistic market structures and non-competitive behaviour sometimes create situations where intervention in the market would be beneficial. Markets do not always provide affordable access to energy for the poorest people, or for the impact of cross-subsidisation. It is in the area of appropriate regulation that issues of energy taxation and the role of subsidies find their true home.

4.4 The Liberalisation and Energy Market Reforms in Japan.

In Japan the growing imperative for economic and regulatory reforms in energy sector emerged basically from concerns about economic stagnation. In response to global trends, deregulation has been a key issue in Japan since the mid-1980s. Recently, it began to spread in earnest into the energy industry. For many years, Japan's energy industry was a textbook case of a regulated industry, but the picture has changed significantly during the past several years. A string of events took place which has shaken the foundation of the regulatory framework for the industry, including a partial liberalization of the electricity and gas retail markets, the abolition of the Petroleum Industry Law, and the decision to dissolve the Japan National Oil Corporation. In Japan, the deregulation of many industry sectors originated in so-called "gaiatsu," or pressure from outside the country[5]. This is also true for the energy industry. Deregulation in general terms has not met with strong domestic opposition despite the fact that it evidently stemmed from external pressure; this is because expectations about the "assumed results" of

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[5] Junji Nakagawa, "Kisei kanwa no kokusaiteki bunmyaku (The International Context of Deregulation)," in Juro Hashimoto and Junji Nakagawa eds., Kisei kanwa no seijikeizaigaku (The Political Economy of Deregulation), Yuhikaku, 2000, pp. 16-17.

deregulation are high. Specifically, these assumed results include: (1) greater benefits to consumers; (2) reduced fiscal burdens (subsidies, etc.); (3) strengthening of industrial structures; and (4) adaptation to internationalization. In reality, however, deregulation has not always produced the intended results, either in Japan or in other countries. Just looking at the energy sector, the deregulation of Japan's oil industry since the mid-1980s has failed to produce significant results in the above-mentioned areas of (2), (3) and (4)[6].

The following is a brief review of the process of liberalization of the power supply in Japan. The process started with the full revision in 1995, the first in 31 years, of the Electric Power Industry Law, which had been promulgated in 1964 and enforced in 1965. The salient points of the revised law, promulgated in April 1995 and enforced in December of the same year, are: (1) wider access for new entrants to the power generation sector; (2) the creation of a system for specified electric power businesses; (3) the improvement and relaxation of regulations on power rates; and (4) the rationalization of safety regulations by clarifying the responsibilities of firms themselves. Point (1) provides for the abolition, in principle, of the approval system for entry into the power wholesale business, and the introduction of a tender system. Point (2) legislates the creation of a new system to open the way for a power retail business. Point (3) provides for a change from an approval system to a reporting system for the menu of power rates used to level load. This point also aims to introduce competition, though still indirect, among power firms while maintaining the overall framework of regional monopoly. This is done through the adoption of yardstick assessments that makes it easier to compare the degree of management efficiency of different companies. Point (4) is designed to introduce a system of self-inspection of facilities by power firms and to focus and minimize the direct involvement of the government. In short, the primary objective of the revised Electric Power Industry Law is to introduce the principles of competition into Japan's electric power industry.

The Electric Power Industry Law was again revised substantially in 1999. The revisions were promulgated in May 1999 and enforced in March 2000. These revisions are mainly designed to put into partial play the principles of competition in the retail sector. They do

[6] Takeo Kikava, "Liberalisation and Japan's Energy Industry", Institute of Social Science,Tokyo.2005.pp.4

this by liberalizing retail sales of power to special high-voltage users who consume at least 2,000 kilowatts and receive power through special high-voltage systems of 20,000 volts or more, creating a third party access system for electric power firms to open up their transmission line networks for use by other power providers, shifting from a approval to a reporting system for power rate reductions, and removing restrictions that have prevented electric power firms from engaging in other businesses[7].

While restrictions were lifted in principle on the power retail business, the supply of power under the last resort contracts was retained as an exception. In order to prevent possible fallout on power users in still regulated sectors, a new system was introduced to divide the cost of supply into the liberalized and regulated sectors and clarify sector-by-sector revenues and expenditures. The revised law calls for an examination of the results of liberalization roughly three years after the new system is introduced, after which a decision is to be made on the direction of further liberalization. For Tokyo Electric Power Co., the largest of the nation's nine power firms, about 29% of volume supplied went to special high-voltage users subjected to the liberalization of power retail[8].

Following the 1995 and 2000 revisions of the Electric Power Industry Law, which were undertaken in line with the international trend of power industry deregulation, Japan's power industry has entered a new era guided by stronger principles of competition, or the arrival of an era of liberalized power supply. The scope of liberalization is likely to be expanded at the time of review of the new system, scheduled for 2003. It is necessary to clarify here that not only power users and new entrants, but also existing electric power firms, will benefit greatly from the liberalization of the electric power business. They will see big benefit in the form of wider leeway in business management. With the progress of liberalization, power firms will gain the ability to conclude supply contracts with users at their own discretion. It will become possible for them to offer made-to-order services to respond to customer needs using a menu of varied rates. They will also have wider options for the disposal of earnings, and will be able to make strategic decisions on whether to use the profits to lower rates or increase retained earnings. Moreover, they

[7] Ibid.pp.17

[8] The figure is an estimate based on actual power sales volume for fiscal 1998.

will be given varied options in the building of facilities, with more leeway in handling investment risks, while the abolition of restrictions on diversification will enable them to use their managerial resources more efficiently. Plainly put, the liberalization of the power industry will present power firms with important business opportunities[9].

The Electricity Utility Industry Council (EUIC) – an advisory committee to the Ministry of Economy, Trade and Industry began discussions over reform of the electricity-supply industry (ESI) in 1994. The Electric Utility Industry Law (EUIL) was amended in 1995, for the first time in 31 years, to allow the entry of Independent Power Producers (IPPs) to supply electricity to the incumbent IOUs under long-term contracts. Between 1996 and 1999, following invitations for tenders for 6.66 GW of new capacity, tenders were proposed for 28.34 GW – the bid was eventually finalised for 7.38 GW of capacity. The principal bidders, which were large-scale steel and oil companies, revealed the potential for competition within the power sector. Additionally, EUIL established special electricity utilities that supply power in newly developed areas using their own generating facilities and distribution lines[10].

As reviewed above, Japanese power firms were capable of making unique and vigorous business decisions in the period before the oil shock. The supply of cheap electricity in Japan during the period of reconstruction and then of high growth owed much to the smooth switch from hydraulic to thermal power generation and from coal to oil as the main fuel for thermal power generation. It is interesting to note that in the process of these switchovers, the power industry often overpowered the Ministry of International Trade and Industry (METI), which outright opposed outright or, at best, took a negative stance toward the changes. During the high economic growth period, power firms often became the targets of sharp social criticism when they raised their individual power rates. Therefore, despite the regional monopolies they enjoyed, the nation's nine power companies, at times and to a certain extent, competed against each other for better

[9] Takeo Kikkawa, "Liberalization of the Power Industry as a Big Business Opportunity," in Nippon Denki Kyokai (Japan Electric Association), Nippon Denki Kyokai-ho (Japan Electric Association Bulletin), March 2001

[10] Australian Financial Review, 1 April 2004, p.10

corporate performance[11]. In the periods prior to the oil shock, the power firms were not so closely associated with METI, and had rival consciousness[12].

