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Executive Summary

The Japanese Forestry Agency of the Ministry of Agriculture, Forestry and Fisheries (MAFF) has implemented a series of policies designed to increase the use of domestic wood. Over the past decade, these policies and programs promoted the "cascading-use of forest resources" to more fully utilize domestic wood resources, including low-grade woody biomass for biofuel. Thus, these programs expand the overall demand for domestic wood products and provide more economic opportunities for the domestic forestry and forest products industries while helping to develop a globally competitive forestry and forest products sector through economies of scope and scale.

The Ministry of Economy, Trade and Industry (METI) oversees and regularly reviews feed-in tariff (FIT) programs. After the Fukushima Dai'ichi nuclear power disaster caused by the Great East Japan earthquake, METI in July 2012 started providing generous tariffs to support the expansion of biomass power generation. The schedule of tariffs was applied over a 20-year time frame and are guaranteed at a set purchase price following METI's approval of a biomass power generator. The new FIT program initially set a purchase price of 40 yen/kWh for biomass power plants smaller than 2,000 kW and 32 yen/kWh for power plants larger than 2,000 kW, but only if they use domestically sourced woody biomass derived from forest thinning operations. For bioenergy plants using imported (sustainably sourced) woody biomass, the FIT program initially set a purchase price of 24 yen/kWh. The generous FIT tariffs have resulted in the rapid increase in the number and capacity of biomass power generators all over Japan. However, in order to reduce the energy burden in Japan, METI has begun to reduce the tariffs for newly joining biomass power generators.

Biomass generating facilities range from large-scale coal-biomass co-firing plants (mainly using imported wood pellets), medium-sized biomass power plants (using domestic wood, imported palm kernel shell (PKS) and wood pellets), biomass facilities co-located with wood manufacturing companies (fueled by wood waste and sawdust), to small-scale heat/electricity co-generators that utilize a wide variety of fuels. The supply of domestic unutilized wood or imported ordinary wood (wood pellets, wood chip, PKS and other agricultural residues) is currently sufficient to meet the demand of this rapidly growing biomass sector. As of December 2019, Japan has approved proposals for biomass power plants with a pooled power generation capacity of 8.5 GW, while the operational capacity of qualifying power plants stood at 2.1 GW. The lack of supply of biomass for the approved, but not yet operating power plants, is the key limiting factor in Japan's efforts to increase its use of biomass for energy generation.

In order to increase the demand for domestic wood and help revitalize rural mountain communities, MAFF and METI have developed and implemented a number of strategies designed to subsidize the expansion of woody biomass energy. Developing this new industry is currently an on-going activity and it is likely that success in this area will greatly increase the demand for woody biomass, exceeding the domestic supply of woody biomass (including forest thinnings) and thereby providing new opportunities for foreign wood suppliers. Exporting wood chips, white pellets and torrefied (black) pellets to Japan represents a strong new market for the U.S. forest products industry. Given the growing demand for woody biomass in Japan (as well as CLT panels which can be manufactured using lower quality softwood lumber), there also exists a possibility to expand exports of lower quality logs and lumber from the US.

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1. Introduction

Japan has implemented a series of policies designed to increase its use of domestic wood in a wide variety of wood products including cross laminated timber (CLT) panels and biomass that can be used as a fuel for the production of bio-energy (both wood pellets and chips). These policies include significant subsidies that are designed to favor domestic wood products over imported wood products by promoting the use of domestic wood products as well as by partially subsidizing the costs associated with establishing new wood production and manufacturing facilities (Eastin and Sasatani, 2014a; USDA 2019a,c; USDA 2020). The effort to replace imported wood with domestic wood was formally implemented in the Basic Forest Plan of 2011 and revised in the Basic Forest Plan of 2016. One of the primary goals of the Basic Forest Plan is to increase Japan's self-sufficiency in timber supply to 50% by 2025 (from 26.6% in 2011). This paper provides a brief description and discussion of one of the major programs designed to expand the demand for domestic wood in Japan: the feed-in tariff (FIT) Program. However, prior to looking at the FIT program, it will be helpful to take a moment to discuss a bit about the forestry sector and the market dynamics for domestic wood in Japan.

