SITUATION OF WOOD BIOMASS PROJECTS IN JAPAN

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***ABSTRACT*:** Large-scale biomass projects have been conducted in many countries such as the United States and European countries, and their achievements are widely recognized as relevant to current environmental and energy production concerns. In Japan, however, biomass projects have not been fully developed though rich forest resources are available. In this study, problems which delay biomass development in Japan are revealed. Study results showed that the key factors that hinder the development of biomass projects in Japan are: dispersed small-scale pellet plants, uncompetitive pellet pricing, problematic forest management, unformed wood pellet markets, duplicate work among energy related agencies, and inadequate dissemination of accurate bio-energy information. Future work should focus on the application of biomass CHP systems in existing public facilities such as universities.

KEYWORDS: biomass, environment, renewable energy, wood pellet

1. Introduction

1.1 History of Environmental Issue in Japan

After the Meiji Restoration in 1886, Japan experienced rapid industrialization, and economic development was priority over environmental concerns. However, this situation changed in 1970 after four crucial pollution cases resulted from the drastic industrialization and economic growth of the 1960's [(23)]. In response to these cases, the Japanese government not only pursued the responsibility of the pollution to the polluting companies but also reconsidered its attitude towards environmental pollution [(18)]. Subsequently, the government enacted many environmental laws, and established the Department of Environment in 1971. Since then, environmental issues have been important in Japan.

Environmental policy in Japan, considered a natural resource poor country, has concentrated on energy conservation and resource preservation. After the world oil crisis in 1973 and 1979, the policies concerning energy conservation and resources preservation as well as pollution prevention technology were implemented by the Japanese government [(23)]. By 1990, Japan had become one of the most advanced countries in terms of environmental safeguards [(23)].

In the Third Session of the Conference of Parties to the United Nations Framework Convention on Climate Change: COP3, Japan ratified the reduction of greenhouse gas (GHG) emission. Also, in the Marrakesh agreement, concluded in the Seventh Session of the Conference of Parties to the United Nations Framework Convention on Climate Change: COP7, Japan pledged to reduce 6% of GHG emission by 2012. In addition, the Japanese government promised at the International Climate Change

Summit in New York, 2009 that Japan would deliver a 25% cut of CO2 emission by 2020.

However, the CO2 emissions increased in the early 2000's and there was no improvement until 2008[23]. With the decline of Japanese economy since 2008, in 2009 CO2 emission dropped to 1,209 million ton which is 4.1% lower from the target year 1990; 1,261.3 million [19] (Fig.1). However, it appeared that the emissions from the industrial sector were reduced by 19.5% due to the reduction of production resulting from economic depression. Therefore, it is expected that emission levels are not sustainable and will increase if the economic situation is improved.

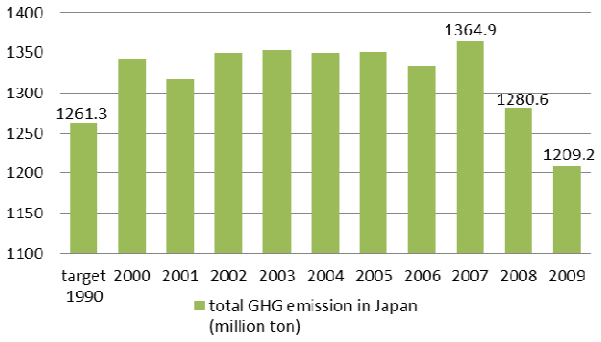

Fig.1 Total GHG Emission in Japan[6]

1.2 Energy Balance and Self-Sufficiency

Until 1960, Japanese energy sources were mainly hydroelectric power and coal. As a result of economic growth after 1960, oil consumption increased drastically for Japan's energy supply. In 1973 with the first oil crisis, oil accounted for 76% of total energy consumption. Afterwards, instead of establishing the renewable energy resources, the Japanese government increased coal production and introduced liquefied natural gas (LNG) and nuclear as subsidies to oil energy (Fig.2). As a result, Japanese energy supply resources in 2008 were oil, coal, LNG and nuclear for 42%, 23%, 19% and 10% respectively. However, renewable energy resources share was 6% which has been constant since 1980.