In the post-oil shock period, however, the nine firms gradually increased their dependence on the guidance of the government, and appear to have lost rival consciousness. As they raised the power rates uniformly and simultaneously, three times between 1974 and 1980, in the face of sharp rises in crude oil prices, they relied on schemes under the three electric power development laws enacted in 1974 to deal with the serious difficulty of finding locations for new power plants, or followed a pattern of unified actions to cope with growing popular movements against nuclear power stations. As they did so, the distance that existed between them and the government regulators narrowed, and rival consciousness weakened. Under the trauma of the oil shock, the nine power firms degraded themselves to spiritless government agency-like entities[13].

Japan's electricity-supply industry is experiencing a dynamic change in its structure through liberalisation. The magnitude and speed of deregulation, is progressing with a cautious and gradual approach, with a careful eye on the experiences of other countries.

In the energy sector, Japan has moved to a limited extent to reduce direct government intervention and to increase competition in markets. For example, public tendering by independent power producers for some new thermal power stations was introduced in 1996 and competitive bidding has been introduced for all new thermal power supply coming on line after 2008. In Japan's retail electricity market, consumers of over 0.5 MW a year (accounting for roughly 40 per cent of Japan's electricity market) were made contestable in April 2004. In April 2005, this barrier could be further lowered such that only residential consumers and small businesses will remain subject to monopoly[14] Further reforms to Japan's electricity sector could include the separation of electricity generation and distribution and the regulation of electricity distributors so that prices charged for electricity distribution reflect distribution costs (OECD 2002). There have also been moves to deregulate the distribution and sale of oil, gas and petroleum

[11] Takeo Kikava, "Liberalisation and Japan's Energy Industry", Institute of Social Science,Tokyo.2005.pp.13
[12] Ibid.pp.13
[13] ibid.pp.14
[14] Australian Financial Review, 1 April 2004, p.10

products. For example, the gas market for users of gas that consume over 1.0 million cubic metres a year is now competitive. This threshold may be lowered to annual consumption of 0.5 million cubic metres in the near future (Energy Argus 2003). The Japanese petroleum refining and retail industries were deregulated in the 1990s. Import restrictions on petroleum products were lifted, resulting in a consolidation of oil refining companies. In the retail sector, deregulation has resulted in the number of retail outlets increasing and the price of petroleum products falling (OECD 1999). However, the structure of Japan's petroleum market, in which oil companies sell to intermediaries who then on sell to retailers, still contains inefficiencies that slow the responsiveness of petroleum prices to consumer demand[15].

4.5 Process of Price Regulation in Japan

4.51 Grid Access Regulation

The Electric Utilities Industry Law requires designated utilities to notify tariffs to METI. METI can order transfer supply[16] if it is refused without good reason. METI must approve tariffs and other conditions for back-up power supply to a special Electric Utility Supply Business (EUSB), and can impose tariffs and other conditions if a general EUSB and a special EUSB cannot negotiate an agreement.

4.52 Tariff and Profit Regulation

Standard tariffs and other conditions of supply must be approved by METI. In order to be approved the tariff "for supply of electricity shall be the sum of the fair and proper cost of electricity and the fair and proper profits under efficient management". Also, "there shall be no discrimination against specific persons." If, because of social or economic changes, the tariffs and conditions for the supply of electricity have become unfair and improper to

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15 Sam Hester, "Japan's energy future, economic imperatives and environmental challenges", Prepared for the Australian Government Department of Industry, Tourism and Resources. July 2004 pp. 23

16 Transfer supply allows a customer who generates power at one site to use a utility's transmission lines to transfer the supply for use by the same customer at another site. Also known as self-wheeling. The 1995 amendments adjusted the rate of return approach to allow slightly augmented incentives to reduce costs. These incentives are called "yardsticks" because they rely, in small part, on comparisons among the utilities. The current rate regulation process is summarised in the box below. The net impact of the latest yardstick assessment was to reduce utility revenues by 0.6% from what they would have been absent the yardstick aspect.

the extent that advancement of public interests is thereby impeded, METI may order the EUSB or wholesale supplier to submit an application for a change in the tariffs or conditions.

Utilities are permitted to offer optional tariffs to contribute to the efficient use of facilities. Interruptible supply contracts for large consumers and time-of-use rates have both been offered to contribute to load levelling. The basic regulatory scheme for the Japanese electricity sector is rate of return. As of September 1998, the regulated rate of return on capital was set at 4.4%; by contrast, the rate of return on government debt at that time was under 1%. The asset price is based on a MITI assessment. MITI sets out the accounting system to be used by electric utilities[17].

4.6 Energy taxation

In this section, the impacts of most of the changes to Japan's energy tax structure are modeled to illustrate their impacts on the policy paralysis scenario. Some elements of the new tax structure are not modeled, including the increase in Japan's LPG tariff and the possible application of the coal tariff to coking coal imports from 2005.

Fuel taxes the important component of energy tax varied considerably over time. Oil prices peaked in the early 1980s, and generally have been declining in real terms for the past 20 years. Price trends for countries such as Japan and the United States reflect this, since these countries have not substantially increased fuel taxes, and real gasoline prices in 2000 were comparable or lower than in the mid 1970s. On the other hand, most European countries offset much of the oil price decline by raising fuel taxes. In some cases, such as Germany and Finland, taxes have been increased at a greater rate than the oil price decline, yielding a steady rise in retail fuel prices since the 1980s and mid 1990s.

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

[17] Energy Policies of IEA Countries, Japan, 1999 Review, IEA. Pp.77-78

Gasoline: **Gasoline Tax plus local Road Tax**

Gasoil (diesel)[18]: **Gas Oil Transaction Tax**

Jet Fuel: **Aircraft Fuel Tax**

LPG: **Petroleum Gas Tax**

Exemptions and reimbursements apply to fuel oil in agriculture and fishery use, to crude oil and naphtha used in the petrochemical industry, and to asphalt and petroleum coke produced domestically. Special depreciation allowances and exemptions or reductions of local taxes apply to anti-pollution facilities and sophisticated facilities such as cracking units. Gas used in automobiles, which accounts for 9% of gas use, is also subject to a Petroleum Gas Tax of ¥17.5/kg. Revenues from oil-related taxes are mostly allocated to specific purposes[19]:

The Customs Duty was introduced as a temporary measure in 1960 to fund assistance to the coal industry against competition from oil. The Gasoline Tax was introduced as a temporary measure in 1954 to fund road construction.