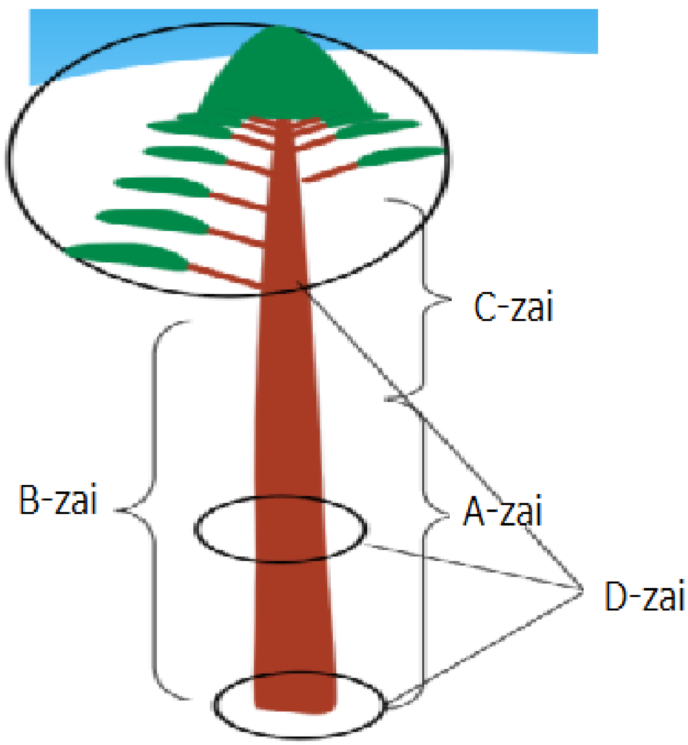

Figure 1. Japanese log classifications

The value of timber harvested in Japan is generally based upon the value of the products that can be made from the logs. This value is dictated by the log size (diameter and height), timber species, and log quality. In the US, logs are generally graded for use as veneer, lumber, pulp wood and other uses. In Japan, foresters segregate logs into four categories: A-zai, B-zai, C-zai and D-zai[1], Figure 1. It is important to note that Japanese foresters generally adopt cut-to-length logging, unlike North America's full-tree logging and tree-length logging. In Japan, foresters fell, delimb, and then cut trees into 2-4 meter lengths based on a variety of market factors. The logs are then sorted and shipped to specific log auction markets. These A to D-zai classifications are based on the length of the logs, not necessarily on the quality of the wood. It is possible to obtain A, B, C and D-zai from the same tree as shown in Figure 1 and they are not mutually exclusive. A-zai is the straight large diameter log derived from the base of the tree and it is mainly used to produce structural and non-structural lumber. B-zai logs are medium-sized slightly crooked or tapered logs that are generally used to produce laminated lumber and plywood. C-zai logs are small diameter

[1] "zai (材)" means general material, but it usually refers to logs when used in the Japanese forest sector.

logs/branches or tapered logs from the tops of trees that are mainly used to produce wood chips and wooden boards. Finally, D-zai logs are unutilized forest residues (tops, branches completely crooked logs or unutilized thinnings) that are usually chipped for biomass energy. Traditionally, A-zai logs are the most expensive, followed by B-zai and C-zai, though prices fluctuate according to local supply and demand. Loggers often leave D-zai material lying in the forest because the collection and transportation costs for this material is generally higher than its market value.

Over the past decade, the policies and programs of the Japanese Forestry Agency have been developed to promote the “cascading-use of forest resources”. These “cascading-use” policies are designed to ensure that all potentially usable domestic wood materials are utilized and thereby reduce demand for imported raw materials while promoting the production and use of bioenergy from woody biomass. The central idea of these policies is to more fully utilize wood from domestic forests, expand the overall demand for wood products and provide more economic opportunities for the forestry and forest products industry, especially in rural mountain communities. The eventual goal is to help rural communities develop globally competitive forestry and forest products sectors through economies of scope and scale.

By diversifying the forest products industry and utilizing previously unmerchantable parts of the tree, the Forestry Agency hopes to increase the competitiveness of the Japanese forestry industry in several ways. First, it is anticipated that stumpage prices may increase and provide an incentive for more people to harvest trees and actively manage forests. In this way, the forestry sector can maintain a consistent supply of domestic logs to the forest products industry. Second, in the past, demand for structural and non-structural lumber has been volatile due to an over reliance on the construction sector which has experienced significant fluctuations since the bursting of the economic bubble. While housing starts have always fluctuated based on the economy, the negative demographic trend in Japan is also exerting downward pressure on housing starts. Diversifying the demand for wood products in other sectors of the economy is critical to stabilizing the financial situation for forest owners and the wood processing industry. Third, diversification of demand for wood can help identify new uses for the dominant (but low quality) timber species in Japan, sugi (*Cryptomeria japonica*). Sugi lumber has relatively low mechanical strength properties and is less suited for structural applications where material strength is important (e.g. beams). Therefore, developing new demand for lower strength sugi should help to increase its utilization. Fourth, developing the demand for bioenergy could help to monetarize forest thinnings, which would encourage more forest owner to engage in active forest management. Ultimately, the goal of these policies is to help the Japanese forestry sector more sustainably manage their forests while enhancing the competitiveness of domestic wood relative to imported wood (USDA FAS, 2019c).

The Forestry Agency has determined that stimulating the demand for cross-laminated timber (CLT) and biomass energy could very well be game changers for the Japanese forestry industry. These innovative new uses for domestic wood could increase the demand for Japanese domestic wood, enhance the competitiveness of Japanese forestry and provide a basis for sustainable forest management. The CLT industry (which will be discussed more fully in a future report) is expected to stimulate the demand for sugi B-zai logs while the biomass energy sector is expected to increase the demand for D-zai and some C-zai logs. Those two industries are expected to fill the gap in the cascading-use model for Japanese forest resources. The Forestry Agency, the Ministry of Economy, Trade and Industry (METI), the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) along with other government ministries are working closely together to introduce synergistic policies and programs designed to subsidize the development and competitiveness of these new industries (Eastin and Sasatani, 2014a).

Figure 2 shows the price trend of sugi logs (per cubic meter) between 2011 and 2017. There are four different diameter classifications of sugi logs that are used to manufacture lumber with large diameter sugi logs (30-36 cm diameter) generally being the most expensive. These four log sizes are all used for lumber production (A-zai), which explains why the prices are correlated over time. A-zai log prices spiked at the end of 2013, primarily in response to four factors. First, the number of housing starts in Japan increased as homebuyers rushed to build houses before the consumption tax was raised from 5% to 8% on April 2014. Second, Japanese domestic wood became more competitive relative to imported wood due to the exchange rate when the Japanese yen depreciated against other major currencies due to the Japanese economic policy known as Abenomics (named after Japanese prime Minister Shinzo Abe). Third, the Forestry Agency subsidized Japanese home builders to increase their use of domestic wood species through the introduction of the Wood Use Point Program (WUPP). The WUPP program was designed to increase the demand for domestic "local" wood species by providing substantial subsidies. As a result, home builders increase their use of Japanese domestic species substantially (Eastin and Sasatani, 2014b). Fourth, the Forestry Agency provided substantial subsidies to support the development of the CLT and biomass energy sectors.

In addition to A-zai logs, the Japan Wood Products Information and Research Center (JAWIC) began collecting prices for B-zai sugi logs (which are typically used to manufacture plywood and lamstock for laminated lumber) in 2013. The prices of B-zai logs are is similar to that of small diameter sugi logs used for lumber (8-13 cm), although the prices are less volatile. The price of C-zai logs (typically used for chips and pellets) are much lower than those of A-zai and B-zai logs. It is important to note the upward price trend for C-zai logs that began in early 2013 following the introduction of the feed-in tariff (FIT) program designed to subsidize the use of domestic woody biomass for bioenergy production.

