JAPAN
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ENERGY
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Recommendation for the "Basic Energy Plan"

Towards New Growth without Nuclear Power

December 2013

Japan Renewable Energy Foundation

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Towards New Growth without Nuclear Power

Japan's energy policy is at a watershed; the country must now decide which form of energy to adopt as its foundation of the society. Japan Renewable Energy Foundation is urging the government to take the following three points into consideration in preparing a new Basic Energy Plan.

Proceed to "zero nuclear power"

First, the Japanese government should acknowledge that there seems to be no end in sight to the problems associated with the Fukushima Daiichi disaster, which occurred more than two and a half years ago. The government, when carrying out a new energy policy, should ensure that such a horrible experience will never again be forced to the people in Japan or anywhere else in the world.

According to a number of public opinion surveys taken after the accident, majority of the Japanese people, regardless of their political stance or party affiliation, share the will to exit from nuclear power, although there are some differences of opinion as to how to achieve this goal and how fast it should occur. That is why the statement by Former Prime Minister Junichiro Koizumi calling for the "zero nuclear power" has received strong popular support.

The government should take public opinion into account in revising its Basic Energy Plan. Unfortunately, there is a huge chasm between what the people want and the proposals being discussed by the Strategic Policy Sub-Committee, the government's study panel. Panel members opposed to nuclear power have been replaced under the new ruling parties, contrary to the will of the majority of Japanese people. Therefore, the legitimacy of the panel's work should be called into question.

Confront the danger of climate change

Secondly, the Japanese government should confront the urgent danger of climate change, which is becoming more of a threat as the years go by. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change, parts of which began to be released in September 2013, clearly indicates the rapid progress of climate change. Abnormal weather conditions that have been observed in Japan and elsewhere in the world during the past several years are clear harbingers of the crisis ahead. Japan's energy policy must be aimed at reducing carbon dioxide emissions drastically.

Target new economic growth through the use of new energy sources

Thirdly, the energy problems that have been plaguing Japan since the Fukushima nuclear disaster could present a great opportunity for Japan's new economy. Japan experienced two oil crises about 40 years ago. However, the country managed to overcome the crises by implementing a series of energy saving and efficiency measures, and subsequently achieved vital growth. The deployment of renewables and distributed power systems has been on the rise in many parts of the world. Japan should seize this opportunity and take the lead in this emerging field, allow the country to transform itself into a society with sustainable energy, and at the same time create new businesses. The pursuit of new sources of energy is a great growth strategy which is suitable for Japan today.

Based on these three points, the Japan Renewable Energy Foundation has compiled five recommendations. We would like to further create new growth strategies to revive Japan in cooperation with various organizations, companies, and individuals with the aim of establishing a safe and sustainable energy system.

RECOMMENDATION

1 Japan should decide on “zero nuclear power,” avoid the accumulation of a "negative legacy", and accelerate investments in safer energy sources

- The final disposal site for high-level radioactive waste and spent nuclear fuel is still without solution. Japan should avoid accumulating a further “negative legacy” for future generations.
- The cost of building a state-of-the-art nuclear reactor in Europe is twice that in Japan. In Japan as well, the cost could reach at least 17 yen per kWh after the expenses of dealing with safety issues and insurances against accidents are added in. There is no "economic merit" with nuclear power plants.
- Japan must make the decision on “zero nuclear power” and put forth a clear policy to develop a safer alternative. Such a policy would spur investments in other power sources, such as renewables and CHPs. It would also encourage the replacement of inefficient and aging fossil fuel power plants.

Disposing radioactive waste is the fundamental problem of nuclear power

Spent nuclear fuels are stored at every nuclear power plant for a certain period of time, and then get transferred to the Rokkasho Nuclear Fuel Reprocessing Plant in Aomori Prefecture, northern Japan. The government's policy has been to reprocess all spent nuclear fuel, and this deferred the discussion on the necessity of final disposal sites. The completion of the reprocessing plant, which had been scheduled to happen in 1997, has been postponed 20 times, and is still undermined as of December 2013, although the spent nuclear fuel in Rokkasho’s storage pool is already filled to capacity.

Events during the past 100,000 years

100,000 years ago	Homo Sapiens migrate from Africa to Europe
80,000 years ago	Sea levels rise due to global warming
50,000 years ago	Cro-Magnon man appears
30,000 years ago	Neanderthals die out
29,000 years ago	The Japanese archipelago is separated from the continent
13,000 years ago	Volcanic eruption near Kagoshima creates a huge caldera

Even if the plant is completed and subsequent reprocessing goes well, the process produces separated plutonium, large amount of middle level radioactive waste and high level radioactive waste (vitrified high level waste), which is just as radioactive as spent nuclear fuel. The amount of radiation in spent nuclear fuel or vitrified high level waste takes 100,000 years to decline to the level found in natural uranium. These materials must be stored at a safe location throughout that time. However, no such location has been identified in Japan at the present time. It is the height of irresponsibility to continue to operate nuclear plants and increase the amount of radioactive waste when the existing waste is still waiting to be disposed of.