The Petroleum Tax was established in 1978 to fund oil policies such as oil stockpiling, and later extended to fund expenditures on alternative energy sources. Expenditure on oil policy accounted for 9.4% of oil-related tax revenue in FY 1998.

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

[19] Fore sited foot note,17.pp.107

Table19: Energy Taxes in Japan, FY2002

(in ¥)[20]

Sector/fuel	Petroleum tax.¥/unit	Other excise taxes¥/unit
Households/electricity	–	0.445/kWh
Households/natural gas	720/tonne	–
Households/liquefied petroleum gas	670/tonne	9.8/litre Petroleum Gas Tax)
Households/kerosene	2.04/litre	-
Non-commercial use/unleaded gasoline	2.04/litre	53.8/litre[21] (Gasoline Tax and Road Tax)
Non commercial use/diesel	2.04/litre	32.1/litre(Gas Oil Transaction Tax)
Industry/electricity	–	0.445/kWh
Industry/natural gas	720/tonne	–
Industry/all oil products	2.04/litre	–
Industry and commercial use/liquefied petroleum gas	670/tonne	9.8/litre (Petroleum Gas Tax)
Industry and electricity generation/steam coal	—	—
Industry/coking coal	—	—
Industry and commercial use/diesel	2.04/litre	32.1/litre(Gas Oil Transaction Tax)

Source: *Energy Prices and Taxes,* IEA/OECD Paris, 2003.

The changes in the Japan's Tax structure were projected to lead to a minor reduction in Japan's total primary energy consumption but to have a much larger effect on its thermal

[20] Taxes indicated do not shows the consumption tax of 5%which is applied to the post-tax price for all client groups. For diesel, the consumption tax is applied to the pre-tax prices.

[21] .¥45.6/litre gasoline tax and ¥8.2/litre road tax.

coal consumption, which was projected to fall by around 3.6 million tonnes of oil equivalent in 2015 as a result of the tax changes. Although coking coal was largely unaffected by the tax changes, this reduced the growth in coal consumption in Japan from 0.52 per cent a year between 2001 and 2015 under the old tax regime to 0.28 per cent a year. Nuclear power was projected to be the main beneficiary of the new tax regime, while LNG and oil were affected only slightly by the changes to Japan's energy tax structure. The reduction in thermal coal consumption in Japan resulting from the changes to Japan's energy tax structure imply a reduction in Australian thermal coal exports to Japan of around 3.5 per cent at 2015 and a reduction in Japan's greenhouse gas emission of around 5 million tonnes of carbon equivalent at 2015 (or around 0.5 per cent of Japan's 1990 emissions).

4.61 Oil Taxes

Oil is subject to a complex set of taxes. All imported crude oil and petroleum products are subject to a general Petroleum Tax and a Customs Duty. In addition, gasoline is subject to a Gasoline Tax and a Local Road Tax, gas oil (diesel)[22] to Gas Oil Transaction Tax, jet fuel to Aircraft Fuel Tax and LPG to Petroleum Gas Tax. Exemptions and reimbursements apply to fuel oil in agriculture and fishery use, to crude oil and naphtha used in the petrochemical industry, and to asphalt and petroleum coke produced domestically. The Customs Duty on oil products was introduced in 1960 as a temporary measure to protect the coal industry against competition from oil. As domestic coal production has almost been phased out, the government has reduced the Customs Duty rate from ¥215 per 1 000 liters in FY2001 to ¥170 per 1 000 litres in FY2002 and decided to abolish it by the end of FY2005.Petroleum tax revenues are put into the Special Account on Oil and used for energy policy objectives such as development of oil stockpiling and energy diversification. The tax on electricity is called Electric Power Development Promotion Tax .Its revenues are put into a Special Account on Electricity for the promotion of energy policy objectives by giving subsidies to local governments to

[22]Gasoil is the name given to the middle distillate, mostly diesel. The oil product used for space heating in Japan is kerosene whereas in most other OECD countries light fuel oil is used for such purposes. The proposed tax revision is likely to be a lighter burden for the power utilities that are not burning much coal than for those that do. It will also impact on some manufacturing industries, including pulp and paper and chemical industries. The impact on steel and cement industries will be negligible because the type of coal they burn will not be subject to new taxes.

facilitate power plant siting approvals and to promote diversification away from oil use by encouraging the use of natural gas, nuclear and renewables.

Table 10: Proposed Revision of Excise Taxes in 2002.

Tax	Petroleum	LNG	LPG	Coal	Electric power development promotion tax
Current	2.04 ¥/litre	720 ¥/tonne	670 ¥/tonne		0.445 ¥/kWh
Revised	2.04 ¥/litre	1080 ¥/tonne	1 080 ¥/tonne	700 ¥/tonne	0.375 ¥/kWh

Source: METI.

A consumption tax of 5%is applied to the prices which include excise taxes for all client groups and all fuels. Diesel is the exception because the consumption tax is applied to the price prior to the excise tax. The consumption tax is not like Value-Added Tax which is reimbursed to industrial and commercial users. The Japanese government planned an excise tax reform in 2002 (see Table:4.1).The objective is to remove distortions in inter-fuel competition because coal has been exempt from tax, and taxes on oil have been higher than other fuels on an energy equivalent basis. The government does not regard this as an "environmental tax reform". The coal tax will be levied only on coal used for electricity generation. The tax revision will be revenue-neutral by reducing taxes on electricity (Special Account on Electricity) and increasing them on fossil fuels (Special Account on Oil).The increased tax revenues in the Special Account on Oil will be divided equally between METI and MOE, which will use the revenues for climate change mitigation projects. In the past, almost all revenue from the petroleum tax and the electric power development promotion tax has been used by METI. One-third of the tax increases on fuels and decreases on electricity are to be levied in October 2003, another third in April 2005 and the last third in April 2007[23].

[23] Energy Policies of IEA Countries. Japan 2003 review. IEA.Paris. 2003pp. 26-28)

Table 12: Assumed changes to Japan's energy tax structure in this scenario.

	Initial level	October 2003	April 2005	April 2007
Thermal coal yen/tonne	0	230	460	700
Natural gas yen/tonne	720	840	960	1080
Electricity yen/kWh	0.445	0.425	0.400	0.375

Source: Sam Hester, Japan's energy future, economic imperatives and environmental challenges, Prepared for the Australian Government Department of Industry, Tourism and Resources. July 2204 pp.35

The tax changes are projected not to have significant effects on Japan's economic growth over the period 2001–15 but are projected to lead to slight reductions in the output growth of sectors that consume these fuels intensively, including iron and steel, chemicals, rubber and plastics and electricity. For example, the output of Japan's electricity sector is projected to grow by 8.9 per cent between 2001 and 2015 when no changes are made to Japan's energy tax structure but by 8.8 per cent when the changes are imposed.