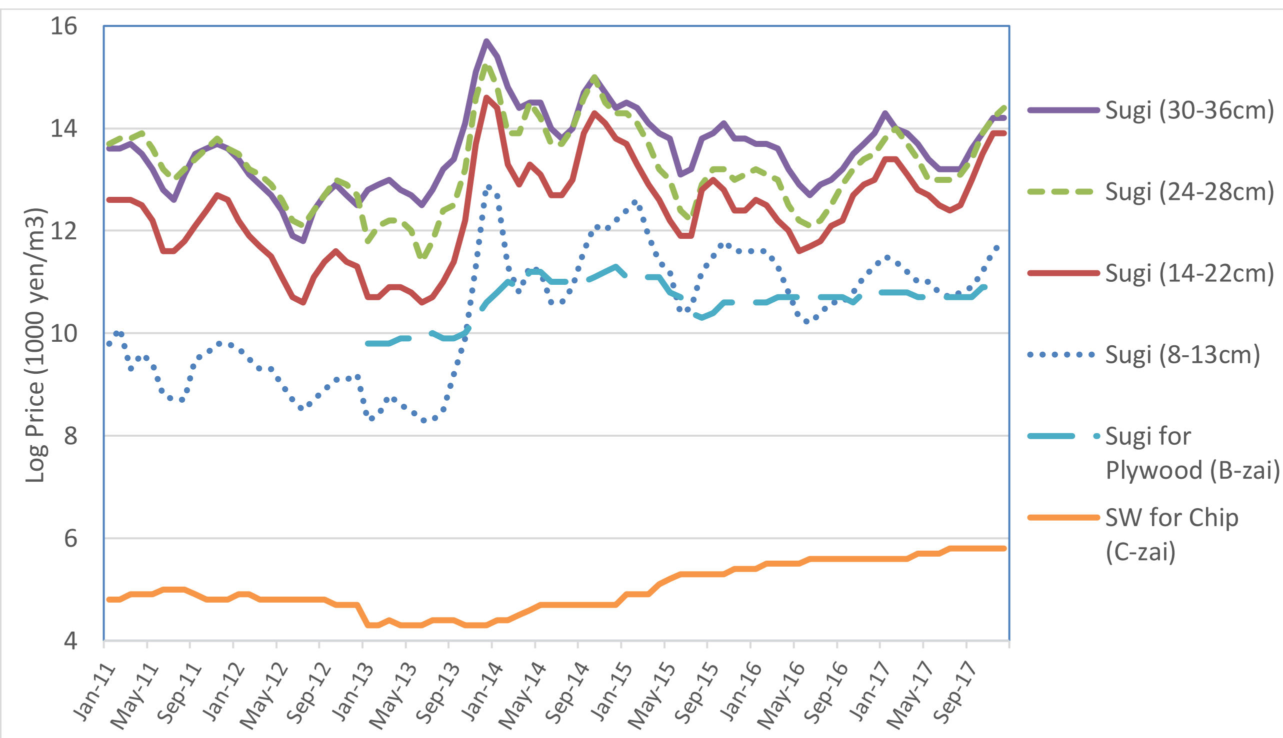

Figure 2. Price trend of A, B and C-zai logs

Figure 3 shows the price ratio of small diameter sugi logs (8-13 cm) relative to larger diameter sugi logs (24-28 cm) between 2013 (when the FIT program was implemented) and 2017. The data clearly shows that prior to the introduction of the FIT program, the price ratio of small and large diameter sugi logs was consistently around 70%. Beginning in 2013, and following the introduction of the FIT program, the price ratio jumped from 0.7 to 0.92 as demand for small diameter sugi logs increased within the bioenergy sector. The increased prices for smaller diameter sugi logs has caused some hardship for Japanese pulp and paper manufacturers who often compete for these same logs (e.g., Kumazaki, 2015; Nikkei, 2018).

Figure 3. Price ratio of small sugi logs (8-13 cm dia.) relative to larger sugi logs (30-36 cm dia.)

In the past, the Forestry Agency has implemented numerous policies and programs designed to improve the competitiveness of Japanese structural lumber and glue laminated beams within the residential construction sector. Typically, the Forestry Agency has utilized subsidies and "buy domestic" policies to encourage the increased use of domestic wood in residential construction, to the detriment of imported lumber (Eastin and Sasatani 2014a). With the introduction of these new programs designed to subsidize the establishment of a new CLT industry and greatly expand the use of woody biomass for bioenergy, the Forestry Agency has shifted their efforts from working within an established market (residential construction) to creating new wood demand sectors (CLT and wood bioenergy). From a purely marketing perspective, they have shifted their focus from increasing the market share of domestic wood within a stagnant to shrinking market segment (residential construction) to increasing the overall demand for wood in Japan through the development and expansion of two new wood demand sectors. The net effect of this strategic policy shift will be to expand the overall demand for wood products in Japan. This is particularly important given the fact that residential housing starts are projected to decline in response to the shrinking population in Japan (Sasatani et al., 2010). One important caveat is the heavy reliance on massive subsidies to establish these new markets. For example, the program to develop a new CLT industry calls for subsidies of up to 50% of the investment capital required to establish a CLT manufacturing facility. In addition, the demand for CLT in construction was promoted through a program that subsidized 75% of the cost of CLT panels in 2018. From the perspective of foreign timber suppliers, these types of subsidy programs distort the market and undermine the competitiveness of imported wood products in Japan.