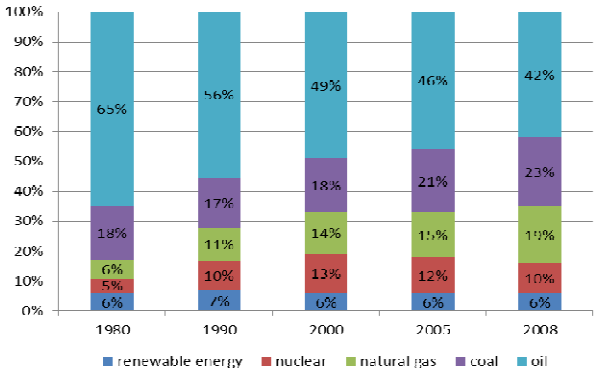

Fig.2 Transition of Prime Energy Resources in Japan [16]

In 2009, compared to other countries, Japan relied heavily on coal, oil, gas, and nuclear for primary energy consumption, as shown in Fig.3,

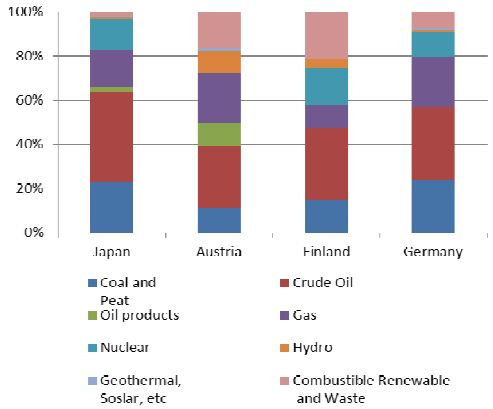

Fig. 3 Prime Energy Balance in 2009[5]

Fig.3 also shows that combustible renewable and waste consumption is lower than other countries. In Energy Basic Policy, approved by the cabinet council in July 2010, it was stated that the Japanese government aimed to raise the share of renewable energy from 6% to 10% by 2020 [17]. This indicated Japan's position is behind many countries in renewable energy policy.

Moreover, Japan imports 96% (excluding nuclear) of its energy which is relatively large percentage compared to other countries (Fig.4).

Therefore, it is urgent that Japan restructure its total energy strategy and distribute its risk by shifting to self-sufficient renewable energy and enabling sustainable CO2 emission reduction.

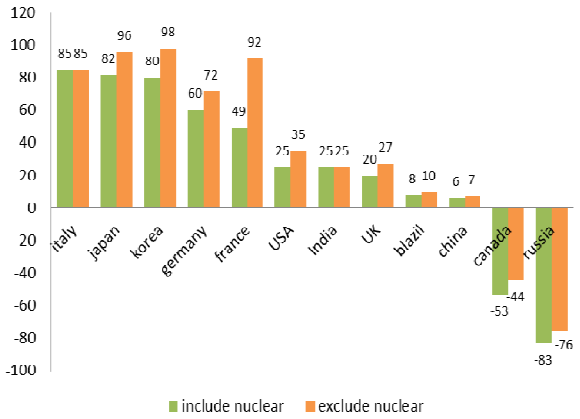

Fig.4 Energy self-sufficiency in major countries [4]

1.3 Wood Pellets in Japan

Wood pellet production in Japan started in 1982. The number of wood pellet plants grew rapidly, and by 1984, there were 26 pellet factories with a total production capacity of 28,000 ton/year [7]. After that, due to the oil price drop, immature pellet burner technology and poor wood pellet quality, pellet production declined [7]. As a result, the number of plants dropped to two with total capacity of 1,500 ton/year [8]. However, recent rising concerns about global warming and climate change have made wood pellets attractive as potential bio energy. Consequently by 2009, pellets plants increased to 75[10] with total production capacity of about 101,000 ton/year. By October 2010, 73 wood pellet plants were reported, of which 60% produced less than 2,000 ton/year (Fig.5).

Although there are many wood pellet factories in Japan, it is hard to say that they are successful.