The proposed tax revision is a positive step in correcting uneven tax burdens of various fossil fuels. While the government does not regard it as an "environmental tax", the use of the incremental revenue for climate change mitigation may have some effect on energy-related CO2 emissions. Its impact on fuel use, environment and industry, as well as its effectiveness, need to be evaluated.

4.62 Protectionism.

In 1985, Japan implemented a law to protect Japanese refiners from a wave of imported light products by limiting such imports exclusively to domestic refiners. It was designed to expire in March 1996, giving domestic refiners plenty of breathing room to prepare for the market opening. Coupled with tariffs on imported products and rules that protected refiners' margins by transferring costs (plus margins) to dealers, domestic refiners were further isolated from world markets. This encouraged Japan's refiner-marketers to proceed with a service station building spree through the mid-1990s. Thus the onset of deregulation in 1996 has spawned a massive consolidation in Japan's retail sector that is only now beginning to gather momentum[24].

4.7 Energy Prices and Costs

Electricity prices in Japan are the highest in the OECD (Figures 20, 21 and 22 of IEA-WEO, 1999).There are a number of reasons for these relatively high prices. High generation capital costs: Japan has the highest investment costs for nuclear, gas and coal-fired power in the OECD. Expensive land, compensation payments made to local communities, and high safety standards (including earthquake resistance) contribute to increased costs. In addition, Japanese utilities used to rely on a limited number of suppliers and only recently have been actively encouraging foreign participation in their equipment procurement tenders. Very high technical standards for equipment compared with other countries force prices up and limit the number of competitors.

In the majority of IEA countries residential electricity prices in real terms have undergone less dramatic changes than oil prices, and to some extent less than coal and gas prices. Fossil fuel prices increased significantly in the aftermath of the oil price shocks in 1973-1974 and 1979, and fell again with the crash in crude oil prices in 1986. In Japan electricity prices between 1973 and 1986 increased moderately in most and declined in a few. After 1986, electricity prices fluctuated somewhat, but with a general downward trend, especially over the last few years. Gasoline and diesel prices decreased in 1998-1999 after the initial market opening. They then increased in 2000-2001, together with world oil market prices, and declined again in 2002.

[24] Oil & Gas Journal, 97:10, 3/8/1999

Table 13: Changes in Energy price (1980-1998)

PRICES	Units	1980	1990	1993	1996	1998
GDP per capita (at purchasing power parities)	$95p/cap	15641	21930	22845	24295	23833
Average energy price for final consumers (at ppp)	$95p/toe	n.d.	256	236	232	213
Average electricity price (at ppp)	c95p/kWh	17.7	12.6	12.2	11.6	11.0
Average price of fuels (at ppp)	$95p/toe	n.d.	322	297	294	274
Average energy price for industrial consumers (at ppp)	$95p/toe	129	63	39	40	42
Average price of motor gasoline (at ppp)	$95p/l	n.d.	0.92	0.84	0.73	0.63
Average price of diesel (at ppp)	$95p/l	n.d.	0.50	0.48	0.49	0.45
Average price of motor fuels (at ppp)	$95p/l	n.d.	0.75	0.69	0.63	0.55
Average electricity price for households (at ppp)	C95p/kWh	21.5	15.9	15.0	14.5	13.7

Source: World Energy Council (WEC)

Fuel prices for passenger transport are an important driver of travel demand, mode choice and fuel intensity. Fuel prices have varied considerably across IEA countries and continue to do so, particularly when fuel taxes are taken into account.

4.71 Gas Pricing

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

Netback prices impede growth in demand, except for those consumers with no acceptable alternative fuel for technical or environmental reasons. Consumers will tend to be clustered near the terminals, as there would be little or no incentive to invest in a network when alternative fuels are available at lower supply cost. Gas penetration is likely to be limited as a result. In other countries, combined heat and power production has been an important driver in encouraging the use of market-based pricing. In Japan, there would appear to be potential for tri generation (combined heat and cold production and electricity generation) as a means of expanding the range of competitive electricity generators in the market. Tri generation would also help to reduce the summer air-conditioning peak load by producing cold water at night. Gas air-conditioning is recognised in Japan as a means of coping with summer peak load, and market-based gas pricing could provide the appropriate mechanism to encourage its expansion.

Expanding gas consumption would assist Japan in achieving energy security, since sources of LNG are more diverse than for oil, and would assist in achieving environmental objectives, by supplementing the planned expanded role for nuclear. In these circumstances, competitive gas pricing would facilitate the development of the gas market (such as for Independent Power Producers and cogeneration)[25].

4.73 High fuel costs:

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

[25] Fore sited Footnote,No,17.pp.127

import gas as liquefied natural gas (LNG) and because of taxes. The costs associated with LNG means that natural gas prices are much higher than natural gas prices in OECD countries that use pipeline gas. High transmission and distribution costs: Costs for transmission and distribution infrastructure are high because of high land costs, mountainous terrain, the remote siting of new power stations, very high construction standards to withstand earthquakes and typhoons, and very high operating standards.

4.74 Additional regulatory costs:

Japanese environmental regulations are quite strict. As a result, nearly all coal-fired and most oil-fired power stations have equipment to greatly reduce SOx emissions (through flue gas desulphurisation). The majority of coal-fired plants also have advanced NOx removal technologies (principally selective catalytic reduction). The Air Pollution Control Law allows local government to set even stricter limits still, resulting in additional utility expenditures. For example, despite the use of advanced Sox emissions control equipment, utilities still use coal and oil with lower sulphur content. Regulations regarding maintenance of power plants are highly prescriptive. For example, nuclear plants are required to have a refueling outage every month, although longer fuel cycles have been proven to be both safe and feasible. Government regulations also require natural gas turbines to be 70 completely disassembled for inspection every 30 months – a requirement not duplicated elsewhere and not recommended by the manufacturer.

4.75 Low load factor:

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

4.8 Subsidies

The Government is financially involved in the electricity sector in a number of ways. It is a direct owner of two-thirds of EPDC and of part of Japan Atomic Power Company (JAPC). The Government is financially indirectly involved in the electricity sector through its involvement in fuels, notably in support of nuclear generation and coal-fired generation (through support of the domestic coal 81 industry). The Japan Development Bank has historically provided utilities with low-interest loans for power generation, particularly from non-oil fuels; its loans total about 6% of power sector investment. The bank's policy to offer low-interest loans has now been extended to independent power producers, who can receive low-interest loans to cover up to 50% of their investment. The Electric Power Development Company (EPDC) was created to assist in power development, and has since played a leading role in investment in leading edge power generation technologies such as "clean coal" generation facilities. Sixty percent of EPDC's capacity is hydroelectric, of which 60% is pumped storage, but more than two thirds of its energy sales come from coal-fired generation. The average capacity factor for hydroelectric (excluding pumped storage) was 30% in FY 1997[26]. Since the price of electricity during peak times would be much higher than the average price, if peak load pricing were instituted, EPDC's hydroelectric facilities may be quite valuable. However, EPDC currently sells its hydroelectric energy at cost, which is less than ¥9 per kWh (excluding pumped storage), through long-term agreements with the nine utilities. This is far less than the estimated cost of new peaking facilities of ¥32 per kWh. Currently the excess rent of this low-cost high-value energy accrues to customers in the form of lower rates. However, if electricity generation is liberalised, the utilities, rather than the customers, will enjoy these benefits.