Nuclear power loses cost competitiveness as expenses surge due to new safety measures

The strongest reason cited for the promotion of nuclear power plants is their supposed cost competitiveness. The cost of power generation by a nuclear reactor was previously estimated less than 6 yen per kWh, but a recent analysis conducted by a government panel after the Fukushima nuclear disaster indicates that the actual cost could be 9 yen or more.

This more recent analysis is still underestimating the real cost of nuclear power, because it fails to include additional expenses that would be incurred if Japan were to build nuclear plants with the latest safety features now common in the U.S. and Europe. In fact, the cost of constructing such reactors would be at least twice the government estimate. The government has also underestimated the expense for dealing with potential plant accidents, for reprocessing, and for decommissioning of reactors. After all these additional expenses are taken into account, the cost of nuclear power generation would reach at least 17 yen per kWh. Nuclear reactors are not cost competitive at all.

Policy changes to encourage investments in renewables and highly-efficient gas-fired generation

Many companies are seeking to enter the power industry by building highly-efficient gas-fired power plants. However, investors are holding back because the government has not put forth a clear policy for abandoning nuclear power. A lack of policy articulation makes it extremely difficult for companies to create long-term business plans.

Many oil-fired and gas-fired power plants use inefficient, outdated systems. These plants have a combined production capacity of 50 GW. If these plants are converted to the latest combined-cycle systems, their generation efficiency will rise from 38% to 54%, reducing fuel costs by 30%. Tokyo Electric Power Company (TEPCO) alone has at least 10 GW of aging fossil fuel power plants at least 40 years old. The company's power plants are generally located in large premises that have enough space to accommodate the "build-and-scrap" method, which involves the construction of a new plant before the old facility is demolished. (In fact, TEPCO built 1.04 GW of emergency power plants within such premises immediately after the March 2011 earthquake. These facilities were fully constructed by the summer of that year.)

Japan needs to decide to pursue the direction of "zero nuclear power," and new market entrants should be allowed to build efficient power plants in various locations, including the premises owned by large power companies. This would lead to the development of a more competitive market, which would in turn spur further effective industry reform. It would be like "killing two birds with one stone".

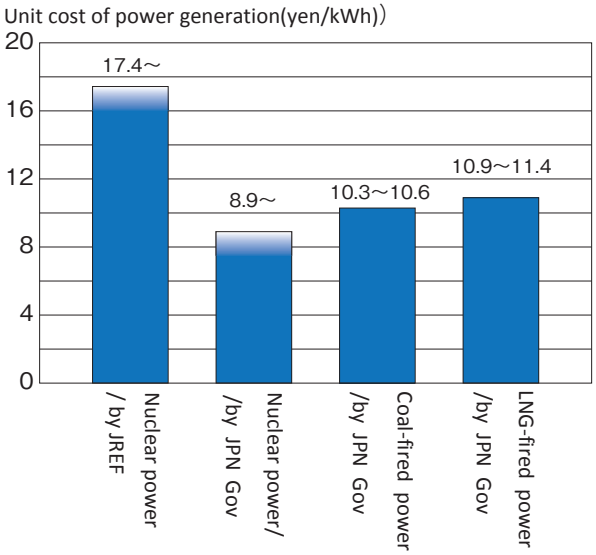


Fig. 1-1 Cost for different power plant

Fig.1-2 Emergency facility within the premises of TEPCO's Hitachinaka Coal-Fired Power plant

The government has been so preoccupied with restarting nuclear reactors that it has neglected to replace aging fossil fuel power plants. It is important that the government decides to move toward shutting down nuclear power plants, which will enable Japan to accelerate promotion of investments in renewables, highly-efficient gas-fired generation, combined heat and power plants (CHPs) and fuel cells, which can replace nuclear power easily.

Decide on "zero nuclear power" and save more than 1 trillion yen a year

As of December 2013, all nuclear power reactors in Japan are shut down. These nuclear plants cost a huge amount of money even when they are not in operation. Maintenance costs for Japan's 50 reactors total 760 billion yen a year (the figure for the fiscal year 2012), and the government spends 450 billion yen a year to promote nuclear power. Once Japan adopts a policy of "zero nuclear power" and starts to decommission those reactors, the country could save more than 1 trillion yen a year, including 180 billion yen for nuclear fuel costs.

The nuclear industry is being scaled back all over the world

In the U.S., five nuclear reactors were announced to cease operations in 2013 and plans for nine others were abolished. The cost of building new reactors is rising, and moreover, existing power plants are losing their cost competitiveness as a result of an increase in a number of highly efficient power sources such as wind and natural-gas. This trend is predicted to continue, and at least 10 more reactors are expected to be shut down in the coming years. Similarly, in Brazil, the country has seen a huge increase in competitive wind power, which coupled with its existing hydroelectric and natural-gas generations, can cover the electricity demand, and the country's plan to build four nuclear reactors by 2030 has been declared unnecessary.

