論説 Commentary

National circumstances in energy shift and investment for the future

Koichi KITAZAWA
Adviser to President, Japan Science and Technology Agency

The degree of urgency differs among various countries on global warming and nuclear risk, risk of price increase due to depletion of fossil energy and uranium, and concerns over securing initial investments and installation sites necessary for accommodating renewable energy.

Difference by land area and resources

The United States and Russia are able to watch the situation without urgency over a time period of 20-30 years. They have vast and barren lands. Russia exports its abundant oil and natural gas resources, while the United States has turned into an energy exporter with the advent of shale gas drilling technology. However, after 20-30 years, both countries will have to change over to low-carbon energy sources furthermore, in consideration of global warming, but they also have suffered painful experiences with nuclear power: The nuclear meltdown at the Three Mile Island Nuclear Generating Station occurred in 1979, and the explosion of the operating reactor at Chernobyl Nuclear Power Plant in 1986, which were both caused by operational errors. The number of nuclear reactors increased rapidly worldwide to 440 by the 1970s, but after the two accidents, the number of reactors became completely saturated. The United States has not built a single new reactor in the last thirty years. It is looking towards seeing out the next several decades mainly by using the existing 140 or so nuclear reactors for the remainder of their lifespan and replacing coal with shale gas to reduce greenhouse gas emissions. In the meantime, the United States ranked top in the world in 2008, for adopting wind energy, revealing its underlying luxury of having plenty of land area to generate wind power whenever required.

In China, as the smog caused by coal combustion becomes more serious, nuclear power generation is being adopted. Although there are only a few reactors at present, should China decide to adopt nuclear energy as its main power source, it would require a thousand reactors, against Japan's 54. At the same time, China ranked top in 2009 in terms of total domestic capital investment in renewable energy. Currently, China's investment has reached an annual figure of 5 trillion yen, exceeding that of Japan even on a per capita basis. The country has started investment in renewable energy on a level several times that for nuclear power. China has vast expanses of land suitable for generating wind and solar power. India's investment in renewable energy also exceeded 1 trillion yen for 2011. Japan's investment is one decimal place smaller compared with these countries.

The world's renewable energy industry started rapid growth in the beginning of the twenty-first century, increased tenfold in the five years following 2004, and its total investment reached 20 trillion yen in 2010. The scale of this investment is several times greater than that for nuclear energy. When we consider the potential, it seems self-evident which technology will be of most value to us as an investment for the future.

In Europe, Switzerland, Austria, Germany and Italy decided on denuclearization immediately after the Fukushima nuclear accident. The goal was set to substantially shift to renewable energy over the next 30-40 years to reduce greenhouse gas emissions. When I visited the atomic energy research institute in Switzerland last September, I clearly remember having been told, "It would have been worse for Switzerland. If an accident like Fukushima ever occurred in our country, it would mean the end of the country. It is hard to think of Switzerland without visiting tourists." It seems that country size and tourism will become important factors in determining the energy policy of various countries. All of these countries are smaller than Japan in land area.

Following the Fukushima accident, German Chancellor Angela Merkel set up the Ethics Commission, involving not only scientific and industrial circles but also humanities and religious circles, to consult on the future path for nuclear energy in Germany. The Ethics Commission argued that it was unethical for the present generation to enjoy economic affluence and pass on a negative legacy to the children of future generations based on economic efficiency, and urged the government to make basic changes in its energy policy, including industrial transformation, stating that "there would be no future for the country if Germany could not denuclearize and accomplish a change in energy." Germany has already started an annual per-capita investment of about 50,000 yen in renewable energy. The country will increase its fossil power generation for the time being in order not to become a net power importer and create a moral hazard, but plans to accelerate its shift to renewable energy within 30-40 years.