4.81 Tax and purchase of domestic coal:

Subsidies for power development, primarily funds paid to communities near new power plants for regional development, are recovered through a special electricity power development tax of ¥0.445 per kWh (1998 budget for subsidies was ¥224 billion). The remainder of tax revenue from this source (¥238 billion) goes towards measures for development and diffusion of alternative energy to oil. Electric utilities are also committed to purchasing domestic coal (4.25 million tonnes in 1997, about 10% of total utility requirements) at a price approximately three times the imported coal price. Domestic coal prices were recently cut to ¥15 800 per tonne, with a commitment to cut

[26] Implying that hydro facilities are used mainly for peaking or midload operation. IEA -WEO-1999.pp.82

prices a further ¥1 800 per tonne by FY 2001. This compares to imported coal prices of approximately ¥5 500 per tonne. The cost premium (¥69.8 billion in FY 1996) is shared among all the utilities, although the coal is actually used by only three general utilities and three wholesale utilities. The utilities also purchase power above cost from renewable sources, although the amounts involved here are quite small.

Japanese energy policy includes a complex web of financial and fiscal incentives to encourage particular energy supply and end-use technology choices. It is not clear how well these mechanisms are working individually or collectively. Japan should develop a comprehensive map of all the various incentives and disincentives, financial, tax, regulatory, R&D, etc. that impact the energy sector; determine the effectiveness and the cost effectiveness of these measures; and rationalise these policy options for maximum impact and leverage effectiveness of these measures; and rationalise these policy options for maximum impact and leverage[27].

Over the past two decades a desire to lower energy prices as well as concerns about poor performance of government regulated utilities and government budget constraints have provided impetus for energy sector reform. These reforms have focused on increasing competition in energy markets and improving the regulatory frameworks governing those markets so that energy prices more accurately reflect costs .The expectation underlying energy sector reform is that well functioning markets can deliver lower prices than heavily regulated markets and can also provide incentives for better service quality and more rapid innovation.

The variety of policy goals and objectives in Japan with respect to the electricity sector presents a challenge both for the traditional form of regulation in the sector and for reforming that regulation. One of these challenges is the harmonisation of the three goals of energy security, environmental protection and economic growth. An emphasised element in economic growth is the target of internationally comparable prices by 2010, which is very ambitious in light of the exogenous factors which contribute to high costs in Japan, including high fuel and siting costs. Price Regulation the present mechanism based on rate of return, even with a yardstick approach for setting the rate, gives utilities

[27] Energy Policies of IEA Countries. Japan 2003 Review. IEA.2003.pp. 29

very limited incentives to reduce their costs, as nearly all cost savings are passed on to customers. While partial liberalisation of retail supply can be expected to provide some competitive pressure to reduce generation costs, there will be no corresponding pressure to reduce network costs. Furthermore, there are no competitive pressures on utilities to reduce supply costs for captive customers by purchasing power from other utilities or from IPPs.

Other forms of yardstick regulation do provide a stronger incentive for a utility to reduce costs, particularly regulation that makes a more direct link between one utility's regulated maximum price and other utilities' costs. This form of regulation allows more of a utility's cost savings to be retained in the form of greater profits and thus provides greater incentives for a utility to be cost efficient. Similarly, the fuel-cost adjustment mechanism, while it ensures that customers obtain the benefits of a fall in fuel prices, reduces the incentive for the utility to reduce fuel costs, by changing fuel purchase strategies.

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

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

Chapter 5

SUMMARY AND CONCLUSION

Energy the fifth factor of production plays an important role in economic and social development of any country. Since sharp global discontinuities in supply and high stakes in the energy resource management determine states' energy policies, the state's responses to global energy supply are mostly related to its decision-making systems, resource profiles and values and perceptions. The consequences of energy deficiency on the working of the national economy are of vital importance. Surely, a sufficient supply of energy is essential for the proper working of the economy; further, due to the ubiquitous role of this commodity energy policy cannot be defined without taking into account the inter relations between the energy sphere and the economic sphere as whole. Energy resources themselves are not the problem. The problem is the management of the world's vast energy resources, and all the complex political and economic decisions, choices and events that surrounded the management task.

The study analyzed the global and domestic factors that determined the growth and pricing of energy in Japan after the 1979 oil crisis. The selection of the time period for present study has particular importance because of the experience that Japanese economy and energy sector experienced during these two decades of 1980 and 1990. Energy problems however proved far more complicated than originally anticipated. None of the alternative technologies now appear simple or inexpensive with changed world economic conditions brought about by ever rising oil prices, future economic growth and thus growth in energy demand are far more uncertain than had been predicted during the period of rapid economic growth in Japan and many key factors of supply and demand lie beyond their control.

Japanese responses to energy problems have encompassed energy conservation, the maximum utilization of domestic sources, the development of energy substitute for oil as well as emphases on efficient and effective energy installations, energy research, close meeting the challenges stands as brilliant. This evaluation, however doesn't meet the agreement of most Japanese energy critiques as they have on the contrary tended to be overly pessimistic. For example, most Japanese reviewers would consider Japan's efforts in overseas petroleum development a total failure, as these did not succeed in achieving the projected supply of 30% of Japan's oil needs nor have they proved profitable.

Japan is still 82% dependent on imported energies, and in light of the tremendous degree of vulnerability, the diversification of sources of supply and of the domestic energy mix and pattern of consumption can only been seen as a palliative rather than as a comprehensive solution to continuing dependence. The Japanese response to later condition, given the funding and timing limitation of energy substitution and new technological development, will not allow a quick made in Japan solution. Japan's resource diplomacy has had, therefore, to be innovative in the context of new and complicated economic and geo politic relationship between states. The management of dependence has led to new trading and investment opportunities.

While energy security and environmental issues have been well addressed in Japan, more needs to be done to improve economic efficiency, including efficiency in the energy markets and cost-effectiveness of government policies. Japanese energy policy includes a complex web of financial and fiscal incentives to encourage certain energy supplies and end-use technology choices. It is not clear how well these mechanisms are working individually or collectively. Japan should develop a comprehensive map of all the various incentives and disincentives –financial, tax, regulatory, R&D, etc.–to determine the cost-effectiveness of these measures and rationalize these policy options for maximum impact and leverage. Despite some recent reductions, energy prices in Japan are still among the highest within IEA member countries. To increase market efficiency, the government has launched market reform. This process is most advanced in the oil sector which has been fully liberalized. However, the implications have not yet been fully ascertained because the industry is still in the middle of restructuring which involves closing excess refining capacities and rationalizing retailing.