2. Biomass and Feed-in-Tariff (FIT)

The Fukushima Dai'ichi nuclear power disaster

The devastation caused to the energy generation infrastructure within Japan by the Great East Japan earthquake that occurred on March 11th, 2011 was a significant factor in the decision to increase the use of bioenergy in Japan. The earthquake triggered a massive tsunami that affected the Pacific coast of northeastern Japan. The tsunami caused significant nuclear accidents at the Fukushima Dai'ichi Plant complex, primarily the level seven major accident on the International Nuclear and Radiological Event Scale that occurred at three different nuclear reactors. Prior to the tsunami, Japan had 54 operating nuclear power reactors that generated 30% of the country's electrical power. Nuclear power was a national strategic priority in Japan given that it does not contribute to global warming. Prior to the Great East earthquake, the goal of the Japanese government had been to increase the share of electricity generated by nuclear plants to 40%. However, following the earthquake and subsequent nuclear disaster, people became skeptical about nuclear power, questioning whether nuclear power was a safe option for energy production in light of the perceived risks. Due to the safety problems experienced at Fukushima, and in response to public pressure to close the remaining nuclear power plants, the Ministry of Economy, Transport and Industry (METI) asked all electric power companies to conduct stress tests of their nuclear power plants during July, 2011. As a result of strong public concern, whenever a nuclear power plant went offline to conduct periodic maintenance it was not allowed to resume operation. By May 5, 2012, the last operating nuclear power plant went offline, leaving Japan completely without nuclear electrical power for the first time since 1970.

Since the closure of the nuclear power facilities, several nuclear power reactors were approved to resume operations in Japan. In July 2012, the Oi No.3 and No.4 reactors in Fukui Prefecture were allowed to resume operations while the Sendai No.1 and No.2 nuclear reactors in Kagoshima Prefecture resumed operations in August and October 2015, respectively. The Takahama (Fukui Prefecture) nuclear reactor reopened in October 2017, followed by the Ikata (Ehime Prefecture), and Genkai (Saga Prefecture) nuclear reactors in late 2018. The government plans to reopen most of the remaining nuclear power plants by the end of 2020, though, only five of 33 nuclear reactors were operating as of May 2020.

Since approximately 30% of Japan's electricity was derived from nuclear power before the tsunami, the nuclear power plant closures created significant electricity shortages. Tokyo Electric Power Company (TEPCO) implemented rolling blackouts on an area-by-area basis to deal with the energy shortages. On the supply side, TEPCO and other electricity companies worked to increase the supply of energy derived from non-nuclear sources, and many suspended liquified natural gas (LNG) and coal power plants were restarted across Japan. However, these measures were not enough to balance supply with demand and the government called for energy-saving efforts by consumers to reduce power demand, especially during the hot summer months.

Prior to the tsunami, the Renewables Portfolio Standard (RPS) system had been introduced in 2003. The RPS is a regulatory mandate for electric companies to increase production of energy from renewable sources such as wind, solar and biomass as an alternative to fossil and nuclear power. The RPS system increased the supply of electricity generated from biomass from 2.0 billion kWh in 2003 to 4.2 billion kWh in 2011 (+43%). To further increase alternative sources of power, Japan adopted a Feed-In Tariff

(FIT) program on November 1st 2009 that required power companies to contract with households to purchase excess electricity generated by residential photovoltaic systems (e.g., rooftop solar panels).

Developing a renewable energy policy

Pulp and paper mills have traditionally consumed much of the woody biomass residuals produced in Japan. However, paper production has been gradually declining in Japan, falling from 32 million metric tons (MMT) in 2000 to 27 MMT in 2014 (Forestry Agency 2015). At the same time, the ratio of recycled/used paper increased from 51.5% in 1990 to 64.1% in 2017 (Japan Paper Association 2018). In addition, about 70% of the pulp that Japanese paper manufacturers use is imported. Given the declining demand for woody biomass by paper manufacturers, the Forestry Agency began exploring alternative uses for low grade forest resources to help revitalize Japan's forestry industry.

Using low-grade wood for biofuel is not a new idea in Japan where, until fossil fuels became more available, a large portion of the timber harvest had been used to make charcoal. Japan produced 2 MMT (million metric tons) of charcoal in 1955, primarily for heating and cooking. As the Japanese demand for charcoal declined, charcoal production dropped to just 34,000 MT (metric tons) in 2009 where it was used mainly in niche markets (e.g., charcoal for restaurants[2] and water/air purification products). Charcoal is now categorized as a specialty forest product and its production is monitored by the Forestry Agency.

The Forestry Agency had been emphasizing the importance of utilizing low grade forest resources for biomass energy for a long time. Biomass energy was first mentioned in the 1999 Forestry White Paper and it has been mentioned in every White Paper since 2003. It is important to note that the 3rd Conference of Parties (COP3) to the United Nations Framework Convention of Climate Change (UNFCCC) was held in Kyoto Japan in December 1997 and at the end of the conference, the Kyoto Protocol was adopted. Japan's target under the Kyoto Protocol was to limit its CO_2 emissions by 6% over the 2008-2012 period (relative to the 1990 level). To achieve this goal, the Japanese government estimated that 3.8% of the 6% CO_2 reduction could be achieved through carbon sequestration in domestic forests, especially in rapidly growing young forests that are planted following a timber harvest operation. Thus, it has become a national priority (and one that Japanese citizens and the government take quite seriously) to promote biomass energy as a strategy to help mitigate global climate change (USDA FAS, 2019a). It should be noted that the energy sector is regulated by the Agency for Natural Resources and Energy (ANRE) which is located within the Ministry of Economy, Trade and Industry (METI) whereas the Forestry Agency is housed within the Ministry of Agriculture, Forestry and Fisheries (MAFF). As a result of this administrative structure, the Forestry Agency and MAFF traditionally had little direct influence on the development of Japanese energy policies.

In December 2002, the Japanese Cabinet approved the "Biomass Nippon Comprehensive Strategy" which stated that it was important to utilize biomass energy to: 1) mitigate global warming, 2) create a recycling-oriented society, 3) create a competitive new industry, and 4) help revitalize rural forest communities. This strategy covered not only forest resources and woody biomass but also many other types of agricultural waste (e.g., rice straw). Based on this new strategy, MAFF decided in 2007 to develop a subsidy program designed to support rural municipalities who wanted to achieve a recycling-oriented

[2] Traditional Japanese chefs prefer to use charcoal for grilling as do mass-restaurants (e.g., yakitori, eel and robata-yaki). While Japanese charcoal is usually made from oak, Japan imports low cost mangrove charcoal from SE Asia.

society through biomass energy generation. These municipalities, which MAFF referred to as biomass towns, were eligible to apply for 1.3 billion yen (USD 11 million) worth of subsidies being provided by MAFF. The goal of this policy was to develop approximately 300 biomass towns across Japan by 2010. By 2008, 214 projects had received a subsidy from the program.