RECOMMENDATION

2 Expanding renewables will lead to 19 trillion yen in investments -- both businesses and local economies will benefit

- The cost of renewables has been rapidly declining. In Germany, the cost of installing a solar PV system has fallen to one-third during the past six years. It is forecasted that the generation cost of a solar PV will decline to the level of conventional electricity prices in many countries by 2020.
- In Japan, the percentage of renewable electricity in overall power generation has risen and costs of renewables are becoming cheaper after the government introduced the Feed-in Tariff Scheme.
- Japan will be able to increase the electricity from renewables to at least 20% of its total consumption by FY2020 without putting an undue burden on corporations or on households.
- The total amount of the investments required to expand renewables at that level by FY2020 is 19 trillion yen. Such investments will benefit both domestic businesses and local economies.

Global rapid expansion of renewables and their declining costs

By the end of 2012, the global capacity of wind power increased by 16 times from 2000. During that time, the global capacity of solar power also rose by 73 times. Meanwhile, the cost of renewables has fallen. In Germany, the cost of installing a solar PV system declined to one-third of the previous level during the six years between 2006 and 2012. Citigroup Inc., a global financial institution, said in a report released in October 2013, that the price of a solar PV has now declined to a “grid-parity” level (a level comparable to conventional retail electricity prices) in most of Europe. According to the report, this level will also be reached in many other parts of the world in coming years. Deutsche Bank has released a similar report. These results suggest that sustainable increase of a solar PV installation without subsidies will probably become possible in a short while.

Deployment of renewables is on the rise in Japan while costs are falling

After the Great East Japan Earthquake, the deployment of renewables in Japan is accelerating. The share of renewables in the power companies’ overall generated and purchased electricity, excluding hydropower, rose to 1.6% during a two-year period after the earthquake, an increase of 0.5 percentage points. Prior to the quake, the same rate of increase took 10 years to achieve – from 0.6% in 2000 to 1.1% in 2010.

Penetration of renewables is further accelerated in 2013 after the government introduced the Feed-in Tariff Scheme (FiT), and the share reached 2.3% during the first half of the fiscal year. This will rise to 4.5%, if all the 23.61 GW of registered power facilities (as of the end of July 2013) begin operating at full capacity. In which case, the share increases to 13.4% including traditional hydro power, and it may be only a matter of time before it reaches 20%.

Renewables cost in Japan used to be high. For example, the cost of installing a solar PV in Japan was at least twice as expensive as in Germany. However, costs have been falling, as the deployment is accelerated. According to a survey conducted by the Japan Renewable Energy Foundation, the average cost of installing megawatt-scale solar in the first half of 2013 was 300,000 yen per kW, and the average cost of

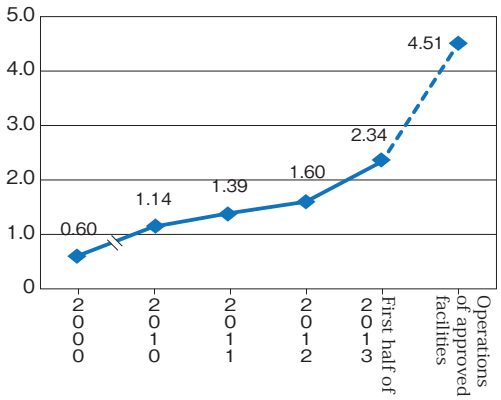


Fig. 2-1 Share of renewables in Japan’s overall generated and purchased electriciy

installation of solar power for overall non-residential was about 360,000 yen. These costs are half the level of 2006.

Costs could further decline in Japan as global module prices continue to fall. Japan can also reduce cost disparities with overseas markets by simplifying the procedures involved in the grid connection for renewable energy systems.

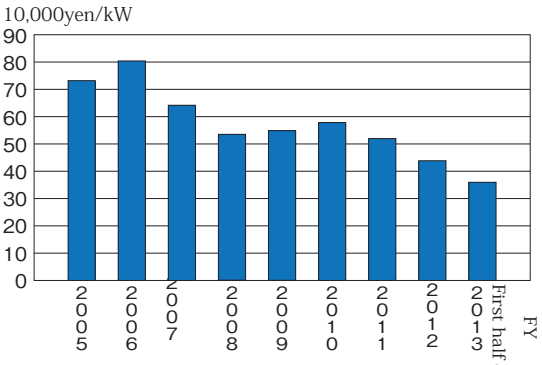


Fig. 2-2 Costs of installation of non-residential PV solar

Deployment of renewables without an undue burden on companies or on households

Some argue that the financial burden on individual companies and on households may increase along with the expansion of renewables, taking as an example of the rise of renewable electricity surcharge in Germany. According to an estimate by the Japan Renewable Energy Foundation, Japan should be able to raise renewables including hydropower by 20% by FY2020 in its overall power production, without putting undue burdens on companies or on households. This can be achieved through declining cost trend of renewables and a proper setting of "avoided costs" for power companies that are used for calculation of surcharges under FIT.

Renewable electricity surcharge for the fiscal year 2020 is estimated to be about 2 yen per kWh. That would translate into about 500 yen per household on a monthly basis, but this can be offset by 10% reduction in energy consumption. Manufacturers' production costs will increase by an average of only 0.25%. Therefore, together with various energy saving and efficiency measures, it is not at all difficult to expand renewable electricity without excessive financial burdens.