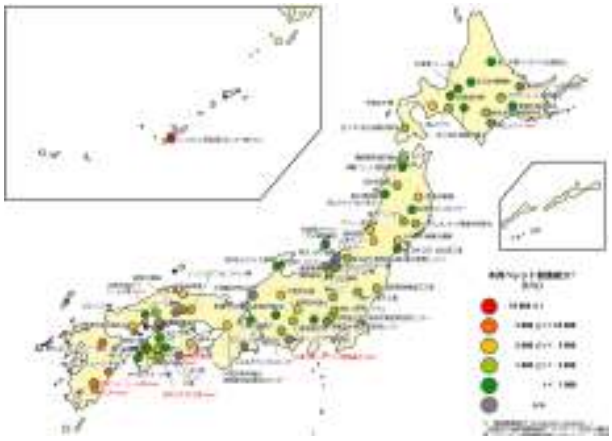

Fig.5 Production capacity of Wood pellet plants in Japan 2010[22]

The Ministry of Internal Affairs and Communications reported in Evaluation of Biomass Utilization policy <evaluation result and recommendation> issued in February 2011 that more than 137.4 billion yen was invested to 214 biomass projects. However, only 35 projects were reported as effective, whereas others were reported as ineffective and inefficient due to duplication among several ministries and departments of similar projects. In addition, only 3 facilities accounted for the CO2 amount through total process of their production activities [20].

Therefore, this paper clarifies and analyzes the problems of wood pellet plants management in Japan, and suggests solutions.

2. Methodology

In this paper, the current situation and problems of wood pellets plants in Japan were clarified through literature review.

The situation of Japanese pellet production capacity was identified by comparing it with that of other countries. For this comparison, the World Pellet Map 2007, 2009, and 2011 issued by Bioenergy International were used to define the numbers and plant production capacity and their tendency to increase capacity. These tendencies

were compared to Japan to clarify the differences, and the causes of differences were analyzed.

The list of following countries in specific year was excluded from this statistics analysis due to lack of production capacity data.

2007 : Slovakia, Moldova, China, Indonesia, India, South Korea, the United States
2009 : Bulgaria, Moldova, India
2011 : India

Regarding to the production amount and number of plants in Japan for 2007 and 2009, the data were employed form the White Paper on Forestry 2010 issued by The Ministry of Agriculture, Forestry and Fisheries of Japan [15]. For information of 2011 in Japan, the data was extracted from the retest number of Japanese Plants in 2010, reported from JST research development program in October 2010.

However, the production capacity data were not found in these above mentioned documents. Based on surveys and interviews conducted by Kochi University of Technology, it was found that actual production is approximately half of capacity. Therefore, in this study, production capacities were calculated as double of actual production amount.

3. Study Result

3.1 Comparison with Europe

In Europe, the European Committee takes a leadership role in promoting renewable energy. Since 1990, renewable energy has been promoted as a strategy combatting global warming and ensuring energy security [16]. In 2004, 46% of energy supplies were imported from outside the European Union. However, reduction of fossil fuels due to the reduction of crude oil production was anticipated. As a result, in 2009 the Renewable Energy Policy set targets which member countries in EU have been working to reach by 2020. The targets are as follows. [11].

1) reducing 20% of fossil fuel and natural gas usage
2) reducing 20% of GHG emission
3) increasing 20% of renewable energy

As shown in Fig.6, the number of pellets factories in European countries is increasing. From 2007 to 2009, 22 countries among 31 countries showed a tendency to increase pellet factories, and a total 102 plants were constructed. Regarding production capacity, the tendency to increase was found in 26 countries with a total increase of pellet production by 7.4 million tons.

From 2009 to 2011, in 12 countries among the 31 countries, the tendency to increase factories is evidenced by a total increase of 36 plants. Regarding production capacity, the tendency to increase was found in 17 countries with total increase of pellet production by 2 million tons.

In 2011, a wide range of production capacity was observed. The biggest plant in Leningrad Region, Russia could produce 900,000 ton/year while the smallest plant in Galway, Ireland could produce 2,500 ton/year. Russia has the largest number of pellet plants, at 69 plants in 2011. However, this number is still fewer than in Japan.

Russia also has the biggest total plant capacity with the ability to produce 3.093 million tons a year in 2011 while the smallest total plant capacity is Belarus with the ability to produce 71,400 ton/year. On the other hand, total production capacity in Japan, 2009, was about 101,000 ton/year which is almost 1/30 of Russian capacity.