Following the unprecedented political victory of the Democratic Party of Japan (DPJ) in 2009, the Ministry of Internal Affairs and Communications (MIC) was tasked with evaluating the performance of the subsidy programs developed by the Liberal Democratic Party of Japan (LDP), including the Biomass Program. In 2011, the MIC review of the Biomass Program concluded that the Biomass Program had not been effective and urged MAFF to improve the program. According to their evaluation, only 16.4% of the projects (35 biomass projects) were slightly successful while the remaining projects (179) were deemed to be failures. The experts believed that the high failure rate could largely be attributed to the lack of business experience of the project managers in the public sector.

Following this review, the DPJ Cabinet adopted the “Biomass Utilization Promotion Basic Plan” in December 2010. In reviewing the Plan, MAFF projected that the biomass energy market proposed within the Plan would help to sequester 26 MMT of carbon[3], and support the development of a 500 billion yen biomass industry (in both the forestry and agriculture sectors) while helping 600 municipalities across Japan by 2020. The Plan aimed to increase the utilization rate of: salvaged wooden building materials from 90% in 2010 to 95% in 2020 (about 4.1 million MT by 2020), paper from 80% to 85% (about 27 MMT by 2020), and forest harvest residuals from 0% to over 30% (about 8 MMT by 2020) while maintaining the recovery rate for sawmill residues at 95% (3.4 MMT by 2020) and black liquor recovery from paper mills at 100% (14 MMT by 2020). If successful, MAFF estimated that Japan could supply about 11.11 million carbon tons for energy production (13 billion kWh equivalent). If we conservatively assume that the average cost of biomass electricity is 25 yen/kWh, the new biomass electricity industry was expected to generate approximately 325 billion yen of electricity by 2020. As of FY 2017, biomass electricity generation was about 10.2 billion kWh, and in order to achieve the Plan’s goal, Japan would need to increase its bioenergy production capacity by about 33% between 2016 and 2020.

However, the implementation of the “Biomass Utilization Promotion Basic Plan” was thrown into disarray when the Fukushima Dai’ichi nuclear disaster forced a reevaluation of Japanese energy policy. Overwhelmed by political pressure from renewable energy lobbyists, the government moved quickly to expand the FIT scheme without engaging in a substantive discussion of an overall energy policy. The newly developed FIT scheme was introduced in July 2012 and provided generous subsidies for renewable energy producers. For example, with respect to solar panels, the new FIT program established a purchase price of 40 yen/kWh for systems larger than 10 kWh for a guaranteed period of 20 years and a purchase price of 42 yen/kWh for systems smaller than 10 kWh for a guaranteed period of 10 years. As a result, solar panels sprang up like mushrooms after the rain on rooftops all across Japan. Similarly, the new FIT program set a purchase price of 55 yen/kWh for wind turbines smaller than 20 kW for a guaranteed period of 20 years and of 22 yen/kWh for systems larger than 20 kW over a guaranteed period of 20 years. With respect to forest biomass, the new FIT program set a purchase price of 40 yen/kWh for biomass power plants smaller than 2,000 kW and 32 yen/kWh for power plants larger than 2,000 kW for a guaranteed period of 20 years, but only if they use domestically sourced woody biomass derived from forest thinning

[3] 1 carbon ton ≈ 0.27 CO_2 ton (based on Kyoto Protocol)

operations. For bioenergy plants using imported (sustainably sourced) woody biomass, the FIT program set a much lower purchase price of 24 yen/kWh for a guaranteed period of 20 years. Figure 4 shows the amount of monthly FIT subsidies paid, by the type of electricity generated. The total monthly payment of FIT subsidies was about 20 billion yen at the start of the new FIT program in mid-2012. However, in response to the generous subsidies provided under the new FIT program, the monthly subsidies increased rapidly to over 250 billion yen by the end of 2018. The subsidy data shows that solar dominates the subsidy payments under FIT scheme and that both wind and solar power generation are seasonal. Solar generates more power during the spring to summer seasons while wind generates more power during the winter season. The data also show that the amount of energy generated from biomass has increased significantly since the start of the new FIT program.

Households have paid a substantial premium for renewable energy under the new FIT program. METI estimated that the average household paid a renewable energy premium of 791 yen per month in 2017 and that this premium is forecast to increase to 886 yen per month per household by 2030.

