Achieving Japanese Energy Security in a post-Fukushima world[1]

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Summary: In its post-Fukushima energy policy, Japan should continue to diversify its fuels and sources, as well as develop nuclear power, including nuclear reprocessing. A balanced energy portfolio should be pursued which reduces primary energy demand, yet provides economic progress for a maturing Japanese population. Energy technologies for mottainai and renewables can help Japan deliver "green exports" to an energy hungry world. Significant opportunities exist for the US and Japan to work together to achieve economic prosperity, environmental quality and energy security based on a new era of conservation, expansion of LNG imports, renewables and nuclear power.

In the wake of the Fukushima accident, there is a new reality for Japanese energy policy. Legitimate questions about the future role of nuclear power in Japan have arisen, and options must be weighed but it is important to balance this with the need to sustain the Japanese economy and provide quality of life to its citizens. Some key questions:

- What are the energy options for Japan that meet its economic, environmental and energy security objectives in the post-Fukushima period?

- What are the alternative futures for nuclear power? Official government projections had called for Japan to meet 50% of its electrical needs through nuclear power. Can Japan meet its overall energy security and environmental objectives with less than expected nuclear power growth? What would a slowdown in construction of nuclear power imply for reprocessing of nuclear fuel and the future of Rokkasho?

- How can the US and Japan remain competitive in forging the common objective of commercial deployment of nuclear power plants throughout the world, especially in newcomer states? What is the role within this future of small modular nuclear reactors?

- What are the options for meeting electrical demand with nuclear power in the short, medium and long-term? In the short-term, what is the capacity to meet demand through increased LNG and the reintroduction of some thermal plants? What is the cost of these measures? How will the electric utilities be able to meet the needs of higher short-term energy costs and the need to contribute to compensation of victims?

[1] This draft is revised from the August 3 version due to the contributions made by the article of Ryoichi Komiyama of the Institute of Energy Economics (http://www.worldenergy.org/documents/congresspapers/188.pdf)

- What can be done on the demand side to increase energy efficiency and implement mottainai? Are there specific technologies, such as heat pumps, that can be promoted more aggressively to Japanese consumers to achieve this?

- What are the likely patterns of Japanese economic growth in the future recognizing that the population of Japan is likely to decline from 120 million to less than 100 million within the next fifty years? What type of economy does this suggest as Japan seeks a higher quality more service oriented GNP?

- Can Japan achieve this by adopting more energy efficient appliances and autos? In the transportation sector, one possible strategy is to increase the penetration of electric vehicles, thereby reducing oil use and improving energy security. And in this scenario of greater usage of electric vehicles, what fuel share of electricity would ensure energy security and environmental benefits?

- How can Japan build a new energy economy based on optimism, economic opportunity and sustainable development? How can this energy economy not only provide energy to Japan but export potential for green technologies, including advanced energy efficiency appliances and autos?

- What does the current energy policy debate imply for US-Japan relations, especially common concerns over energy security, environmental quality and non-proliferation? What initiatives should be considered to strengthen US-Japan ties, recognizing that the two countries remain leaders in the global economy, technological advancements and shared democratic values?

I. The Four Phases of Japanese Energy Policy

As one who has been involved with Japanese energy policy since an initial visit to Japan in 1975, I've watched Japan's energy situation evolve over the last forty years. From an outside perspective, it appears that there have been three distinct phases of energy policy and now a new policy which will emerge in the post-Fukushima situation.

- Phase I – (1945 - 1972) Provide adequate supplies of energy to enable dramatic economic growth (doubling in a decade) by consolidating the nation's utility companies. During this twenty year period, Japan achieved unprecedented economic expansion. My first experience in Japan was to remember the six day work week and the admired policy of lifetime employment. This burst of economic activity that rose out of the devastation of WW II showed the perseverance of the Japan people and also their commitment to setting a target and achieving that target.

