Chapter 18

Renewable Energy and Lifestyle Change - An Example of Yakushima Island's "Zero Emissions" Initiative -

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1. Introduction

Tohoku earthquake, which occurred on March 11, 2011, was a cause of great shock, not only to Japan but to the rest of the world as well. The quake has led to a paradigm shift in terms of the use of electricity power. We must now review our nuclear power policy and change our lifestyles by imposing limitations on the use of electrical power. In the past, we have thought of nuclear power as being low cost, which is important in terms of business activities. Subsequently, we have found nuclear power to be high risk, as evident in this accident. We have to find alternatives. Nuclear power is the most effective way of generating large amounts of electricity, and it is difficult to achieve these large volumes except other energy sources.

Yakushima Is., a World Natural Heritage Site located in Kagoshima Prefecture, Japan, is almost completely powered by hydroelectricity. Focusing on this unique island, Kagoshima Prefecture is promoting the "Zero Carbon Emission Island" initiative, which aims to create a developed area where carbon dioxide (CO_2) emission is effectively reduced.

This paper thus proposes alternatives to nuclear power as well as a new lifestyle, using Yakushima Is. as an example.

2. Use of renewable energy

Accidents such as those at the Fukushima nuclear power plant are not the only dangers posed by nuclear power. In this paper, we thus consider more secure, safer, and cleaner alternatives to nuclear power. We suggest renewable energies including, amongst others, solar power, solar thermal power, geothermal energy, water power, wind power, and biomass energy. Renewable energies are based on natural energy, so they do not emit the large amounts of CO_2 that thermal power generation does. Nuclear power remains a big problem in the treatment of waste after use. On the other hand, there is no such problem in the use of renewable energy. Renewable energies have been used worldwide, their use depending on the country's terrain. For example, wind power and solar power methods are being developed in Spain and the United States. In Japan, hydropower is the most popular, but wind power is not widely accessible because of the country's terrain and difficulty of setting up it. On the other hand, Japan is surrounded by the sea: it could therefore make use of offshore wind.

According to an investigation by the International Energy Agency (IEA), the amount of electricity generated by renewable energy in 2008 accounted for only 18 % of electricity generated in the world. Iida (2012) states that the diffusion of renewable energy power generation in Japan is approximately 10 %. This percentage has not changed in the last 10 years. However, there has been an increase of 18 % in renewable energy power generation in Germany over the same period, and an increase of 20 % in Spain. While Germany and Spain are already advanced in the use of renewable energy, Japan has the potential to develop in this area. In explaining the reasons for the delay in promoting renewable energy in Japan, Iida (2012) identifies four problems: (1) lack of a support system, (2) monopolization of the transmission line by a power company, (3) excess of the local government and the country regulations, and (4) absence of any agreement with the local community.

In terms of the first problem, feed-in tariffs for renewable energy were adopted late in Japan. In Spain and Germany, where it has already been adopted, solar cell manufacturers, such as Q-Cells, have increased their share. In the early part of this century, Japanese companies, such as Kyocera and

Sharp, owned the majority of the solar power share. These were reversed in Western companies because they effectively used the feed-in tariff. There is now momentum in Chinese companies such as Suntech Power and JA Solar, both offering low costs that will dominate the market.

For the second problem, the power industry tends to promote nuclear power rather than renewable energy because each power company has a monopoly on the wall next to the power transmission network.

The third problem reflects the adverse effects of the Japanese legacy system. Companies trying to take advantage of renewable energy are hampered by numerous regulations. For example, geothermal energy has been placed under the control of the National Park, meaning that no other party is able to actively use this energy. To avail of this source, one has to submit numerous applications to more than one municipality, prefecture, city, government, and so forth.

The fourth problem is related to water rights, which is a major concern in the region. In setting up hydropower, one must get water rights permission from those downstream. This is a difficult task. To make this easier, it will be necessary to create awareness of renewable energy. The biggest advantages of renewable energy are that it is eco-friendly and clean. It is, however, difficult to understand. The biggest concern in terms of water rights is that these rights might be infringed upon.