Expanding renewables creates new investment in Japan

Some argue that Japan may not benefit economically from an expansion of renewables, especially a solar PV, since the modules for mega-solar could be made in China and elsewhere. This is a misplaced concern. According to a study conducted by a PV research institute, 72% of the PV modules used in 2012 were made in Japan. At the same time, modules comprise only about 40% of the overall cost of a solar PV installation. Most other expenses, such as the cost of construction, are domestic spending. Moreover, the cost of the modules will continue to decline, and the ratio of module costs within the installation cost will decline accordingly.

It is estimated that an investment of some 19 trillion yen is required in order for Japan to generate 20% of its power from renewables by FY2020. Most of that money will be invested in Japan. In other words, renewables are a fledging growth sector for Japan's economy.

In Germany, which is a pioneer in this field, around half of the renewable energy facilities are owned by individuals or by groups of farmers. In Japan, too, individual companies and residents in many local communities are raising funds to construct renewable energy facilities. Renewables are regional resources and rightly belong to the local residents. Profits from such resources should be shared by the people in the community - this is where the strength of renewables lie. This will put local resources to good use and help to stimulate local economies.

Source: The People's Association for Renewable Energy Promotion

The biggest challenge is grid connection and integration

The biggest obstacle to an expansion of renewables in Japan is the difficulty of connecting to and integration with the power companies' grid systems. Power companies, that are still vertically integrated and own power grids, impose a limit on the capacity of grid system for renewables to be connected. In the U.S. and Europe, much research indicates that grid systems can handle 20-30% of renewable electricity capacity increase without causing any serious technical problems. Indeed, renewable electricity share is already up to that level in various countries, being supplied through the current grid systems. Japan should be able to do the same since the capacity of grid systems in the U.S. and Europe is not substantially different from that in Japan. Changing the management of grid systems is important, and if the change occurs, Japan will be able to significantly increase renewables connected to the grid.

RECOMMENDATION

3 Energy savings, efficiency, highly-efficient gas-fired generation and expanding renewables are the only ways to reduce present and future fuel costs
Restarting nuclear reactors does not solve the fuel cost problem

- Some argue that Japan should resume the operation of nuclear reactors to limit an increase in fuel costs.
- 40 years ago Japan had a more serious fuel problem, and solved the problem through various energy saving and efficiency measures.
- In 2012, Japan reduced its overall fuel costs by about 1 trillion yen through energy saving. We can further reduce energy use by 30% by FY2030
- The Costs will rise due to increasing fuel prices, if Japan continues to rely on fossil fuels. The promotion of energy saving, energy efficiency, and deployment of renewables are the fundamental means for controlling fuel costs.

Half of the increase in fuel costs stems from a rise in the price of fossil fuels

The strongest argument that has been put forward for the resumption of nuclear reactors is that too much money is draining out of the country for fuel due to an increased dependence on thermal power plants. This argument is now more commonly accepted than a previous assertion that nuclear power was necessary because of a shortage of enough electricity. The fuel costs of power utilities, which were 3.6 trillion yen in 2010, rose to 7 trillion yen in 2012, and it is often explained that most of the increase was due to the closure of nuclear reactors. However, this argument is wrong. This is because prices of fossil fuels are also rising. For example, the price of LNG has risen by 40% over the past two years. In fact, about half of the fuel cost increase stems from rising prices. The yen also became weaker during the fiscal year 2013, making imports more expensive.

How Japan overcame much more serious problems 40 years ago: the oil crisis

After the breakout of the Fourth Middle East War in October 1973, Japan faced a serious oil shortage. There was also another oil crisis in 1979. In the fiscal year 1980, the amount of money Japan spent on fuel imports reached 47% of the country's overall import spending. In contrast, when Japan increased fuel imports after the March 2011 earthquake, the ratio for 2012 was 34%. In the 1970s, Japan faced an economic crisis as a result of the surge in oil prices. However, the country implemented a variety of energy saving and efficiency measures and overcame the crisis, which was gore serious than what we are facing today.

To be sure, the increase in fuel prices that Japan is currently facing poses a challenge to small- and- medium-sized companies. However, what Japan needs now is not the resumption of nuclear reactors nor the adherence to nuclear policies. Japan must adopt a new policy to encourage energy saving and efficiency and the deployment of safer energy sources.

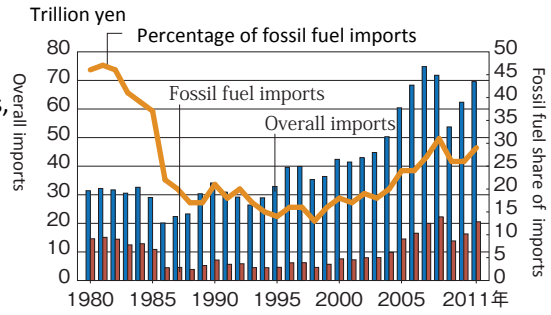


Fig. 3-1 Japan imports of fossil fuels snd share of fossil imports

Japan has reduced its fuel costs by about 1 trillion yen through reducing energy consumption and we can further reduce it by 30% by 2030

Following the earthquake, energy saving and efficiency have contributed to a significant reduction in fuel costs. The government had estimated that fuel costs would increase by 3.1 trillion yen in 2012 if fossil fuel power plants were used to make up for a decline in power generation as a result of the closure of all nuclear reactors. However, the actual electricity generation by fossil power in 2012 turned out to be 30% less than the government's estimate of 259.3 TWh, due to the reduction of energy consumption of both companies and individuals. As a result, fuel costs declined by 1 trillion yen.