Japan is making great efforts to ensure security of supply. Despite many measures already in place, growing oil import dependence from a single area is still a concern.

While Japan's oil emergency measures such as oil stockpiling are very solid, efforts should continue to reduce oil dependence and diversify supply sources. However, Japan is encountering new issues of energy security other than oil supply security. Recent disruption in gas supply from Arun (Sumarta, Indonasia) LNG plants is a typical example. Gas supply security is becoming more crucial in Japan because the gas share in TPES is increasing. Concerns are emerging in the electricity sector following recent events at TEPCO nuclear plants. Energy security does not stop at national boundaries but is moving down to the final consumer. Gas, oil and electricity have to be considered as both in the short and longer term perspectives. These issues are more critical in Japan than in most IEA countries owing to its isolated location without gas and electricity interconnection with neighboring countries and lack of indigenous energy resources. In particular, development, integration and strengthening of natural gas and electricity networks warrant more efforts.

The government aims for a rapid development of renewable energy by 2010, although Japan's starting point is relatively low. The indicative target include an increase from 209 MW to 4.8 GW of installed capacity for photovoltaic, from 83 MW to 3 GW for wind, and from 900 MW to 4.2 GW for wastes by 2010.It is supported by a set of instruments, including a renewables portfolio standard introduced under the "Law Concerning the Use of New Energy by Electric Utilities" of June 2002.By 2010, utilities must use new renewable sources amounting to 1.35%of their total output.

The government also introduced a subsidy to encourage the closure of old coal-fired plants and the shift to natural gas-based generation. Under this system, the government would subsidize 10% of the construction cost of a natural gas plant if a coal plant of more than 35 years of age were closed. The annual budget of this policy is ¥2.5 billion, and it is planned to run for the next ten years. The Federation of Electric Power Companies (FEPC) has adopted a goal to reduce the CO2 intensity of end-use electricity by 20%from the 1990 level (to 0.34 tCO2 per MWh against 0.379 in 2001)by 2010.But it also projects a 16%increase (corresponding to a 1.5 %annual growth rate)in the total output of the ten electric power companies between 2001 and 2011,less than the 24%growth in the 1990s.On the whole, the FEPC projects that utilities emissions will rise by about 14%from FY1990 by FY2010.

Because of its heavy dependence on imported fuels, Japan has always placed a great importance on measures to enhance the security of energy supply. Though market operators are free to choose their supply sources and negotiate their contracts, the government has had an important role in creating favourable conditions to support the development and procurement of oil and natural gas, and, more recently, procurement of coal from new sources.

Japan is making great efforts to ensure security of supply by diversifying its energy mix away from oil. Furthermore, oil stocks exceed the IEA stockholding obligation, many flexibility tools (such as supply diversity and possibilities for fuel- switching) are used for natural gas, and policies to promote nuclear power and renewables help towards diversification.
From the empirical analysis of the given statistical time series data (appendix viii) by using Karl Pearson's co efficient of correlation, it found that Japan's energy diversification is having a significant correlation with the changes in international crude oil price and domestic oil demand.

However, growing oil import dependence from a single area is still a concern. Japan is also encountering new issues of energy security. The disruption in gas supply from Arun (Indonesia) shows a potential security threat as the share of gas is increasing in the fuel mix. The outage of TEPCO nuclear plants is another example. In addition, sharpening summer peak demand for electricity may cause a risk in matching demand and supply. Energy security issues are more critical in Japan than in most IEA countries owing to its isolated location and limited domestic energy resources.

Nuclear power has a central role in Japanese energy policy both in terms of security of supply and climate change mitigation. Nuclear power is also broadly competitive with other electricity generation forms in Japan. The government's target is to increase nuclear generation by 30 %(equivalent to 10-13 new nuclear plants)between 2000 and 2010.This target, however, has become more difficult to reach because of safety-related incidents in recent years, undermining public confidence and jeopardizing energy security after significant plant outages. The first challenge is to restore public confidence. Secondly, since the load factor of Japanese nuclear power plants is much lower than the best performers in the world, more attention should be given to shortening the statutory and other outage periods and reducing their frequency. A third challenge is to ensure the role of nuclear power in liberalized electricity markets, a subject that has not been addressed in the recent debate on further market reform in the electricity sector.

There had been different level of concern for the development of new and alternative energies since the oil crisis, but more importance has given to this sector only after 1996. The new energies are contributing to constructing sustainable economic structure as they are environmentally friendly, emit little CO_2, and provide us with alternatives for relying less on petroleum . As domestic energy resources that are almost limitless in Japan, the new energies give the opportunity to secure a stable supply of energy, and to deal with global environmental issues. In addition, introduction of new Energy technologies can bring further advantages such as creating new industry and chance of employment, etc. Moreover strong government support will be needed besides corporate and popular understanding and co operation on the basis of positive judgments about a long term prospects for new energies. Assessment of the long-term prospects should take into account the economics of the new energies.

Historically, energy demand in Japan had risen faster than GDP, particularly during the 1950s and 60s.Between 1965 and 1970 real GDP grew by 11.3% and final energy consumption grew by 14.2% annually. While the trend has changed since the seventies the GDP growth overtaken the energy growth and it continued until 90s. Between 1990 and 1996, when real GDP grew by 1.7% per year, primary energy supply grew by 2.1% per year and final energy consumption by 2% per year. This study shows a positive relation ship between Japanese economic growth and energy growth.

Japan faces an even larger challenge than other IEA countries in reducing growth in energy consumption. Between 1970 and 2001 the pattern of final energy consumption in Japan changed significantly as energy demand in the transport and residential sectors grew more rapidly than energy demand by industry .The reasons for these changes are many and include increased electricity demand by households, rapid growth in the number of freight and passenger vehicles in the transport sector and increased energy efficiency of Japanese industry. It should also be noted that Japan's economic slowdown since 1992 has had a larger effect on industrial energy consumption than energy consumption in the transport or residential sectors.

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

Japan's energy consumption could lead to substantial differences in the pace and pattern of growth in Japan's energy consumption over the period 2001–15. Equally importantly, under all scenarios, imported fossil fuels continue to supply the majority of Japan's energy needs out to 2015 and that, by virtue of Japan's size, this will continue to be a vast amount of energy. Oil will remain Japan's largest energy source despite its slow growth relative to other fuels in all scenarios.

There is a growing awareness of the serious problems associated with the provision of sufficient energy to meet human needs and to fuel economic growth. The study has pointed to the need for energy and material efficiency, which would reduce air, water and thermal pollution, as well as waste production. Increasing energy and material efficiency also have the benefits of increased employment, improved balance of imports and exports, increased security of energy supply, and adopting environmentally advantageous energy supply. A large potential exists for energy savings through energy and material efficiency improvements. Technologies are not now, nor will they be, in the foreseeable future, the limiting factors with regard to continuing energy efficiency improvements. There are serious barriers to energy efficiency improvement, including unwillingness to invest, lack of available and accessible information, economic disincentives and organizational barriers.