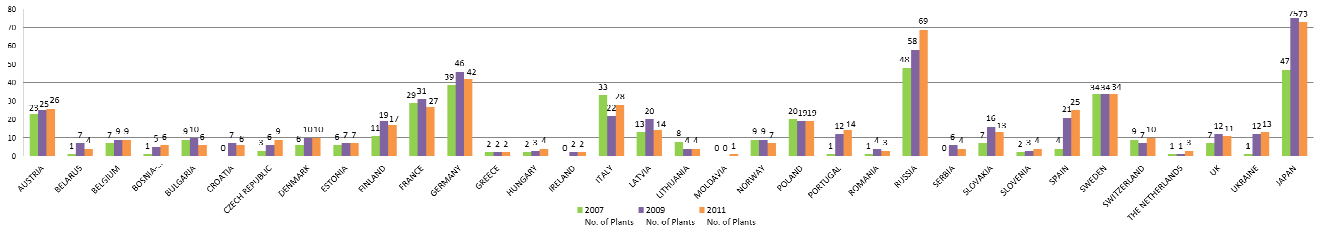

Fig.6 Number of Wood pellet plants in Europe & Japan 2007-2011

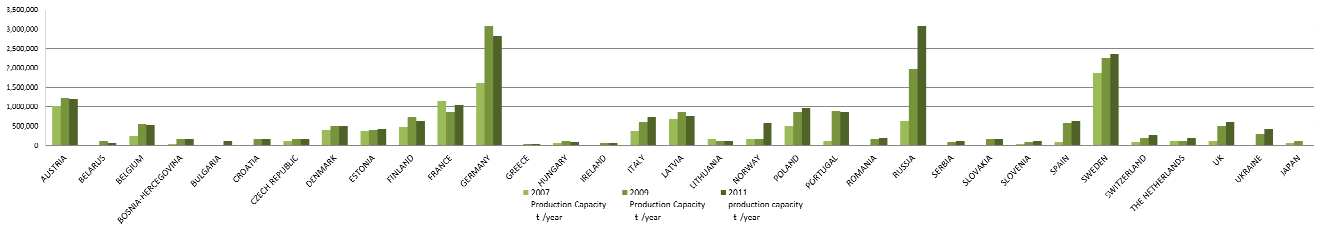

Fig.7 Production capacity of Wood pellet plants in Europe & Japan 2007-2011

3.2 Comparison with North America

Regarding Canada, although there was no dramatic increase in plant number, production capacity has been constantly increasing (Fig.8, 9).

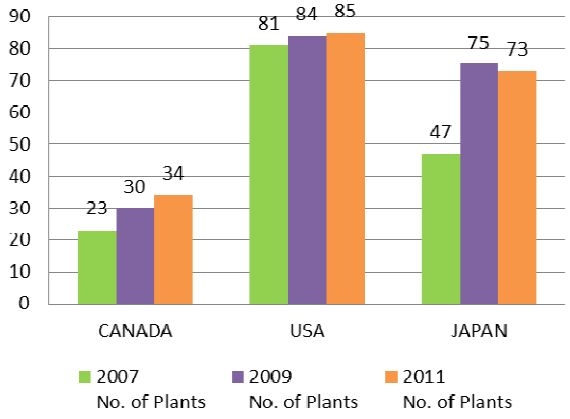

Fig.8 Number of Wood pellet plants in North America & Japan 2007-2011

Plant numbers in Canada are almost half that of Japan while plant numbers in the United States are almost the same as Japan.

Production capacity in the United States in 2011 has decreased even though the number of plants has increased. This is because data of first 1 million ton plants announced in 2009 was not

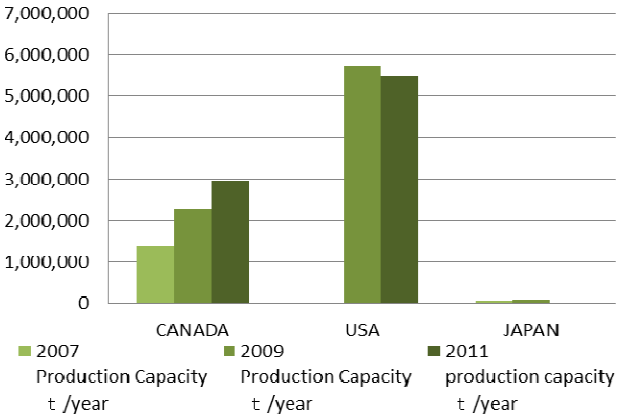

Fig.9 Production capacity of Wood pellet plants in North America & Japan 2007-2011