The present Basic Energy Plan, which was adopted in 2010, does not take into account any reduction of power consumption by 2030. Some people in the industry argued that there was absolutely no room for Japanese companies to reduce their energy use, saying that an effort to further cut energy usage would be like wringing a dry towel. That argument, however, was proven to be wrong when Japan managed to reduce electricity consumption after the earthquake.

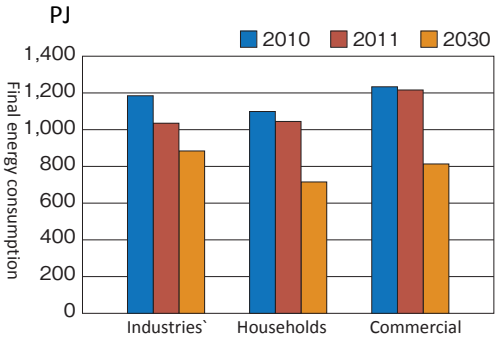


Fig. 3-2 Estimates on the effect of energy-saving measures

Industries such as factories, commercial, households and transportations all have even more room to cut their energy consumption. According to an estimate by Japan Renewable Energy Foundation, based on measures taken immediately after the earthquake, Japan is fully capable of reducing its power usage by 30% by FY2030 as compared with FY2010. This can be achieved by helping businesses that are lagging behind in their energy saving and efficiency efforts and by promoting the use of highly efficient lighting equipment and air conditioning systems. Japan can further slow down an increase in fuel costs by encouraging other energy saving and efficiency practices.

Energy saving and efficiency and an expansion of renewables are the most fundamental means of reducing fuel costs

The fundamental means of dealing with rising fuel costs include an expansion of renewables, in addition to the promotion of energy saving and efficiency. Renewables such as wind, solar, hydro and geothermal, are free energy resources (bioenergy being the only exception at current situation). Unlike fossil fuels such as oil, renewables are immune to price fluctuations linked with demand-supply situations, geopolitical developments or regional conflicts. While prices of fossil fuels are rising, the installation cost of renewable energy facilities continue to decline as more people begin to install them.

	FY2010 Actual	Maintains nuclear and * thermal	Promotes energy efficency and renewables	
			FY2020	FY2030
Nuclear	25.0%	25.0%	0.0%	0.0%
Coal	27.4%	27.4%	15.3%	8.9%
Natural gas	28.5%	28.5%	48.5%	42.2%
Fossil fuels	10.7%	10.7%	13.3%	7.7%
Renewables	8.4%	8.4%	22.9%	41.2%
Total power generation	11,569 100MkWh	11,569 100MkWh	9,270 100MkWh	8,100 100MkWh

*Figures are the same for FY2020 and FY2030

Fig. 3-1 Estimates of power source compositions

Fig. 3-3 shows the fuel-cost estimates for 2020 and for 2030 under two different scenarios. One scenario is based on the assumption that Japan will resume the operation of nuclear reactors and continue to depend heavily on fossil fuel generation. The other assumes that the country will chose “zero nuclear power” and deploy energy saving, energy efficiency and renewables. Under the first option, due to the increase of the fossil fuel prices, Japan’s fuel spending in 2020 would significantly exceed that of the fiscal year 2010, even if the country restarts nuclear reactors and raises nuclear generation to the level seen prior to the March 2011 earthquake. Under this assumption, the country’s fuel spending would not decline even in FY2030. According to the second option, which calls for the “zero nuclear power,” the deployment of energy saving, energy efficiency and renewables, Japan’s fuel spending in FY2020 would be the same as it would be if the country chose the first option. However, by 2030 fuel costs would fall below the level of 2010, when nuclear reactors were in full operation. The gap between the two scenarios becomes larger as the years go by, due to reduction of energy consumption and an increase of renewables.

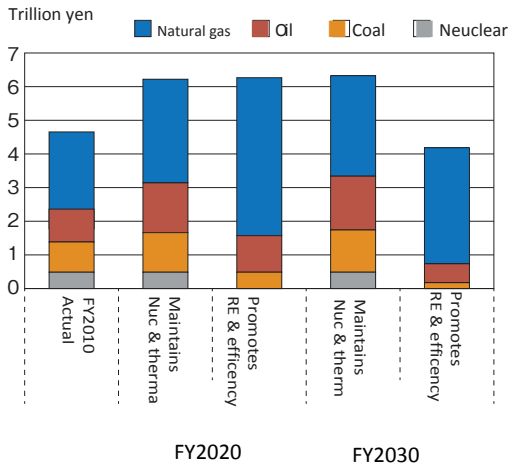


Fig. 3-3 Estimates of overall fuel costs

The resumption of operating nuclear reactors would not lead to a real solution for rising fuel costs. To address the issue from both supply and demand standpoints, Japan must proceed with its “energy turnaround.”

