Energy-Efficient Technologies and Renewables in Relation to Japan's Energy Security

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ABSTRACT

This brief document discusses three types of energy security problems in relation to energy-efficient technologies and renewable energy sources in Japan: increase in oil prices, oil depletion, and global warming. Energy-efficient technologies and renewable energy sources are shown to enhance Japan's energy security.

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1. Energy Security Problems

The 1973 oil embargo exemplifies what are often called energy security problems. Others examples include the revolution in Iran in 1979 and the Gulf War of 1990-1991. Energy security problems threaten the secure supply of energy of a country. In Japan much debate on energy security has focused on a secure supply of oil from the Middle East. The 1973 oil embargo demonstrated not only that the cost of oil could suddenly jump, but also that sometime in the future Japan and other countries would be faced with the dilemma of depletion of oil supplies. Addressing these twin threats resulted advanced countries diversifying their oil supply sources and developing efficient energy technologies and renewable energy sources. From the late 1970s through the 1980s, energy-efficient technologies were developed and widely introduced due to their economic benefits. As a result, the energy/GDP ratio decreased significantly in OECD countries. In addition, renewable energy such as wind power and photovoltaics (PVs) were developed.

2. Newly Emerging Energy Security Problems

In the late 1980s new types of energy security issues emerged, including energy-environmental security problems. One of these issues was the threat of global warming. Global warming completely changed the energy debate. It linked greenhouse gas emissions to energy use. The 2nd report of IPCC (Inter-Governmental Panel on Climate Change), published toward the end of 1995, suggested that human activity has caused a rise in atmosphere temperature in recent years. Simulation results suggested that our planet will experience a two centigrade degree increase in atmosphere temperature and a 0.5 meter rise in sea level at the end of 21st century. Mitigating global warming depends in part on controlling greenhouse gas (GHG) emissions from fossil fuels. The carbon content per calorie heat value is large in coal, medium in oil, and less in natural gas. It is even less (or zero) for renewable energy sources.

To control GHGs, discussions on carbon taxes, emission trading, and joint implementation between advanced and developing countries has been initiated. These discussions were central at the Kyoto COP3 (third Conference of Parties to the Global Climate Change Convention) in December 1997.

One response to global warming is a “No Regret Energy Strategy.” This strategy assumes widespread use of economically efficient technologies such as insulation, compact fluorescent light bulbs, and solar hot water units. It emphasizes that invested money will be paid back whether or not global warming occurs. This strategy is widely accepted, but its actualization is somewhat different than expected. In Japan, although installation of energy-efficient technologies with a pay back period of three years are widespread, use of technologies with a longer pay back period have not been introduced. This is in large part due to Japan’s extremely low energy prices in the 1980s and 1990s.

Also investment strategies have favored supply side technologies over demand side technologies. For instance, an electric utility can receive investment money with low interest rates for a long

period (say, fifteen years) for the construction of power plants, but consumers can not get loans to buy efficient refrigerators with a short pay back time of less than, say, five years. This investment imbalance works against the promotion of efficient energy technology.

3. The Role of Efficiency Improvement of Energy Technology in Japan

Energy-efficient technologies are usually adopted in Japan and elsewhere because they not only save energy but also money. One example in Japan is insulation in homes. Design criteria determines how much insulation is adequate for a home. If the insulation is too thin, then the annual heating demand becomes large, and visa versa. Usually, the standard design falls where the marginal economic cost of the annual insulation investment equals the marginal cost of annual heating fuels. The calculation, though, depends on fuel price and interest rate because the insulation investment requires some years to be paid back. Before 1973, energy-efficient technologies, such as insulation, were not widely applied in Japan. Statistics show that only 5% of the housing stock was insulated in 1973. Today, however, 40% is insulated. Well insulated houses usually consume 20-30% less fuels than non-insulated houses.

Automobile technology provides another example of development and adoption of energy-efficient technologies in Japan. Two automobile technologies are discussed below.

1) Gasoline Direct Injection Car
Gasoline direct injection engines save 30% on fuel compare to conventional cars. Mitsubishi Motors has already commercialized this technology. Toyota announced their intention to enter this market, too. The direct fuel injection valve is the key to gasoline direct injection technology. The price of gasoline direct injection car is nearly the same as that of a conventional car. This technology will also be applied to improve diesel engines. Since CO2 emissions from the transportation sector are nearly 20% of total CO2 emissions in Japan, it is estimated that the gasoline direct injection car will decrease total CO2 emission by nearly 5% at no additional cost.

2) Hybrid Car
Toyota introduced their hybrid car (a car with a combination of gasoline engine and an electric motor with a battery) to the public for the first time in July 1997. This car fuel efficiency is 28 kilometers per liter (65.7 miles per gallon). This is twice as efficient as conventional car (12-14 kilometers per liter or 28.2-32.8 miles per gallon). In addition, hybrid cars compensate for arbitrary acceleration and braking in driving. These actions consume most of the energy. Thus, microelectronics in hybrid cars help eliminate energy inefficient aspects of driving. The Toyota hybrid car is 130 kilograms (289 pounds) heavier than a conventional car. Toyota stated in 1997 that mass produced hybrid cars (nearly 1000 cars per year) would cost US$18,000, which is about US$4000 higher than conventional cars of the same class. About 70-80% of this additional cost would be paid back by the less fuel expenditure in 7-8 years. If produced at the scale of more than 100,000 cars a year, the price drop to that of normal cars.

In sum, efficient automobile technology can drastically decrease oil demand at a global scale in the beginning of the 21st century if cars such as the hybrid car and gasoline direct injection car are

introduced. However, if energy prices remain low, then energy security problems might be exacerbated in the future because of the lack of implementation of efficient technology.

4. The Role of Renewable Energy in Japan

Renewable energy sources are often carbon-free energy sources. Renewable energy sources include hydropower, wind power, biomass and PVs. The most popular renewable energy is hydro power which supplies nearly 5% of the electricity in the world. Wind power is already commercialized. Biomass is used in many places in the world, especially in developing countries. PVs are a promising renewable energy. Renewable energy can penetration the market by mechanisms such as "the Aahen model." The city Aahen, Germany launched a plan to introduce PVs and wind power using 1% of their annual electricity revenue. Thus, citizens will pay for the introduction of renewable energy. The plan is to subsidize people who buy PV systems on their roof or wind machines in order to generate electricity.

The Japanese government tried a similar system. It offered subsidies for PV systems in 1995. By 1996, 1550 PV systems were built into houses with half of the cost subsidized by the government. A PV system of nearly 3 kilowatts costs US$30,000 per house. It generates electricity for 1000 hours per year on average given the climatic conditions in Japan. The amount of electricity supplied is nearly 70-80% of the total electricity demand for a house. However, the economic pay back time is more than twenty years. This is just one example of how renewable energy is expected to play a major role by the mid 21st century in Japan.

5. Conclusion

This paper addressed aspects of energy security from the viewpoint of efficient energy technologies and renewables. The main points are summarized in Table 1 which indicates the relation between energy security, risk, and responses based on these technologies.

Table 1: Efficient Technologies, Renewables and Energy Security

Energy Security Problem	Anticipated Risk	Responses
Oil price UP	Economic Recession	Introduce Energy-Efficient Technologies
Oil Depletion	Collapse of Conventional Energy Supply System	Introduce Renewable Energy (long term)
Global Warming	Atmosphere Temperature Rise, Sea Level Rise	Introduce Energy-Efficient Technologies (short term) Introduce Renewable Energy (long term)