France, which produces almost 80% of its electricity from nuclear energy, declared that there would be no changes in its energy policy after the Fukushima accident. France is about 50 percent larger than Japan in land area. Its nuclear power is run by companies substantially owned by the government. Meanwhile, President Nicolas Sarkozy already declared in 2007 that "the nation would increase its budget for renewable energy to match that of nuclear energy," and attempted "reconciliation between the nuclear energy and renewable energy camps." France has set a target of 23% share of renewable energy on the final consumption of energy in its renewable energy policy up to 2020, exceeding the EU's target of 20%. Britain's nuclear power has been privatized and its management is mainly in the hands of foreign companies. As a result, Britain has lost its nuclear skills base. However, it was planning to renew its aging nuclear reactors when the Fukushima accident occurred. Immediately after the accident, Britain, France and Germany have all announced large-scale offshore wind power installation plans.

Grid parity and future trends of investment

Denmark, Spain and Germany already use renewable energy to cover more than 20% of total power supply, and their large-scale adoption of renewable energy has led to lower international prices of equipment. In 2011, the so-called grid parity (possible power generation at home and factories at a cost equal to the price of purchasing power from the grid) was attained for the first time in some areas of Japan as well. This is achieved, for example, when the price of solar panels installed on roofs of individual houses decreases and enables sales of panels with a cost performance of 19 yen/kWh, lower than the residential electricity price of 23 yen/kWh. Generation by wind power has already reached as low as 12-20 yen. The Ministry of Economy, Trade and Industry will make efforts in technology development to maintain the cost of offshore wind power at around 20 yen. When grid parity is accomplished, investment from the private sector will have a snowball effect on the energy shift.

In order to fulfill former Prime Minister Yukio Hatoyama's pledge at the United Nations to achieve a 25% cut in greenhouse gas emissions by 2020, Japan will have to make an annual investment of about 5 trillion yen in renewable energy. Japanese imports of fossil energy are rising to 25 trillion yen a year. Until 2010, electricity sales accounting for 45% of Japan's total energy amounted to 15 trillion yen per year, of which nuclear energy constituted about 30%. On the other hand, almost 100 trillion yen is spent on leisure every year in Japan. In addition, Japan's net foreign assets of cumulative trade surpluses reached 270 trillion yen, the world's highest for the past twenty years. With these figures in mind, Japan should outline its plan for the future. Considering that renewable energy is produced domestically, the figure of 25 trillion yen to import fossil energy will serve as a big financial reserve.

As the shift to renewable energy takes place, the need for electricity storage will arise, but for the next ten years or so, it would not be necessary because over half of the electricity will be still generated by fossil energy. However, as further progress is made, the need for storage will increase. Fluctuations in electricity for any given short period of time may be accommodated by broad-area electricity sharing and thermal power. Electricity storage on a day-to-day basis may be provided by battery cells. However, for a longer period of storage, a large-scale electrolysis and generation industry will probably have to come into play. Recently, young Japanese researchers have successfully identified the crystal structures of photosynthetic protein, which has gained the attention of the world. There is considerable potential for artificial photosynthesis, light energy chemistry, and biomass chemistry that has helped accelerate the photosynthesis process of natural plants.

What should young Japanese people pursue in the future? What kind of technology should they study to contribute to the world? An energy shift is a far-sighted national policy. An early start in efforts towards the goal set for a hundred years into the future will be effective, despite hardships, in maintaining Japan's morale. The annual investment of 5 trillion yen necessary for renewable energy in the future would not be expensive if it was considered as an expense to support the challenges of the young people with high morale. The amount is only one quarter of that spent on pachinko. Because renewable energy is produced domestically, the shift to renewable energy will gradually make Japan self-reliant in its energy supply. Moreover, it will serve as a means for Japan to support developing countries in the twenty-first century.

The commentary shown here is written by a commentator invited by the Commentary Committee of the Society, and the author is basically responsible for the contents. The Society acknowledges that this is important and worth publishing. Opinions and comments of the readers are highly appreciated.
E-mail: ronsetsu@chemistry.or.jp

The *Kagaku to Kogyo* (Chemistry & Chemical Industry) Editorial is responsible for the English-translated article.