RECOMMENDATION

4 From “nuclear power + coal” to “renewables + natural gas,” resulting in increased self-sufficiency and reduced carbon-dioxide emissions

- Some argue that Japan should keep nuclear power as its primary source of electricity in order to avoid energy security risks, because the country heavily depends on fossil fuels from the Middle East. This argument is faulty, as the biggest energy risk that Japan needs to avoid is another nuclear accident.
- It is true that Japan depends heavily on the Middle East for oil, but only a little more than 10% of the oil that Japan imports is used for power generation. At the same time, the amount of oil-fired power generation, as a percentage of Japan’s overall thermal power generation, is now one-fifth the level of that in the 1970s. Therefore, one cannot cite Japan’s dependence on the Middle East as an argument to promote nuclear power.
- The deployment of renewables, which the country has in abundance, is the best way to increase Japan’s energy self-sufficiency for energy security. A reduction in CO2 emissions, which is essential to avoid risks of climate change, can be achieved without relying on nuclear power.

The energy risk that must be avoided at all costs is another nuclear accident

The government, in compiling a new Basic Energy Plan, is considering the promotion of nuclear power on the grounds that the power is needed to maintain secure energy supplies. New safety standards for nuclear reactors, which were implemented in July 2013, call for measures to guard against aircraft accidents and acts of terrorism. It has been pointed out that nuclear reactors are almost entirely powerless against attacks from above. Japan’s nuclear safety standards even fail to measure up to those of the U.S., Europe and China, which now require improved safety mechanisms such as core-catchers under the pressure vessel or passive safety-related system designs. The most important thing for Japan is to avoid another nuclear accident, and this should be the starting point for the entire debate.

Japan heavily depends on the Middle East for crude oil (petroleum), but the percentage of oil-fired generation in overall power generation, is one-fifth the level of that in the 1970s

Japan heavily relies on the Middle East for 83% of its crude oil imports. However, this oil is used for a variety of purposes such as automobile fuel, petrochemical materials, mining and industrial production. Only about 10% of Japan’s oil consumption goes toward power generation. At the same time, the share of oil-fired power in the country’s overall fossil fuel power fell to 12% in 2010 from 91% in 1973. This ratio rose to 18% in 2012 immediately after the earthquake, but this was still only one-fifth of the level reached in the past.

Japan’s dependence on the Middle East for natural gas, which is used increasingly for fossil fuel power, remains at 29%. This ratio could decline further due to an increase in imports of North American shale gas. Oil is the most expensive source of fossil fuel generation, its use as a power source cannot expand in the future from an economic standpoint. Therefore, Japan’s heavy reliance on the Middle East for oil cannot be cited for the promotion of nuclear power.

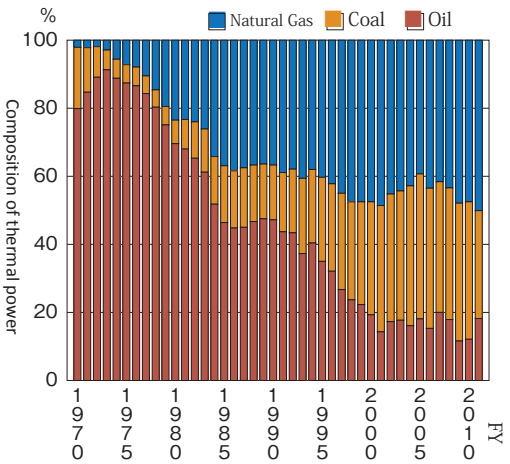


Fig. 4-1 The composition of fossil fuel power generation sources

The best way to raise energy self-sufficiency is to promote energy saving, efficiency, and deployment of renewables

There is an argument that Japan must rely on nuclear power because the country lacks natural energy resources. However, nuclear power requires uranium, for which Japan is entirely dependent on imports. The government and the power industry have been calling for nuclear power as “semi-domestic” energy; by claiming that separated plutonium from reprocessed spent nuclear fuel can be used as fuel again. The problem with this is that Japan’s reprocessing policy has already collapsed in fact. At the same time, nuclear reactors, which provide a high volume of electricity, would lead to a massive loss of power when a failure occurs in their operations. This point was made clear not only at the time of the Fukushima accident but also when an earthquake occurred in the Chuetsu area of Niigata Prefecture in 2007 and the Kashiwazaki-Kariwa nuclear plant had to be closed. Japan has too much reliance on these huge reactors, which make the country’s power supply even more unstable, and as a result Japan has to drastically raise its imports of oil and natural gas whenever nuclear plants have to be stopped.