Renewable energy, however, fails to solve many problems in Japan. The biggest issue in terms of this energy is the lack of understanding. The merit of using renewable energy is that it is a clean energy and that we are able to reuse many times. By acknowledging the benefits, we can view renewable energy as a semi-permanent energy source.

3. Lifestyle change brought about by dependency on large-scale power generation

Carr (2008) states that in the late 19th century, each household self-generated enough power to correspond to the demand. Nowadays, consumers rely on large-scale power generation facilities. As per the economies of scale, when the electricity price is reduced, we see the development of many appliances. An electricity-dependent lifestyle has evolved to maximize the benefits of low cost power. This means that you can use the required amount of power to enrich your life without worrying about a lack of power. As long as economic development continues, the amount of power you need will be increasingly available. Thus, economies of scale in power will advance, promoting the construction of large power plants that can generate electricity efficiently, such as those generating nuclear power.

Currently, this flow is reversed: we need not depend on a power company rather, each household can produce the power required, even if it is only a small amount. Renewable energy enables the realization of this ideal.

4. The history of the electricity industry in Kagoshima

The electricity business in Kagoshima has been around for a long time. That is why Satsuma (a powerful feudal domain in Tokugawa, Japan) originally strove to introduce Western technology. Kyushu Electric Power Co., Inc.

Kagoshima Branch (1998) explains that during the era of Shimadzu Tadayoshi, the 29th feudal lord of Satsuma, there was a hydroelectric power station that used a 35 m high waterfall at the Iso Garden, which was at Shimadzu's villa. This is equivalent to the power of a 5 kW Edison Dynamo DC generator, which could illuminate 130 incandescent lamps. Also, Shimadzu Nariaki, the 28th feudal lord of Satsuma, lit stone garden lanterns by using the gas pipe to Iso Garden in 1857. These were Japan's first gas lamps. The world's electricity business was already a trend: Edison established an electric light company in 1878, and in 1851, the largest industrial waterwheel, "Baden's Water Mill," was developed in the United States. Built by Henry Baden, the waterwheel, a gigantic machine weighing 250 tons and measuring 60 feet high, made a half to two revolutions per minute at maximum speed, and produced five hundred horsepower.

Compared with global developments, Kagoshima seemed to be behind; however, it was at this time that the electric light was finally installed in Tokyo and Yokohama. These were said to be radical developments.

Table 1. Total Generating Power in Kagoshima (1,000kWH)

	Hydro	Thermal	Internal-combustion	Geothermal	Nuclear	Total
1951	225,605	11,656	465	0	0	237,726
1955	244,645	0	3,378	0	0	248,023
1960	239,431	0	3,225	0	0	242,656
1965	255,195	0	18,528	0	0	273,723
1970	275,322	0	34,833	0	0	310,155
1975	249,761	2,602,951	178,849	0	0	3,031,561
1980	282,525	2,607,611	313,945	0	0	3,204,081
1985	212,658	49,446	391,800	0	9,355,869	10,009,773
1990	255,563	2,027,809	493,712	0	14,207,341	16,984,425
1995	245,078	1,474,866	616,354	268,923	11,962,477	14,567,698
1996	232,608	949,276	636,927	494,113	11,429,183	13,742,107