This study reveals that Japan has made energy efficiency and conservation one of the priorities for meeting the energy targets in the short and long terms. However, in view of the rising trends in energy consumption in all sectors, the share of the targets to be achieved by energy efficiency measures would require drastic changes in lifestyle, energy infrastructure and the use of efficient technology. If the measures are not successful, then additional contributions would be required from fuel switching (from coal to nuclear, gas or renewables) or from international flexibility mechanisms. Japan has historically achieved high standards of industrial energy efficiency, so further improvement will be a challenging task. A wide range of policy instruments, as well as innovative approaches have to be implemented in order to achieve the desired energy efficiency approaches. These include: regulation and guidelines; economic instruments and incentives; voluntary agreements and actions, information, education and training; and research, development and demonstration. An area that requires particular attention is that of improved international co-operation to develop policy instruments and technologies.

In discussing the pricing of energy in the last chapter the role of deregulation or liberalization and its impact on pricing of energy also widely discussed along with the expanded application of market principles, but also focused on the roles of players who act in the marketplace.

Governments of course play a pervasive role in the pricing of commercial energy resources and the relative neglect of issues relating to traditional forms of energy.

Government exercise direct influence over energy prices, usually through the ownership of energy sources or price controls. Indirect influences occur through such means as taxes, import duties, market quotas, and taxes on energy using equipment and Government in energy resources.

The variety of policy goals set by the Japanese government ministries and agencies with respect to the energy sector presents a challenge both for the traditional form of regulation in the sector and for reforming that regulation. Therefore total cooperation of corporate houses, manufacturing companies and individual households in Japan is very essential. One of these challenges is the harmonization of the three goals of energy security, environmental protection and economic growth as discussed widely in earlier chapters.

One of the important outcomes of this study is that the extent to which Japan can successfully reform its economy is potentially the major determinant of its energy consumption growth over the period, if Japan accelerates its economic reforms, particularly related to energy sector, its policy settings especially for the diversification of supply and increasing energy efficiency are likely to compel a push for nuclear, natural gas and other new energies and a slow growth in total energy consumption in coming years.

Appendices

Appendix: I

Trends in Primary Energy Supply
(Unit :%)

FY	Oil	Coal	Natural Gas (LNG)	Nuclear	Hydro	Others
1973	77.4	15.5	1.5	0.6	4.1	0.9
1984	59.2	18.8	9.2	7.5	4.1	1.3
1985	56.3	19.4	9.4	8.9	4.7	1.3
1986	56.6	18.2	9.8	9.4	4.6	1.3
1987	56.9	18.0	9.7	10.0	4.1	1.4
1988	57.3	18.1	9.6	9.0	4.6	1.4
1989	57.9	17.3	10.0	8.9	4.6	1.4
1990	57.2	16.5	10.2	9.5	4.2	2.5
1991	55.6	16.9	10.7	9.8	4.5	2.5
1992	57.2	16.1	10.6	10.0	3.7	2.4
1993	55.6	16.0	10.7	11.1	4.2	2.3
1994	56.5	16.3	10.7	11.3	2.8	2.3
1995	54.8	16.5	10.8	12.0	3.4	2.3
1996	54.2	16.4	11.4	12.3	3.3	2.4
1997	52.8	16.7	11.5	12.8	3.6	2.5
1998	51.6	16.3	12.2	13.6	3.8	2.5
1999	51.2	17.2	12.6	12.9	3.5	2.5
2000	51.0	17.8	13.1	12.3	3.3	2.5
2001	49.2	19.0	13.4	12.6	3.3	2.5
2002	49.7	19.5	13.5	11.6	3.2	2.5

(Source: PAJ, Annual Review 2004)

Appendix: I I

Primary energy Supply and degree of dependence.

(Million metric tons of Oil equivalent, except %)

Years	Total supply	Oil	Natural gas	Nuclear power	Coal	Others	Degree of dependency
1980	374.7	256.3	21.9	20.2	53.2	23.1	85.1
1983							82.2
1985	477.6	300.2	39.6	36.5	70.8	30.5	83.1
1990	438.8	252.9	43.3	52.7	74	15.9	80.6
1995	497.23	269.36	52.02	75.90	82.52	17.56	81.5
1997	514.90	271.60	54.95	83.15	86.53	18.67	-
1999	515.45	266.43	62.11	82.51	87.59	16.80	-
2001	520.73	256.11	64.80	83.36	100.19	16.28	-
2003	517.10	256.97	70.95	62.55	107.70	18.93	-

Source: Keizai Koho Centre

Appendix: iii

Long-term Energy Supply and Demand Outlook

(Million kl of crude oil equivalent)

Fiscal year Energy	*Quantity(1990)*	*Shares %*	*Quantity(2000)*	*shares %*
Oil	**306**	**58.3**	**313**	**51.8**
Coal	**87**	**16.6**	**108**	**17.9.**
Natural gas	**53**	**10.1**	**79**	**13.1**
Nuclear	**49**	**9.4**	**75**	**12.4**
Renewables, ***of which1:***	**29**	**5.6**	**29**	**4.8**
Hydro	*22*	*4.2*	*21*	*3.4*
Geothermal	*1*	*0.1*	*1*	*0.2*
New energy	*7*	*1.3*	*7*	*1.1*
Total TPES	**526**	**100**	**604**	**100**

Source: METI.

Appendix: IV

Supply of primary energy resources

(10 billion kcal)

	1980	1985	1986	Percentage
Total	395015	400653	399821	100
Hydro power	22562	21547	21086	5.3
Nuclear	20235	39097	41235	10.3
Coal	67148	79421	76355	19.1
Domestic	12227	10957	10779	2.7
Imported	54921	68464	65576	16.4
Lignite	11	-	-	-
Petroleum	259809	221117	220576	55.2
Domestic	452	630	655	0.2
Imported*	259357	220487	219921	55.0
Natural gas	2333	2315	2168	0.5
Imported LNG	22704	37015	38264	9.6
Charcoal	24	22	25	0.0
Firewood	189	119	112	0.0
Domestic Energy	58033	74687	76060	19.0
Imported energy	336982	325966	323761	81.0

*Including petroleum products and LPG

Source: Statistics Bureau Management and Coordination Agency.

Appendix: v.