Energy saving, efficiency and renewables, made possible through Japan’s technological prowess, constitute “pure domestic energy” that could help the country raise its real energy self-sufficiency. Installation of a solar PV in Germany is now almost 10 times that of Japan, whereas the potential of solar energy resources in Japan is estimated 1.3 times that in Germany. Japan, with its long coastlines, is also blessed with more wind energy potential than Germany. Japan’s geothermal resources are the third largest in the world. Japan can raise energy self-sufficiency by strengthening energy saving and efficiency, expanding renewables, and diversifying sources of natural gas imports.

Japan can reduce carbon dioxide emissions without relying on nuclear power

The need to cope with global warming has also been cited as a reason for the continuing use of nuclear power. However, Japan’s dependence on nuclear power has failed to solve this issue in the past. As it has relied on nuclear power to reduce emissions, the country did not take adequate measures, and has postponed the implementation of a capped emission trading system and the introduction of environment taxes. Whenever a nuclear reactor has had to be shut down, Japan’s CO2 emissions have risen.

While the country was advocating a reduction in CO2 emissions by promoting nuclear power, the actual amount of emissions from nationwide fossil fuel power rose by about 30%, or 80 million tons, between the years of 1990 and 2010 (as seen in Fig. 4-1). This was mainly due to an increased use of coal, which has a high emission factor for carbon dioxide. Emissions from coal-fired plants rose by 140 million tons, far exceeding the amount of the decline at oil-fired plants. The Basic Energy Plan, which is currently being debated, calls for the use of “highly efficient” coal-fired power generation. However, the CO2 emission factor for these “highly efficient” coal-fired power plants is twice that emitted by the latest natural-gas power plants (Fig. 4-3).

According to an estimate by Japan Renewable Energy Foundation, the country has the capability to reduce the amount of CO2 emissions from power generation by 40% in FY2020 from the FY2012 level, without relying on nuclear power. This can be achieved by strengthening energy saving, efficiency, expanding renewables, and adopting efficient gas-fired plants (Fig. 4-2).

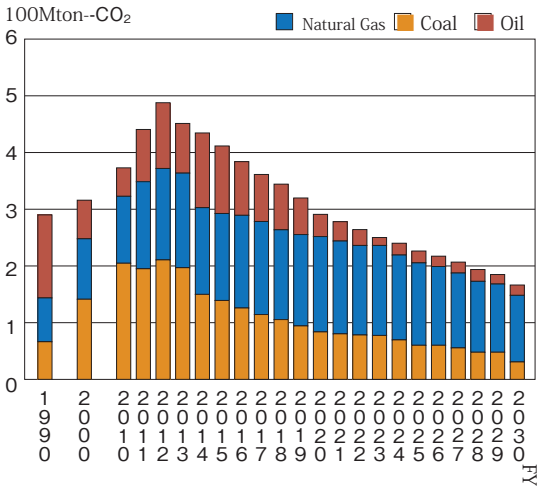


Fig. 4-2 CO^2 emissions from fossil fuel power plants

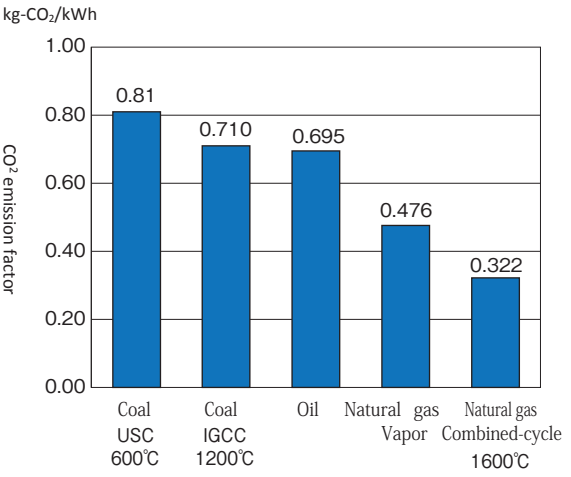


Fig. 4-3 CO^2 emission factor at fossil fuel power plants

RECOMMENDATION

5 A shift to distributed power systems will create a demand-side driven energy autonomous society

- Japan needs a shift to distributed power systems to overcome the weaknesses of centralized power systems that came to light after the Great East Japan Earthquake.
- Rapid technology developments of distributed power systems and IT will lead to the construction of efficient and resilient microgrids, and create new business opportunities in the energy market
- Deployment of fuel cells and solar power will produce a great number of "prosumers", – individuals who are both producers and consumers. This trend will change the landscape of the energy industry.