Within Canada and the United states, the biggest plant capacity in 2011 is found in Georgia, USA, with a capacity of 750,000 ton/year, whereas the smallest capacity of 10,000 ton/year is found in several places in the United States.

In Canada, the 2011 total production capacity was 2.958 million tons which is almost 29 times of production capacity of Japan, while in the United States, the 2011 total production capacity was 5.481 million tons, which is almost 50 times that of Japan

3.3 Comparison with Asian Countries

It appears that the wood pellet industry has not been active in Asian countries outside of China and North Korea.

In China, both production capacity and plants number have dramatically increased recently. This is because since 2000 the Chinese government has been promoting biomass as an energy policy to meet greatly increased demands from its rapid economic expansion.[16] (Fig.10,11). In 2011, the largest production capacity plant was constructed in Jiangsu, with a production capacity of 120,000 ton/year. On the other hand, the smallest plant is in Heilongjiang with a production capacity of 12,000 ton/year. With a total of 20 plants in China, production capacity data is available for 17 plants for total production capacity of 792,000 ton/year, which is almost 7.8 times that of Japan.

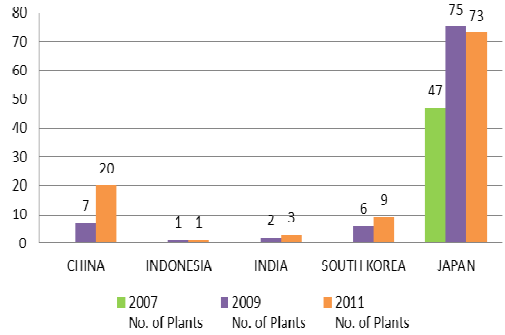

Fig.10 Number of Wood pellet plants in Asia & Japan 2007-2011

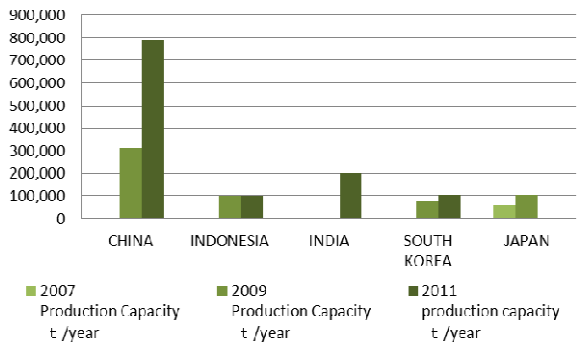

Fig.11 Production capacity of Wood pellet plants in Asia & Japan 2007-2011

In North Korea, a moderate increase was found in both plant number and production capacity. After 2010, as a national policy, the North Korea government sets a target to reduce 30% of CO2 emission by 2020 accompany with introduction of wood biomass energy[11]. As national energy policy, by 2030, the government aims to reduce fossil fuel usage from 83% to 61%, and increase renewable energy usage from 2.4% to 11%[11]. Therefore, it is expected that the wood pellet plants in North Korea will considerably increase in the future.

Regarding wood pellet production capacity per capita, Japan produces less than 1kg/capita, which is quite small when compared to other major countries. This result suggests that pellets have not been popularized in Japan.

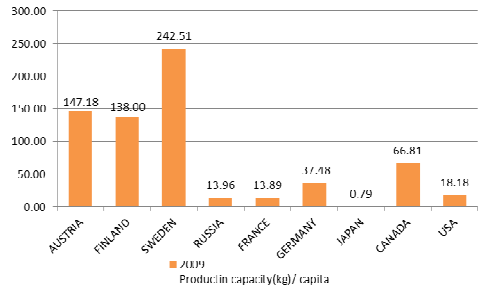

Fig.12 Pellet production capacity (kg)/capita in major countries in 2009

As shown in this section, it is clear that compared to other countries, there are many small-scale plants widely dispersed over Japan. However, pellet production is not promoted in Japan.