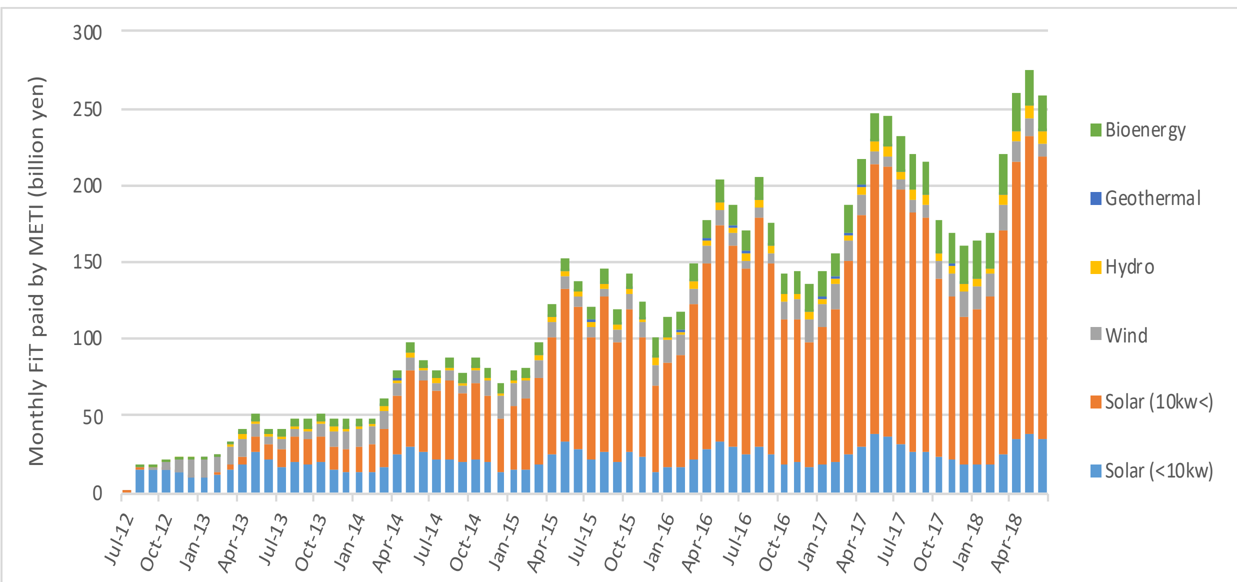

Figure 4. Monthly FIT payment by category

METI's 2030 Energy Outlook

Since 2014, the Japanese government had been engaged in a strategic discussion about the future energy mix for Japan and, in response to public demand, METI finalized the comprehensive future energy mix outlook in mid-2015. The comprehensive future energy plan assumes that the Japanese economy will grow 1.7% per year (Figure 5). In 2030, the total energy demand in Japan is estimated to be about 326 million kl coe (kilo liter crude oil equivalent) including energy savings of 50.3 million kl coe. To meet this demand, the energy supply must reach 489 million kl coe. The higher supply number is due to the conversion and transportation inefficiencies endemic to the energy sector. METI forecast that 10.3% of the energy supply would come from nuclear power and 14% from renewable energy. Since Japan imports virtually all of its fossil fuel, energy self-sufficiency is projected to be 24.3% in 2030 (ANRE 2018).