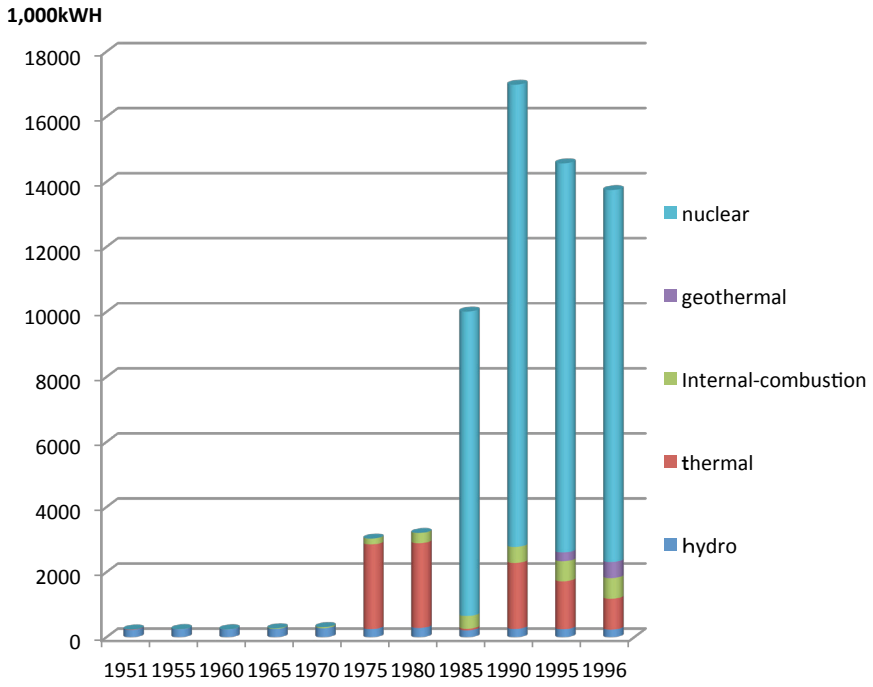

Fig. 1. Total generation power in Kagoshima.

Power in Kagoshima was mostly generated through hydropower because of the surrounding mountainous terrain. Since the initial construction costs of hydropower were high, it was difficult to accumulate the construction funds. The price of coal had been rising since 1897. Thus, the main player in the business began to change from thermal to hydroelectric power generation. Local transmission was then performed. By 1913, hydropower accounted for 63 % of all electricity generation.

Table 1 shows the amount of power generation in the Kagoshima Prefecture since the Showa period.

The graph in Fig. 1 is based on Table 1. Fig. 1 illustrates that there is no change in hydropower, although there is a large variation in thermal power, while nuclear power generation is at its highest since 1985 owing to the operation of the Sendai nuclear power station. The volume of nuclear power generation is also clearly reflected in the era, as the flow changes with the times. The stronger the Japanese economy is, the greater its power needs. From 1995, we see the beginnings of geothermal power, while solar power is spread dramatically.

Above all, in Kagoshima Prefecture, it is expected that renewable energy will penetrate widely, and this will thus be an alternative to nuclear power.

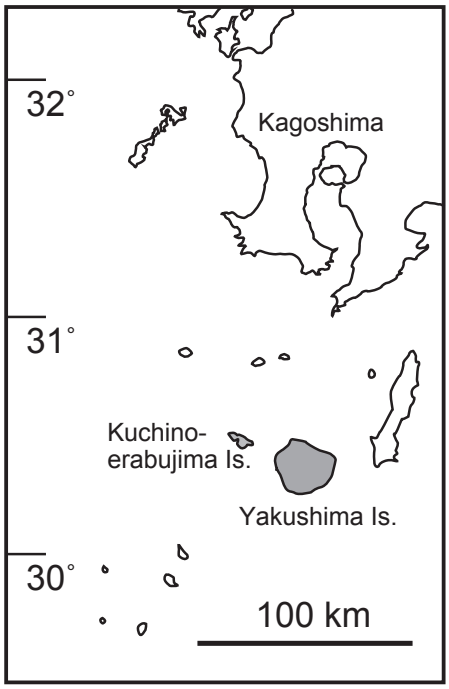

Fig. 2 Map of Kagoshima Prfecture showing Yakushima and Kuchinoerabujima Islands.

4.1. Hydropower in Yakushima Is.

Yakushima Is. is the fifth largest island in Japan with a perimeter of 132 km and an area of 503 m^2 (Fig. 2). In the book "Floating Clouds," Fumiko HAYASHI (1951) writes that "in Yakushima Is. it rains 35 days in one month." The area's high rainfall owes to its mountainous conditions. Yakushima Is. is blessed with a natural environment. Hydroelectric power uses the abundant water supply to generate much of Yakushima's power (Table 2).