- Phase II – (1972 - 1980) The oil shock of 1972 brought a new era of energy security awareness to Japan. Oil prices had been below $3 per barrel and Japan's economic expansion was based on access to cheap oil from the Middle East, as well as inexpensive gas from Indonesia. Prices tripled during this period bringing about economic downturn globally. Japan responded with a strategy to diversify its energy economy (that was

highly dependent on oil) by diversification of fuels and diversity of source plus development of an aggressive nuclear power program and planning for recycling of nuclear fuel. Japan also committed itself to cutting emissions in half within a decade, thereby building a record of environmental quality. In 1984, Japan also began an aggressive build up of oil stocks following the beginning of the Iran-Iraq war and coordination through the International Energy Agency.[2]

- Phase III – (1990-2011) During this period, Japan refined its energy policy by adopting the three e's: energy security, environmental quality and economic competitiveness. Nuclear power expanded to 45 nuclear plants and a reprocessing center in Rokkasho was built. The US-Japan nuclear cooperation accord was signed in 1987 and a close US-Japan partnership to achieve the three s's was begun: nuclear security, safeguards and safety. The Kyoto Accord was signed in 1997 and the world's leading nations agreed to an historic agreement to reduce carbon and protect the earth's climate. Japan became a leader in this effort, especially through energy efficiency, nuclear power and achievement of high thermal efficiencies in power plants.[3]

- Phase IV – (Post-Fukushima) The Fukushima event has cast doubts on the safety of Japan's nuclear power plants. Although the responses to the crisis by Japanese industry and government has been remarkable, questions linger over the regulatory system and also the safety of nuclear power plants in quake prone zones. A major debate has begun in Japan regarding the pros and cons of nuclear power and to what extend Japan should rely on nuclear power in the future. The official forecast by the government of 50% nuclear share has been questioned and a key issue is the extent to which conservation and renewables can meet a growing share of Japan's future needs.

These four phases demonstrate how Japan's energy policy has been not one specific plan but an evolving process that incorporates the challenges (and opportunities) of the time in order to best prepare for the future.

II. Japan's Short, Medium and Long-Term Energy Policy

In thinking about Japan's energy future, it is useful to consider different strategies for the short, medium and long-term.

- Short-Term - In the short-term as nuclear energy is reviewed, emphasis will be placed on mottainai and fuel switching with reliance on LNG and older thermal plants. The goal is to sustain the Japanese economy and meeting consumer needs while ensuring public confidence in the renewal of nuclear power. A key issue in Japan, and within the US-Japan dialogue, is the issue of regulatory reform. It is hoped that as many nuclear plants

[2] I was honored during this period to be program officer of an international energy workshop headed by MIT's Carroll L Wilson, the Workshop on Alternative Energy Strategies. Japanese participants included Dr. Saburo Okita, Dr. Masao Sakisaki and Mr. Toshio Doko, head of the Keidanren. Our Japanese workshop was in Shimoda in 1975.

[3] During this period I was honored to be the US Chairman of the US-Japan energy working group that resulted in the Reagan-Nakasone agreement of l983 and a member of the senior US team that agreed to the US-Japan Nuclear Cooperation agreement of 1987. Since that time we have sponsored eight Santa Fe Seminars on US-Japan nuclear cooperation to deepen the relationship and chart innovative and cooperative means for cooperation)

as possible, from a safety and public confidence point of view, can be restarted within the next three years. During this period, evaluations should be forthcoming about the world energy situation and the likely global increase of use of fossil fuels that will subsequently increase prices and pollution.

Japanese Energy Use (2007 in TWh)

Coal	310
Crude	46
Products	109
Gas	289
Nuclear	283
Hydro	74
Geo	5.5
Other	23
Total	**1139.5**

- Medium-Term - In the medium to longer-term, Japan can find innovative ways to produce energy (nuclear, renewables etc.), conserve energy by improving appliance efficiency (mottainai) and build a new generation of efficient, electric vehicles. The electric sector will be very key in this transition to a new energy economy. High efficiencies in electrical generation should be sought (60%) as well as a balance of electrical generation sources (LNG/nuclear, energy/thermal/renewables etc.).

- Long-Term - Four important goals for long-term (20 years plus) energy policy would be: (1) zero primary energy growth while increasing economic growth by 1% per year (not life style changes but technology fixes by improving the efficiency of electrical devices); (2) greatly expand electric vehicles to as much as 50% of the market in twenty-five years; (3) adopt a 33/33/33) policy with approximately equal parts of : nuclear energy; LNG; and renewables (including hydro) in electricity production, recognizing that renewables will be making another significant contribution to the maintenance of zero energy growth by reducing demand for households, industry, business; (4) produce no more emissions than the 2000 level; and (5) generate economic growth via energy efficiency exports, namely efficient appliances and electric vehicles.

III. Energy Projections 2008 to 2050

Japanese imports of oil, gas, coal remain quite high, despite the efforts of last fifty years to diversity sources and supplies. It appears from the statistics that Japan also exports quite a significant quantity of refined oil products, importing crude and exporting it as products. Nuclear energy is the only significant domestic resource and renewables are currently only a small fraction.