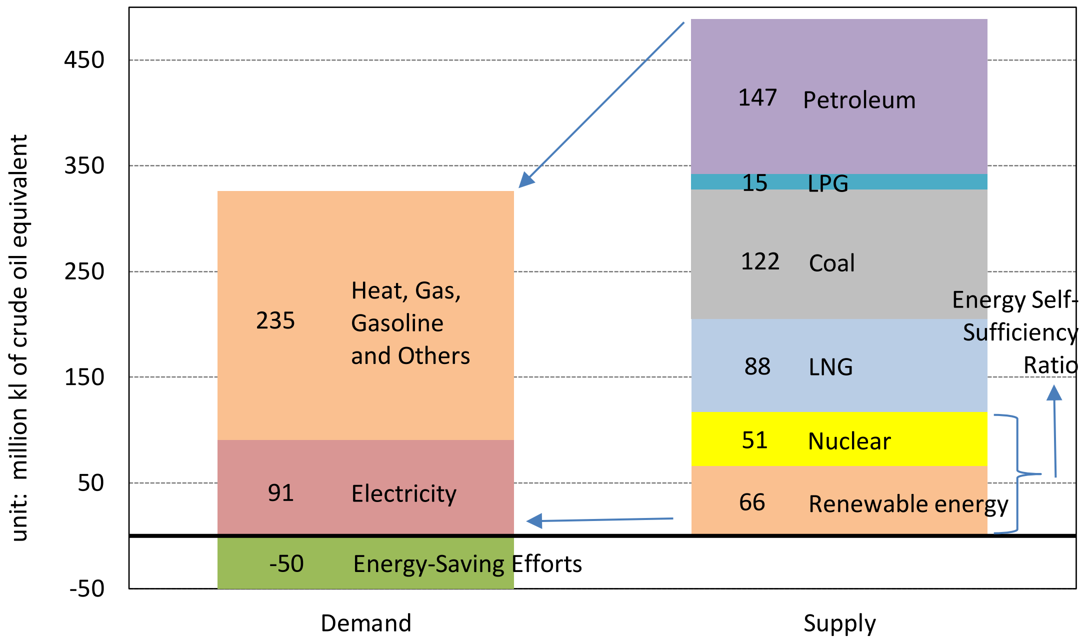

Figure 5. Energy mix outlook in 2030

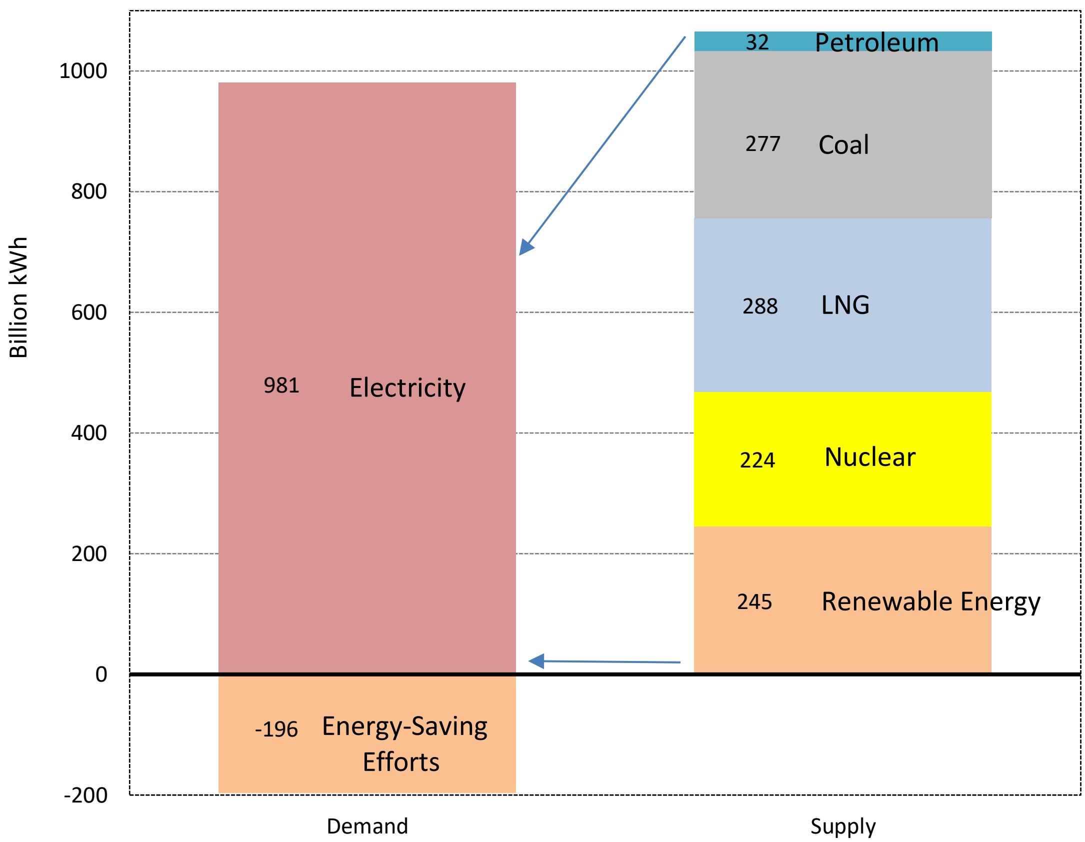

Figure 6. Electricity mix outlook in 2030

The total demand for electricity in Japan was 966.6 billion kWh in 2013 and METI forecasts that it will increase to 980.8 billion kWh by 2030. This projection takes into account a 17% drop in energy demand as a result of: energy savings efforts (estimated to be about 196.1 billion kWh), the declining population in Japan and the fact that the Japanese economy is projected to grow by just 1.7% annually over the projection period. To meet this increased demand, METI estimates that Japan will need to supply a total of 1.065 trillion kWh of electricity. Following a long period of political discussion, METI determined that by 2030 between 22-24% of electricity in Japan will be supplied by nuclear reactors, coal would represent about 26% of the electricity supply, LNG about 27% and petroleum about 3% (Figure 6). About 22-24% of the electricity supply was expected to come from renewable energy sources, with 1-1.2% coming from geothermal, 3.7-4.6% from biomass, 1.7% from wind, 7% from solar, and 8.8-9.2% from hydro.

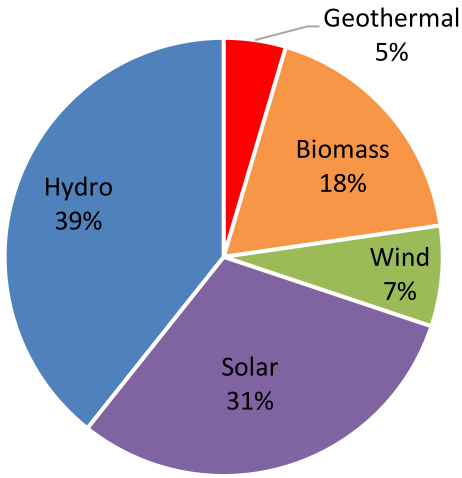

Figure 7. Renewable energy for electricity mix outlook in 2030 (234-256 billion kWh)

Figure 7 illustrates the projected mix for renewable energy for electricity in 2030. The total supply is projected to be between 234.3 and 255.6 billion kWh, with 39% coming from hydro generators, 31% from solar, 7% from wind and 5% from geothermal. Biomass (including wood and agricultural materials) represents about 18% of the renewable energy supply, which means biomass is expected to generate between 39.4 and 49.0 billion kWh by 2030.