4. Discussion

4.1 Plant Scale and Pellet Price

From this comparison, the fact was revealed that production capacity of Japanese wood pellet plants is quite small, and they are scattering over Japan.

It could be concluded that the plant capacity

scale relates to the plant management. As shown in Fig.13, pellet production cost is relative to the plant capacity; as plant capacity increase, production cost tends to decrease.

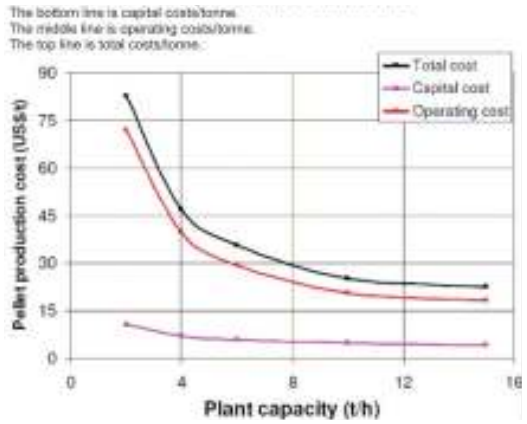

Fig.13 Pelleting cost vs. Plant size [13]

Currently, the pellet price in Japan is approximately between 25-63 yen/kg (excluding transportation cost) [24]. Compared to the price in other countries, this is higher by roughly 20-25 yen/kg (excluding transportation cost) [11]. As shown in Fig.5, most of the production capacity of Japanese pellet plant is less than 2,000 ton/year which results in high prices. For instance, a feasibility study conducted in Ehime prefecture proved that pellet price cannot be lower than 30yen/kg at plants with capacities of 500 ton/year or less without government subsidies [24]. However, expanding the capacity and improving efficiency of production can reduce production costs since specific material cost can be absorbed [11]. As a result, pellet price becomes appropriate for the market (Fig.14).

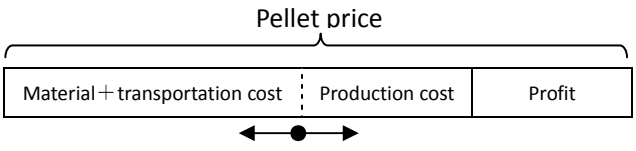

Fig.14 Pellet Price Components [11]

The first reason that Japanese pellet plants are quite small when compared to those in other counties is that the main purpose of pellet manufacturing is not energy production for the market. Instead, it is ancillary to the lumber industry for the processing of wood waste.

The second reason is a difficulty in collecting raw material for wood pellet due to forest management problems. Japanese forestry has been specialized for timber industries, but due to the low efficiency of timber extraction, the timber price was relatively high compared to other countries [15]. This gave rise to an influx of cheap foreign timber into Japan, and a resulting drop in the market share of domestic lumber to 18.2% in 2000 [15]. As the result, forestry has declined and the value of native forest is being lost.

The total forest area of Japan is about 250,000 km^2 which is 66% of total area [11]. Taking Austria as a geographically similar country, pellet production is compared. Austria has steep forest with a total forest area of only 38,400 km^2. However, lumber production is almost the equal to Japan [21]. Moreover, as of 2011, Austria has a more than 1 million ton total pellet production capacity. The major difference between Japan and Austria is the productivity of forestry. In North Europe, since 1960's investment mainly has focused on forest road construction and the development of forestry machine technology to improve productivity and reduce production cost[15]. In contrast, Japan's investment has been focused on forest plantation and the growing of high quality lumber [15]. For this reason, forest road and forestry machine technology development have not progressed [15]. For instance, even now, basic construction machines, which are not designed for forestry in steep forest, are being used

as the main forestry equipment in Japan. As a result, production efficiency is quite low and production costs are high, about 4.3 times that of Austria [10]. In this situation, Japanese lumber industry cannot be competitive in international market, and the current situation in the forest in Japan is bleak. According to the White Paper in Forestry [15],"Forestry" is defined as:

"Forestry is an industry which produces forest products from forest, such as lumber and so on. At the same time, forestry is an industry which demonstrates the multi-function of forests and contributes to job security in mountain regions though production activities"[15]. However, in reality, Japanese forest does not have multipurpose functioning. Forestry is not only to extract timbers but is also a circulatory activity that includes plantation and silviculture. The development of forestry technology would revitalize the forest, which would benefit not only the lumber industry but also serve multi-function activities such as the energy market. As a result, the forest value could be enhanced.