According to "The History of the Power in Kagoshima," hydropower was planned early owing to the area's inconvenient outlying geographical location and its abundant rainfall. In 1916, Kagoshima electricity obtained the water rights to Anbo River and tried to build a fertilizer plant, although this was not successful. In 1924, the Yakushima Hydroelectricity Company was established. Two years later, the Takeno River Plant was completed and electricity was supplied to the Isso, Yoshida, and Nagata areas.

In 1949, hydroelectric power accounted for 385 kW of power in four areas, lighting 1,530 lamps. In 1953, Yakushima Denko Co. Ltd. completed the Senpiro Fall Plant, and in 1960, the Anbo River Plant was completed. In total, as shown in Table 2, there are four hydropower plants and one thermal plant in Yakushima Is. Miyanoura thermal power plant operates only when hydropower supply is insufficient. Rather than Kyushu Electric Power, Yakushima

Table 2. Each Generation Plant in Yakushima Island

Plant	Place	Generation Type	Enable Output (kW)	Annual Energy Production (MWH)	Company
Miyanoura	Miyanoura	Tehrmal	24,750	10,493	Yakushima Denko
Takeno River	Nagata	Hydro	160	883	Kyushu Electric Power Co
Anbou River I	Anbo	Hydro	23,200		
Anbou River II	Anbo	Hydro	34,000		
Senpiro Fall	Anbo	Hydro	1,300	305,242	Yakushima Denko
Kuchinoerabu Is.	Kuchinoerabu Is.	Tehrmal	400	625	Kyushu Electric Power Co

Denko is responsible for the power supply in Yakushima Is.

Yakushima's power demand has been met by hydroelectric power. Yakushima will thus serve as a model for Japan who aims to increase the percentage of renewable energy. We therefore have to think of how to effectively use the available capacity of hydroelectric power and also how to promote benefits that will overcome the disadvantages of the island.

5. Use of electric vehicles

It is possible that the hydropower generated from an abundant water supply in Yakushima Is. can provide most of the island's power. The disadvantage of the island is that gasoline costs about 20 % more than it does on the mainland. The use of electric vehicles by many people means a saving cost of about 50 %. If gasoline powered vehicles can be replaced by electric vehicles, the economic burden of the people in Yakushima Is. can be reduced and the ideal of zero emissions and a CO_2-free zone can be realized.

Many people in Yakushima Is. can complete their activities in less than 30 minutes. The range of these activities is within 20 km. One disadvantage of electric vehicles is the time it takes for a single charge. In essence, electric vehicles are economical and a reasonable alternative in Yakushima Is.

6. New lifestyle

With the spread of electric vehicles, a new lifestyle is proposed in Yakushima Is. An electric car brings not only zero emission but it is also CO_2-free, low cost, and convenient. However, in Yakushima Is., electric cars have not yet sufficiently diffused into society. The environment which electric vehicles spread is not enough in Yakushima Is. We have now discussed the environment surrounding electric vehicles. However, what elements are missing? And what should be improved? If these problems are eliminated, will electric vehicles be prevalent in Yakushima Is? Will we achieve zero emissions and be CO_2-free? We now summarize the problems to be solved, as well as the potential for electric vehicles. Problems include the following:

1. High selling price of electric vehicles compared to equivalent gasoline vehicles.
2. Lack of infrastructure on the island, namely the lack of charging facilities.
3. Lack of understanding about the electric car.
4. Impact on existing industries, and the creation of new industries.

In terms of the first point, not only national and local government subsidies are needed, but also the innovation to reduce the selling price of electric vehicles by automobile companies is necessary. It is important to be able to sell to consumers without indebting them.