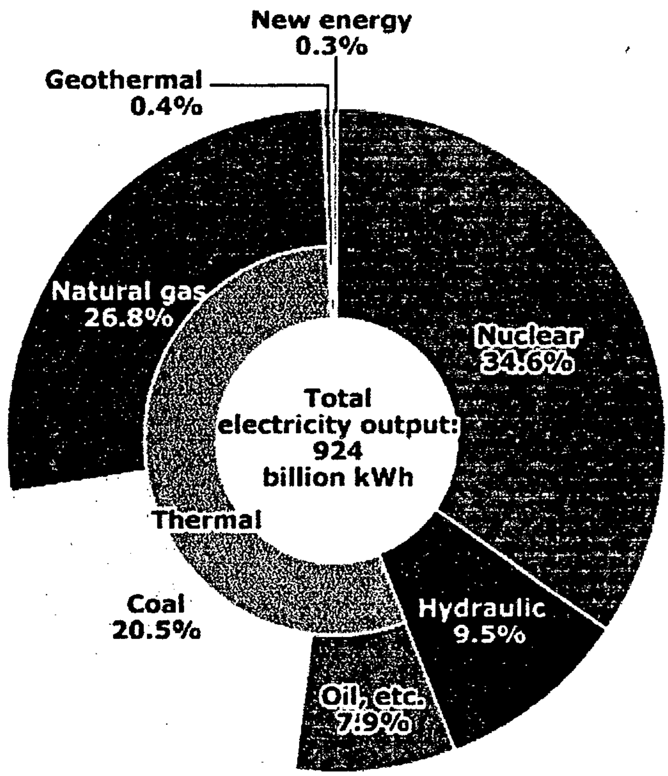
Changes in Primary Energy Supply (%)

	FY1973	FY1990	FY2001
Primary energy supply (crude oil equivalent million kl)	414	526	588
Oil	77	58	49
Coal	15	17	19
Natural Gas	2	10	13
Nuclear Power	1	9	13
Hydroelectric Power	4	4	3
Geothermal Power	0.0	0.1	0.1
New Energy, etc.	1	1	2

Source: Agency for Natural Resources and Energy (ANRE)

Appendix: vi

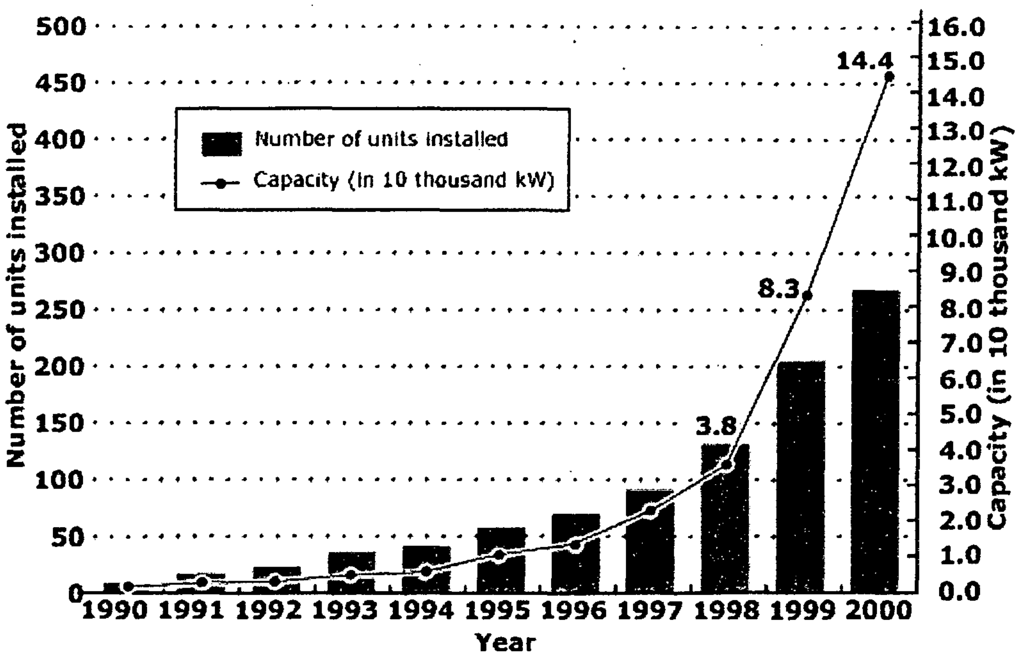
Ratio of Electricity Generated by Nuclear Power in Japan



(Source: Results for 2001 (From data of the METI)

Appendix: vii

Changes in Wind Generation Volume in Japan



Note: Active wind generation systems with capacity of 10kW or more.

Source: Agency for Natural Resources and Energy (ANRE)

Appendix: viii

Prices of Crude Oil, Us$/Barrel And % Share Of Nuclear and Other New Energy

Year	Total oil price $ billion	Spot prices $/ Barrel	Nuclear (Mtoe)	Other (Mtoe)	Combined share of nuclear and new energy
1980	---	32.0	21.52	8.36	29.88
1981	53.3	37.3	-	-	-
1982	46.3	34.7	-	-	-
1983	40.1	30.8	28.00	-	-
1984	39.4	29.4	32.90	-	-
1985	34.6	31.6	39.10	-	-
1986	19.5	13.1	41.24	-	-
1987	20.7	13.8	41.94	7.46	49.40
1988	18.9	17.4	46.56	8.69	55.25
1989	21.5	20.9	47.66	8.86	56.52
1990	31.6	23.3	52.71	9.18	61.89
1991	30.2	20.4	55.63	9.90	64.53
1992	30.1	19.4	-	-	-
1993	28.0	17.7	64.96	12.12	77.08
1994	27.6	16.5	70.14	12.48	82.62
1995	30.0	18.1	75.9	17.3	93.2
1996	33.4	20.3	78.7	17.3	96.0
1997	34.8	20.6	83.1	18.6	101.7
1998	22.5	13.9	78.7	18.5	97.2
1999	27.1	17.0	82.5	16.8	99.3
2000	44.7	28.4	83.9	17.8	101.7
2001	38.9	- -	83.3	16.2	99.5
2002	36.7	25.02	76.9	18.1	95.0
2003	45.9	28.83	62.55	18.93	81.48

Source: compiled from various issues of booklet of Keizai Koho Centre and PAJ, Annual Review 2004.

Appendix: ix

Final Consumption of Total Energy by different sectors.

Year	Total consumption (mmtoe)*	Industry ry %	Trans port %	Others Total %	Agriculture %	Residential %	Non energy uses **
1983	237.83	47.7	22.9	26	1.2	11.8	3.4
1984	251.98	47.9	22.4	26.2	1.5	11.8	3.4
1986	252.72	45.9	23.5	26.9	1.7	12.2	3.7
1987	262.86	45.9	23.6	26.8	1.8	12.0	3.7
1992	335.20	44.4	26.9	25.9	-	-	2.8
1995	345.34	43.59	25.25	29.40	-	-	-
1997	340.46	42.74	27.10	30.15	-	-	-
2000	346.84	42.10	27.22	30.67	-	-	-
2001	342.13	38.40	28.13	33.46	-	-	2.54
2002	358.67	40.47	26.38	33.14	-	-	-
2003	353.53	41.54	26.42	32.02	-	-	-

***Million metric tons of oil equivalent**
****Petroleum products such as lubricating oil or Asphalt**
Source: Compiled form the various issues of "an International Comparison", Keizai Koho Centre.Tokyo.Japan.

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