The revitalization of forestry as the primary industry would also result in the revitalization of a secondary industry such as wood pellet burner industry, which could consequently lead to the economy development throughout the region [11].

The third factor which has led to the creation of small pellet plants is that the wood pellet market has not developed yet in Japan. Energy policy in Japan has focused on maintaining existing industries and the current economic system. Therefore, the government has mainly been providing subsidies to the pellet supply side [1], such as wood pellet plants, without developing the demand by creating new industries or new pellet markets. Since the pellet market is minor, pellet production is considered adequate to supply these limited demands. This corresponds to high production costs. Given the high production costs, the marketing mechanism naturally does not function well. In other words, the energy policy and its projects have created many loss makers which cannot manage themselves without government subsidizes. This situation creates negative image of biomass and retards biomass policy implementation.

In contrast, the pellet market arrangement in Austria is quite different. The government subsidies one-third of domestic pellet stove price, while the Austrian Pellet Association actively promotes the pellet stove market by focusing on heating contractors and maintenance technicians who are often consulted about heating systems by consumers. The Austrian Pellet Association provides accurate information about wood pellets and their heating systems and issues certification to such pellet counselors. Those counselors disseminate the pellet information to consumers, which results in pellet market growth [11].

To enable a successful pellet market, creating pellet demand is as important as creating pellet supply. This task should be implemented concurrently. Otherwise, market mechanisms and logistic systems cannot develop, and the pellet market will never be formed.

4.2Wood Pellet Plant Management System

One of the methods which improves the management of pellet plants is the biomass combined heat and power (CHP) system. Combined heat and power (CHP) integrates the production of usable heat and power (electricity), in one single, highly efficient process [2]. Where the heat efficiency of a single pellet plant or single biomass power plant is low, integration of biomass power plants, pellet plant, and other facilities, such

as commercial or educational facilities can improve heat efficiency through an integrated system. Biomass power plants release almost 70% of their heat as waste heat. This remaining heat can be effectively used by adjacent pellet plants and other facilities (Fig.15). This biomass CHP system enables efficient energy balance for an integrated system.

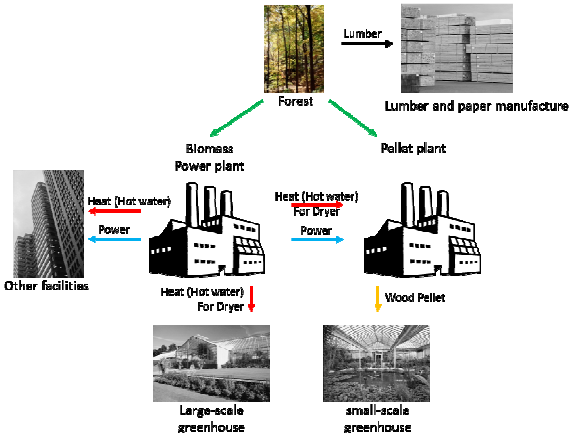

Fig.15 Biomass CHP +Pellet plant system

Although it is often said to be poor in natural resources, Japan actually has an abundance of forest energy resources which have not been properly utilized. To optimize this rich forest energy resource, a large scale pellet plant with an effective biomass CHP system is necessary.

4.3 National Policy of Renewable Energy

One of the problems in developing a renewable energy policy which includes wood pellets is an over compartmentalized bureaucracy. This dispersed energy authorization is presented in Table 1.

As stated in Chapter.1, Evaluation of Biomass Utilization policy (evaluation result and recommendation) issued by Ministry of Internal Affairs and Communications in February 2011 indicated that biomass projects were not effective due to work duplication among different ministries and departments. This implies that energy related agencies lack cooperation among themselves. This structure makes innovative and comprehensive energy policy difficult to develop.