- On the demand side, we see that industrial energy needs are met through coal, oil production and electricity. It appears there is some opportunity for expanding electrical use in industry and reducing oil products. We expect that coal is very attractive economically for industry and there may not be much enthusiasm for decreasing its use at this point. Residential and commercial are very electricity intensive and these sectors will likely grow in line with the aging of the Japanese population. There is also significant use of oil products in the transportation sector (i.e. gasoline for autos). Over time, a big opportunity exists for substituting electric vehicles for gas powered autos and

subsequently, for the Japanese export of electric vehicles for a "transportation hungry world."

- In the electrical sector, we see that in the short-term, LNG must substitute for nuclear power. Coal will also remain very important, almost as much as nuclear. Also, there is a significant amount of oil/products, hydro is reasonably small and other renewables are less than 5%. Over the longer-term, we would expect electricity demand to grow for the following reasons: (1) residential and commercial electricity will rise due to the aging of Japanese society and the attractive option of electrification; (2) Japanese industry will continue to move toward service oriented products that require higher electricity (i.e. more financial managers to manage Japan's oversees business/manufacturing; more service oriented jobs); and (3) a large opportunity exists for the automobile sector with electrification of autos.

- This raises the issue of how future electrical needs of Japan will be met. In my recent Council on Foreign Relations speech, we outlined the following adjustments to 2035 and here I've added to numbers to 2060 (% shares).[4] Please note that de-centralized renewables (i.e. solar panels) will be "counted" on the demand side by reducing consumption.

- The population of Japan is expected to decline from 130 million to 90 million by 2100. Over the last decade, the "real purchase" power per capita of Japan has increased from $22,000 to $34,000. Considering that the population is declining in Japan, per capita GNP can increase significantly per person without a significant increase in the overall GNP of Japan. The following chart, which was prepared before Fukushima by IEEE researcher Ryoichi Komiyama, demonstrates that final energy demand can decline even at a rate of economic growth of l% per year on average over the next forth years.

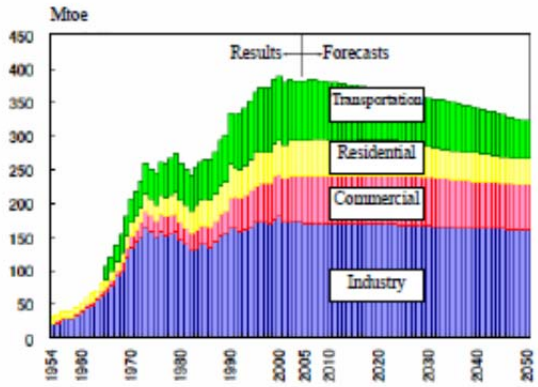

Figure 4-4 Final Energy Demand by Sector (Reference Scenario)

- For example, GNP per capita (purchasing power) could increase to $50,000 per capita by mid century with an average GNP growth at l% or below/year. This would suggest that energy growth need not increase that much and yet we will see a need for greater

[4]For full speech go to: http://www.wpainc.com/PDF/WFM_CFR_4-4-11_Speech.pdf

electrification. Electricity be at least a one third increase by 2050 assuming: (1) aging population; (2) the economy is based increasingly on services and finances (as production is transferred to developing countries), but "profits" remain in Japan; and (3) a great effort is made to electrify autos and to increase the efficiency of appliances and these products can be exported to premium markets (think of Japan as Lexus of manufactured products). All of this will require a TWh increasing from 1119.5 TWh to as much as 1300 TWh in 2060 (at a minimum).

- Thus the increase in electricity can be met with the following fuel mix contributions:

(TWh)	Coal	Crude	Products	Gas	Nuclear	Hydro	Geo/Renewables	Total
2007	310	46	109	289	283	74	28.5	1139.5
2035	195	26	54	445	290	75	115	1200
2050	100	0	0	450	400	75	275	1300

- In this case, nuclear energy must increase by at least 50%. Centralized (electric) renewables increase tenfold remembering that there will be still more renewables in homes, etc. which will reduce overall energy demand. LNG is kept at "comfortable" level in term of energy security. Overall, carbon in the electricity level is reduced from 2007 because of phasing out of coal and oil and increase in non-carbon sources (e.g. nuclear/renewables). In this case, overall primary energy may not increase.