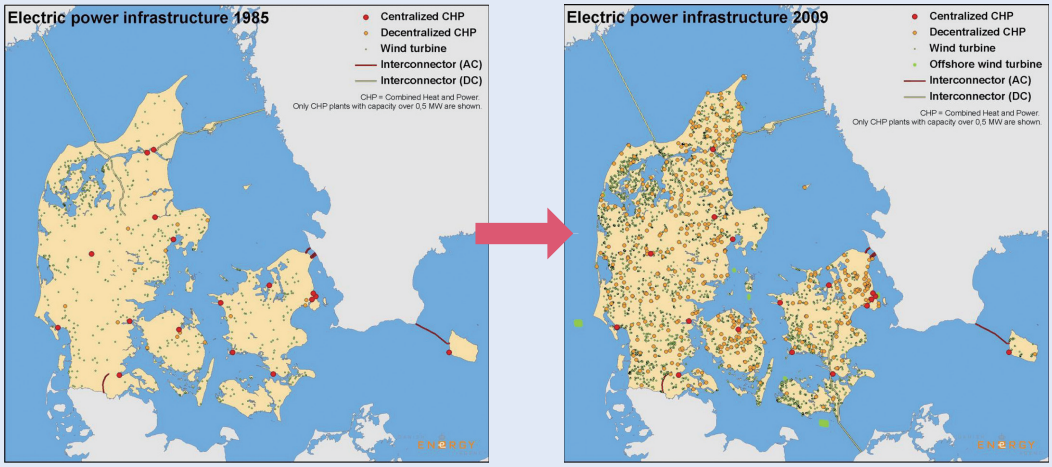
Changeover to resilient distributed energy systems that do not succumb to natural disasters

The Great East Japan Earthquake damaged not only nuclear reactors but also many fossil fuel power plants. Tokyo Electric instantly lost 21 GW of its generation capacity. In 2012, Hurricane Sandy swept through New York and knocked out power lines, further exposing the weakness of traditional power systems that transmit electricity from a large-scale plant to consumers in distant locations through long power lines.

Immediately after the March 2011 earthquake in Japan, the Roppongi Hills building, which is equipped with CHP plants, attracted public attention by producing electricity for its own use and sharing this electricity with Tokyo Electric . In the U.S., university campuses and research institutes with fuel cells and microgrids similarly generated their own power after Sandy had triggered massive blackouts.

It has been pointed out that Japan has entered an active period for earthquakes. At the same time, increasing danger of climate change is expected to produce powerful typhoons and heavy rains that could cause great

The transition from central power plants to distributed power plants in Denmark from 1985 to 2009



Denmark, which relied heavily on a handful of large power plants in the past, drastically changed the way it supplied power from the 1980s to 2010s. The country promotes CHPs and wind power, and investment in such facilities surged throughout the country especially in the 1990s. Now, the country generates about 40% of its electricity from renewables and distributed power supply systems.

Source: The Danish Energy Agency

Source: The Danish Energy Agency

many parts of the world. In the U.S., there are also concerns that terror attacks on transmission lines could cause widespread loss of function. It is necessary to widely expand distributed power systems to reduce such risks and create a resilient power supply network in Japan.

Information technology will help to create highly efficient distributed energy systems

Widely distributed energy systems are important means of improving the efficiency of the power system. Such systems can produce electricity on site, and the loss of electricity through transmission can be minimized. At the same time, information technology enables more flexibility to energy system operators for responding to supply and demand managements, and improves the efficiency of power system.

An example of an energy system that incorporates information technology is what is known as a virtual power plant (VPP). The system, which has drawn a huge amount of attention recently, connects small facilities online and operates them as though they were a single power plant. These facilities include CHPs, a solar PV and micro-hydropower dispersed within a certain geographical location to help balancing supply and demand situations including demand-side management. In Munich, for example, the city owned utility and Siemens AG started a VPP project, connecting renewables such as wind, solar, biogas and various CHP facilities.

"Prosumers" will change the energy industry and the society

Distributed energy supply could also change the landscape of the energy industry. The widespread use of fuel cells and solar power is giving rise to a great number of so-called "prosumers" – individuals who are both consumers and producers at the same time. The popularity of such power generation systems surged in Japan after the Great East Japan Earthquake. Many homebuilders are now creating energy-efficient and energy-independent houses that are also equipped with a solar PV, fuel cells and storage batteries.

The installation of distributed generation is partly aimed at securing power when natural disasters disrupt normal power production. At the same time, an increasing number of people are now seeking to generate electricity themselves without relying on conventional power companies. For them, doing so is important because electricity forms the basis for civilized life and for various business activities. An increase in the number of prosumers, along with the progress of electricity system reforms, could change Japan's power industry, which has long been dominated by a handful of regional monopolies.

Consumers are realizing "they don't need the power industry at all" says David Crane, highlighting a transformation taking place in the U.S. energy industry

Consumers are now realizing that "they don't need the power industry at all," said David Crane, Chief Executive Officer, NRG Energy Inc., the biggest independent power producer in the United States. Crane's statement, made in March 2013, highlights the situation which is taking place within the U.S. power industry. NRG, which provides power to utilities, has a generation capacity of 47 GW, equivalent to the combined capacity of the Kansai Electric and the Chugoku Electric.

According to Crane, power utilities will probably become obsolete just as quickly as mobile phones outpaced the use of landline phones, because solar power systems and fuel cells now allow consumers to produce their own electricity. As a matter of fact, NRG has begun to provide electricity directly to consumers without going through the utilities. PwC's annual survey of executive officers of the power utilities in 2012, shows that more than 90% of CEOs of power companies in North America expects the distributed power systems to expand in the future, and this will drastically change the market that is currently dominated by large power companies. A fusion between distributed power systems and information technology is about to transform the energy industry.