With regard to the second point, not only subsidies for charging facilities and equipment are needed but also the development of a small, lightweight, replaceable battery, such as a 100 V household power supply unit. We could additionally expect increased cruising range with the improved battery technology.

Third, on Yakushima Is., 28.7 % of the population is above 65 years. For them, a car, and driving, is a necessity of life. Many elderly people drive often. For this reason, a simple way of charging batteries during operation to avoid anxiety will be necessary. Highlighting the benefits of electric vehicles alone is not enough to ensure any purchases. We also need to create awareness of electric vehicles among islanders. As described in this paper, the automotive operating environment in Yakushima Is. is limited. Therefore, the possibility of running out of battery charge is similar to a gasoline shortage when driving a vehicle with an internal combustion engine. As long as the battery is still functioning properly, we must ensure that an "out of battery" situation never occurs during the daytime use of the electric vehicle by charging the battery each night.

Fourth, the spread of electric vehicles may have a major impact on conventional industries and business. For example, gas stations would no longer be required owing. Conventional garages will have to be tailored to electric vehicles, as mechanic technology may be different for electrical systems.

Resuming operations at nuclear power plants is difficult, although it may be required owing to increased power rates and rolling blackouts. Therefore,

the potential of hydropower in Yakushima Is. will become coveted by many companies. The disadvantage of being a solitary island hampers the development of new industries, for example, young people have left for the city to find employment. With the abundant hydropower situation, we should actively try to attract new companies. When weighing up the disadvantage of being away from the city with the advantage of a stable power supply, there is potential for companies to advance in Yakushima Is. Hydroelectric power provided by the abundant water supply in Yakushima Is. is a renewable energy source that does not harm nature and that will bring about a new lifestyle.

7. Conclusion

With a focus on renewable energy, we have, in this paper, proposed the creation of a new lifestyle through taking advantage of electric vehicles. In Japan, most nuclear power plants are currently inactive, with reliance now mostly on alternative methods like thermal power. However, thermal power generation has environmental impacts, such as CO_2 emissions. As has become evident in the accident at Fukushima plant, nuclear power also poses a high risk for the environment. The only way to remove the environmental risk is by using renewable energy. Power generation from one facility is very small. In Japan, mountainous areas account for approximately 65 % of the landscape; therefore, since hydropower has been used since ancient times, huge potential exists for renewable energy.

Hydroelectric power does not result in water pollution, meaning that we can repeatedly use the water. Although there are problems, such as those with water rights, while rediscovering the feasibility of hydropower, I wondered if it presents an opportunity to review hydropower as an alternative to conventional power generation.

I used Yakushima Is. as an example owing to its specific situation, abundant annual rainfall, and use of hydroelectric power. It is possible to use hydroelectric power effectively for electric vehicles. Also, because it is registered as a World Natural Heritage Site, Yakushima Is. appeals to nature conservationists. Most of the island is covered by forest, and if we can achieve CO_2-free and zero emissions, we can enhance the value of its presence. If the alternative to gasoline-powered vehicles is electric vehicles that not emit CO_2, the natural environment can, as a result, be protected. The price of gasoline in Yakushima Is. is about 20 % higher than in mainland Japan. It would, therefore, be a great benefit to change from gasoline to electrical energy for powering vehicles. The use of renewable energy is a competitive advantage in other areas as well. In Yakushima Is., very small amounts of hydroelectric power have begun to be implemented. As there are many rivers and waterfalls, it is expected that there are many places from which to take advantage of hydroelectric power. Should we take advantage of these places, we will be able to interchange power units for residents. This will serve as a model of power generation and a supply system based on a recycling orientation that not only Japan but also the world should aim toward. We have thus far built power plants in a way that destroys nature, but by being aware of the use of more natural energy sources, we should think more along the lines of living alongside nature and create environment-friendly power generation facilities.

It is expected that renewable energy will be used in many places in the future as energy recycling systems become more efficiently constructed. Yakushima Is. can be considered a cutting-edge model for this change. We must ensure the creation of a form of energy generation that does not burden the future.

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