- Overall import dependence does not increase (because the increase of the use of LNG is offset by electrification of vehicles). Economic growth per capita increases significantly (by a least a third) and Japan as a whole remains competitive internationally through the export of high end appliances and cars. Eventually, these technologies will be built "offshore," adding more value to the Japanese economy at less expenditure of energy. But to achieve these results, nuclear energy must at least double from today's level during the next 50 years.

What are the implications of less nuclear energy? This issue will be debated and it is important to reflect on the following chart which shows fuel share among major sources for overall primary energy in Japan:

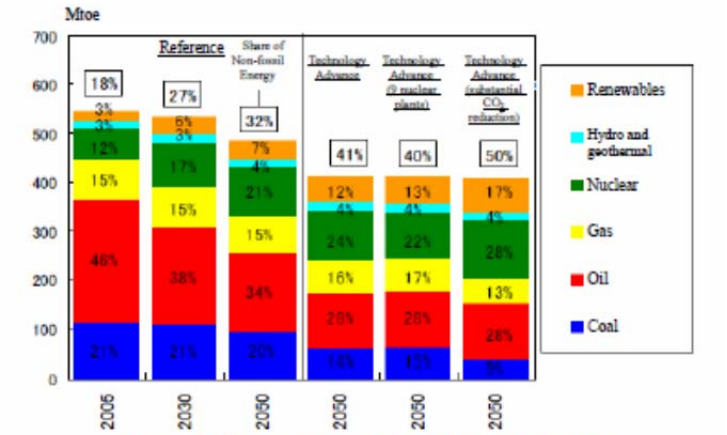

Figure 4-3 Primary Energy Supply by Each Scenario

- Overall electricity growth will need to grow to achieve greater savings in other sectors, especially transportation. Aggressive savings can occur with added conservation and technology advancements in renewable energy as seen in the "Technology advance case." But in this case nuclear power must also increase (not decrease).

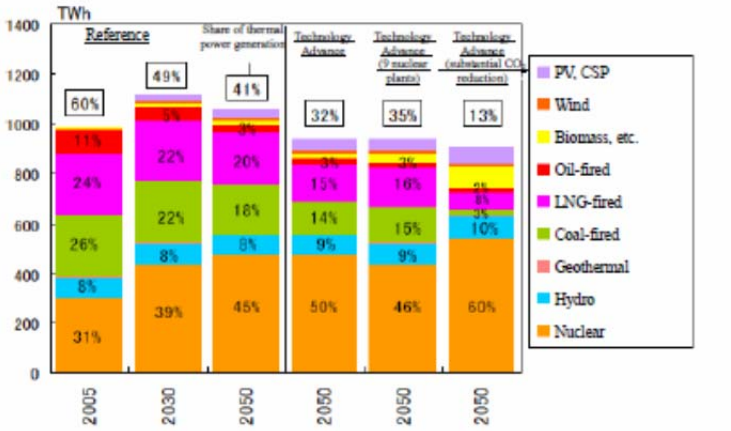

Figure 4-7 Power Generation Mix by Each Scenario

- In this forecast (prepared pre-Fukushima), nuclear power was required to increase to as much as 60% of electricity in order for Japan to meet aggressive carbon reduction plans. Consider if nuclear power were greatly reduced in these scenarios, what fuel source would make up the difference? It is clear that LNG can play a more important role, but this will require further reliance on uncertain international markets, requiring continued "diversification" of sources. Over the longer term, Alaskan North Slope might provide another key part of diversification. But even in the increase LNG scenario.

- Renewables are foreseen to play an important role, but as seen from the chart they begin with a very low base. Aggressive policies to deploy renewables will be necessary to make a significant contribution. A recent Department of Energy study concluded that it is cheaper to have centralized electricity sources, rather than decentralized sources for the production of nuclear power. While renewables and other distributive electricity systems can make a contribution large base load demand is required and that will be primarily met by LNG, coal and nuclear power.

- Middle Eastern and Russian LNG pose potential energy security risks and are very inefficient from the standpoint of the conversion losses. Furthermore, natural gas producers must increasingly use their own gas for domestic purposes.

- Nuclear is the key to successful electricity growth in terms of energy security and environmental quality, with a 50% increase of nuclear energy needed at a minimum. Japan's future strategy will actually result in an increase of foreign sources of LNG, as well as some oil for transport as nuclear energy, coupled with reprocessing of the nuclear

fuel, remains a key element of energy security/diversification, as well as contributing to environmental quality.

- Bottom line: Japan can build aggressive renewables future but a mix of fuel is required and a balance between LNG, renewables, nuclear and mottainai.