Table 1 Energy issue and authorization agency

Energy resource/issue	Authorization Agency
Energy issue	Department of energy under Ministry of Economy, Trade, and Industry
Hydroelectric power	Ministry of Land, Infrastructure, Transport and Tourism Ministry of Agriculture, Forestry, and Fishery
Wind power	Ministry of Environment Ministry of Economy, Trade, and Industry
Biomass	Ministry of Agriculture, Forestry, and Fishery Ministry of Economy, Trade, and Industry

To achieve innovative and comprehensive energy policies, a new organization, or reorganization of existing energy related agencies into a single structure with strong authority, is critical. [14].

4.4 Wood Pellets situation in Kochi

In Kochi prefecture, located in Shikoku Island, Japan, 84% of the area is covered by forest. Wood pellet production began in 1982. Currently, there are six wood pellet plants with total production capacity of 6,500 ton/year. As early as the 1950's, greenhouse horticulture was developed to take advantage of mild winters in this region[24]. Kochi administration has been introducing wood pellet boiler to greenhouses, and 123 pellet boilers have been used [12]. Wood pellet demand has increased to 3,000 ton/year, which is one of highest in Japan. This growing interest in wood pellets is due to cooperation between Kochi University of Technology and a local enterprise to develop a holistic system of pellet burner technology and pellet demand.

Kochi prefecture aims to increase pellet burner usage by 300 to 400 per year after 2012. However,

in order to achieve the target, 9,000 to 12,000 ton/year of wood pellets need to be produced [12], and the demand would increase to 45,000 tons to 60,000 tons per year within next 5 years. However, current total pellet production capacity in Kochi is obviously inadequate for the target demand.

Therefore, biomass strategy needs to consider both a significant increase of pellet boiler installation and pellet market development. Furthermore, the volume of demand and supply in the region needs to be considered.

4.5 Dissemination of knowledge

Another problem for renewable energy policy in Japan is poor knowledge dissemination. Educational campaigns, such as Energy education or proposal of new sustainable lifestyle with new energy, have not been emphasized. Since Kyoto Protocol, Japan set a target of 6% GHG reduction by 2012. As a result, Ministry of the Environment started campaign called Challenge 25. However, public awareness about this campaign is considerably low, at approximately 20% [9].

To cope with poor information dissemination, accurate renewable energy information and the trends of renewable energy development in the world should be required in school curricula and social education. Through education, an awareness of the importance of renewable energy could be increased throughout society, which in turn would support decision making in the renewable energy market. Such knowledge dissemination is required for the introduction and practice of new technology.

5. Conclusion

As shown in this study which compares pellet plants in Japan and other countries, it is clear that Japanese pellet plant production capacity is relatively low, and that plans are widely dispersed throughout Japan. This is due to the ancillary role to process by-product from lumber industry and the difficulty of collecting raw material due to inappropriate forest management. Because of low pellet plant capacity, Japanese plants face high production costs and management difficulties without government subsidies. For these reasons, the image of wood biomass is poor, and biomass policy is retarded.

In addition, ineffective renewable energy policies in Japan are caused by over compartmentalized bureaucracy and a lack of renewable energy educational campaign.

On March 11th, 2011, the Tohoku earthquake disaster gave widespread rise to security concerns about nuclear power plants. The Ministry of Economy, Trade and Industry has decided to amend it basic energy plan, and a midterm report will be published in the middle of August.

Energy consumption awareness was triggered after the Tohoku disaster. In July 2011, the previous Prime Minister Kan declared that the government would make effort to reduce nuclear power reliance, and eventually create a society without nuclear energy. Due to a significant increase in global awareness of future energy policies, it is time to fulfill a concrete target and implement a plan of renewable energy, such as biomass energy, to reform a safe and secure energy supply system.

Key issues for successful sustainable and secure energy supply system are: review of current forestry management as multi-function industry, utilization of a certain large scale pellet plant with the effective biomass CHP system, formation of the pellet market, and promotion of a renewable energy educational campaign. Steps towards creating a successful wood biomass project need to

be taken using a cross-sector strategy, from forestry management to education to consumers, for sustainable optimization and management of valuable resources in Japan.

6. Future Study

Future work should focus on the application of biomass CHP system to existing public facilities such as universities.

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