IV. Program for US-Japan Cooperation

Over the past forty years, the United States and Japan have experienced significant cooperation, including the Reagan-Nakasone Energy Accord, the US-Japan Nuclear Cooperation Agreement as well as many generations of Santa Fe Seminars.

During each of these milestones, our two nations have had the opportunity to share expertise, expenses in R&D and to formulate a coordinated energy policy with each country's policies supportive of energy security and environmental concerns. Together, the US and Japan provide strong support for international energy security considering the fact that they represent forty percent of the world's economy.

In the future, we need to consider the global energy dynamic and the expansion of Asian demand while at the same time, looking at appropriate policies that keep the United States and Japan competitive in the global environment.

Some areas that should be explored include expanding cooperation in the scientific understanding of radiation, especially as it applies to the return of productive life near the Fukushima site. At the moment there are over 800 square miles impacted by the radiation of the accident. Department of Energy officials and its globally respected network of national laboratories should be assisting Japanese officials in determining parameters of clean up – including the important issues of "how clean is clean" and " how safe is safe." Understandably, the Japanese public wants a 100% assurance—at the same time, life must go on, people want to return to their homes, industry wants to restart and schools want to reopen. US Government experience, especially DOE, can assist in this task with scientific evidence and experience.

The Japanese should consider now the possibility of making the Fukushima nuclear power station an international site for understanding the complexities of the decommissioning of nuclear power plants. The dawn of nuclear power for electricity was in the 1960s and many nuclear power plants are reaching maturity. In some cases, the plants will be extended to as much as a 60 year life or even more, but in a practical sense, some nuclear plants will be decommissioned as will be the case of the Fukushima Daiichi plants. Coupled with the work on decommissioning can be an international program of safety, especially in the training of operators associated with newly developed nuclear programs in Asia and elsewhere.

A third priority might be the establishment in Japan of a "PKO" – a peacekeeping-type operation to be activated in times of nuclear emergency. For decades the United States has had a program to assist nuclear emergency situations, including security threats to US nuclear facilities and American cities. This program – run by the National Nuclear Security Administration (NNSA) also has an emergency international component which was evident during the Fukushima crisis.

Associated with this is the coordination between nuclear power plants and nearby military installations. Valuable lessons from this working relationship begun after 9/11 were applied to the crisis of 3/11.

A fourth priority is the use the experience of Fukushima in the establishment of a "safety first" culture in new nuclear energy programs internationally. The experience of Fukushima stimulates interest in reviewing post-Chernobyl protocols agreed by the IAEA – these protocols (including: Post-Accident Analysis and Review; Plant Safety Reviews and Technical Exchanges; Event Analysis and Safety Assessment; Emergency Notification and Assistance; Supporting Health and Environmental Networks; Liability for Nuclear Damage; Event Reporting; and Safety Codes and Principles.) should be reevaluated and strengthened in light of Fukushima. We need a more pronounced safety and security program in the IAEA and protocols that give the Agency some teeth in implementing and reviewing safety programs of member states. It is widely viewed that the IAEA is the nuclear watchdog – but this is primarily focused on safeguards; the issue of safety and security has been primarily a responsibility of member states – this should change after TMI, Chernobyl and Fukushima. A nuclear accident anywhere in the world is a nuclear accident for every nation.

A fifth area of opportunity lies in collaborative nuclear energy research and development. Budgets in both the US and Japan are constrained, but we are interdependent on each other for research reactors – for example, the Idaho National Laboratory and Hanford National Laboratory can provide insight to future reactor design and fuel cycle technology. The Japanese nuclear research program can provide facilities and insight to US scientists in the areas of fast reactors and Monju facility. Also, the recent construction of the Rokkasho reprocessing plant can give American scientists insight to the issues of reprocessing, MOX fuel utilization and vitrified waste disposal. The US does not currently endorse reprocessing but as controversy over spent fuel disposal increases, it is clear that minimization of waste via reprocessing is one option the US should seriously consider and learn from the Japanese example.

Finally, we should recommit each nation to energy security, reasonable energy prices and environmental quality, so necessary for each nation's economic, energy and environment future. Emphasis on the 3 s' – security, safety and safeguards should also be reinforced. Opportunities abound for technology development outside of nuclear energy: renewable energy resources, solar, geothermal and alternative fuel for vehicles (hybrid and electric). Development of clean coal technology remains a priority for each country. And we need to look at export possibilities of the US fossil fuels to Japan, including in the short-term LNG from the Gulf of Mexico and in the long-term from Alaskan North Slope.