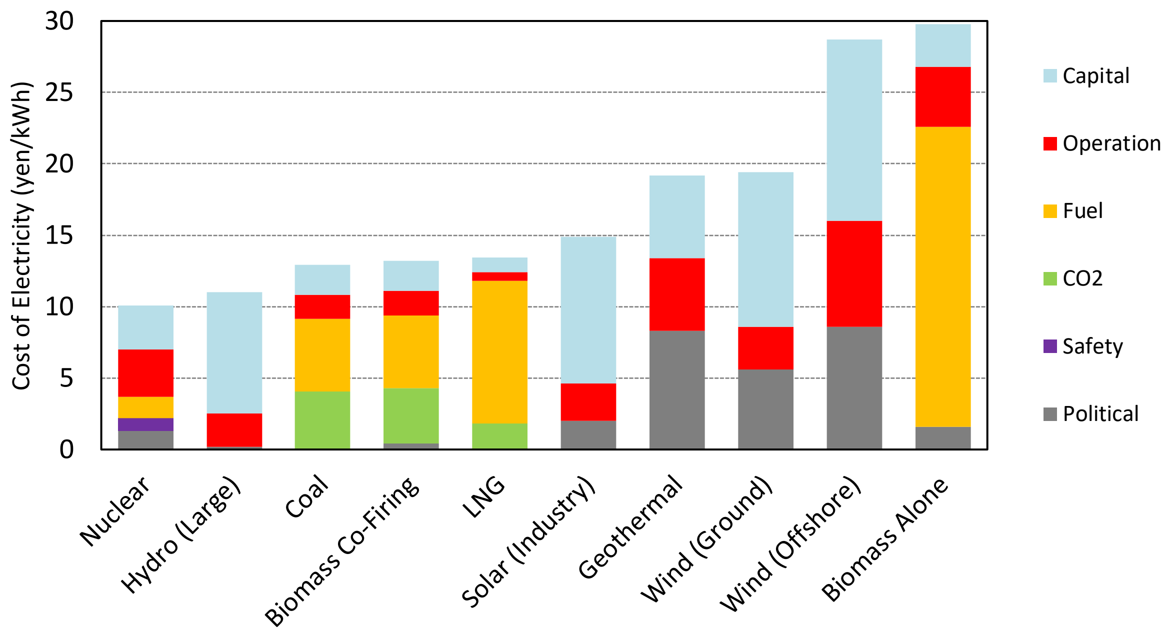

Figure 8. Electricity cost outlook by types in 2030

METI also forecast the cost of electricity in 2030 using a sensitivity analysis to estimate the cost structure for 10 electricity supply options, Figure 8. Despite the huge impacts of the Fukushima Dai'ichi nuclear disaster, the cheapest source of electricity was determined to be nuclear: about 10.1+ yen/kWh. However, in the aftermath of the nuclear disaster, the costs associated with safety and risk mitigation are projected to be quite high for nuclear generators. The data used to develop the cost estimate for nuclear power was based on the evidence collected from Fukushima, but since this information is still uncertain, METI added "+" to the cost estimate to reflect this cost uncertainty. In terms of increasing electricity costs, the cost of nuclear energy was followed by large-scale hydro power, coal power, biomass co-firing plants (coal/biomass), LNG power and large-scale (industrial) solar power installations. All of these types of electricity were estimated to cost less than 15 yen/kWh. Using biomass alone to generate electricity is one of the most expensive options, estimated to be 29.7 yen/kWh. More than 70% of the cost of generating electricity from biomass is attributable to the cost of purchasing the biomass (note that other types of renewable energy do not require fuel purchases (i.e.: solar, wind, geothermal and hydro). Biomass co-firing plants generally use a very small amount of biomass (generally less than 5%) since coal is cheap, meaning that biomass co-firing coal plants are a relatively cheap, albeit a highly pollution intensive, option for generating electricity.

New FIT Program and Biomass

In order to participate in the new FIT program, prospective biomass power generators are required to register with METI before being eligible to receive subsidy tariffs under the FIT program. The schedule of tariffs is applied over a 20-year time frame and are essentially guaranteed, Table 1. From fiscal year 2012 to 2014 (the FY is from April to March in Japan), the FIT program paid 32 yen/kWh to all biomass plants that used unutilized domestic wood and biomass derived from forest thinning operations. In 2015, the FIT program, in an effort to promote the establishment of smaller biomass energy plants, increased the tariff they would receive to 40 yen/kWh, but only if the biomass facility was smaller than 2,000 kW and they used domestic woody biomass derived from forest thinning operations. Within the FIT program, the

Table 1. Biomass FIT tariff, broken down by fuel type

FY (Apr-Mar)	Unutilized wood & thinning		Ordinary Wood			Liquid Biomass	Recycled Wood	Fermented Methane Gas	Other Biomass
	<2000 kw	2000 kw≤	<10 Gw	10-20 Gw	> 20 Gw				
2012	32		24			Ordinal	13	39	17
2013	32		24			Ordinal	13	39	17
2014	32		24			Ordinal	13	39	17
2015	40	32	24			Ordinal	13	39	17
2016	40	32	24			Ordinal	13	39	17
2017	40	32	24	24	21	Ordinal	13	39	17
2018	40	32	24	Auction	Auction	Auction	13	39	17
2019	40	32	24	Auction	Auction	Auction	13	39	17
2020	40	32	24	Auction	Auction	Auction	13	39	17
2021	40	32	-	-	-	-	13	39	17

definition of forest thinning operations is somewhat fluid and selective harvest operations may be considered to be thinning operations. As shown in Table 1, ordinary wood includes other woody raw materials (such as imported wood chips and pellets) as well as imported palm kernel shells (PKS) and palm oil. Using ordinary wood in any size of biomass facility qualified for a subsidy of only 24 yen/kWh of electricity generated until 2017 when the FIT program reduced the tariff to 21 yen/kWh for large biomass power plants (>20,000 kWh) using ordinary wood. Beginning in 2018, an auction system was introduced for biomass power plants larger than 10,000 kW that use ordinary wood, and any biomass power plants that use liquid biomass (i.e., palm oil). The first auction was held in autumn 2018 and METI has not yet decided on a FIT price for power plants using ordinary wood after 2021. It is also important to note that only imported wood biomass derived from sustainable sources is eligible for the tariffs under the FIT program. Importers of woody biomass products need to be able to prove the sustainability of their biomass materials.

Co-firing coal plants can also receive biomass FIT tariffs up to the percentage of electricity generated from the biomass that they use. Following the shutdown of the nuclear power plants, many coal plants were reopened to help restore the supply of electricity. Given the huge disruption in the power supply, many companies started new coal-fired plants or reopened older coal plants across Japan. Local and national governments have asked coal plant operators to voluntarily increase the amount of biomass they burn to help reduce greenhouse gas (GHG) emissions and thus help meet Japan's Kyoto Protocol obligations. This effort is voluntary since METI has not mandated any CO_2 targets for coal-fired power plants that would require an increase in the amount of biomass mixed with the coal. Since co-firing plants use only a small amount of biomass (on the order of 3-5% of the total fuel mix), co-firing with biomass has little impact on the GHG emissions of coal plants.

According to METI, the FIT subsidy for unutilized domestic wood was intentionally set high to encourage biomass and coal plants to consume more domestic forest residues. METI deliberately established the high tariff level to ensure that investors in biomass energy plants would earn an internal rate of return (IRR) of at least 8% on their investment. In addition, construction of a new biomass energy facility can be eligible to receive up to 50% of the construction costs. In comparison, the FIT tariff for methane plants was set to provide a very low 1% IRR, although the FIT program incentivizes methane plants to incorporate forest residues into their feedstock by providing a pro-rated percentage of the biomass FIT as the proportion of forest residues used increases. Also, co-gen methane plants qualify for a heat utilization project subsidy of up to 50% of the cost of converting the methane facility to become a co-gen plant. While many energy experts believe that biomass is more suitable for producing heat rather than electricity, the FIT program does not include heat or steam facilities.

The trend of total monthly FIT tariffs paid to biomass energy producers shows a very strong upward trend between 2013 and 2018 as the program has proven to be a widespread success given the very high level of subsidies provided to biomass energy producers, Figure 9. The total monthly FIT payment for biomass reached 10 billion yen in September 2015 and exceeded 25 billion yen by the beginning of 2018.

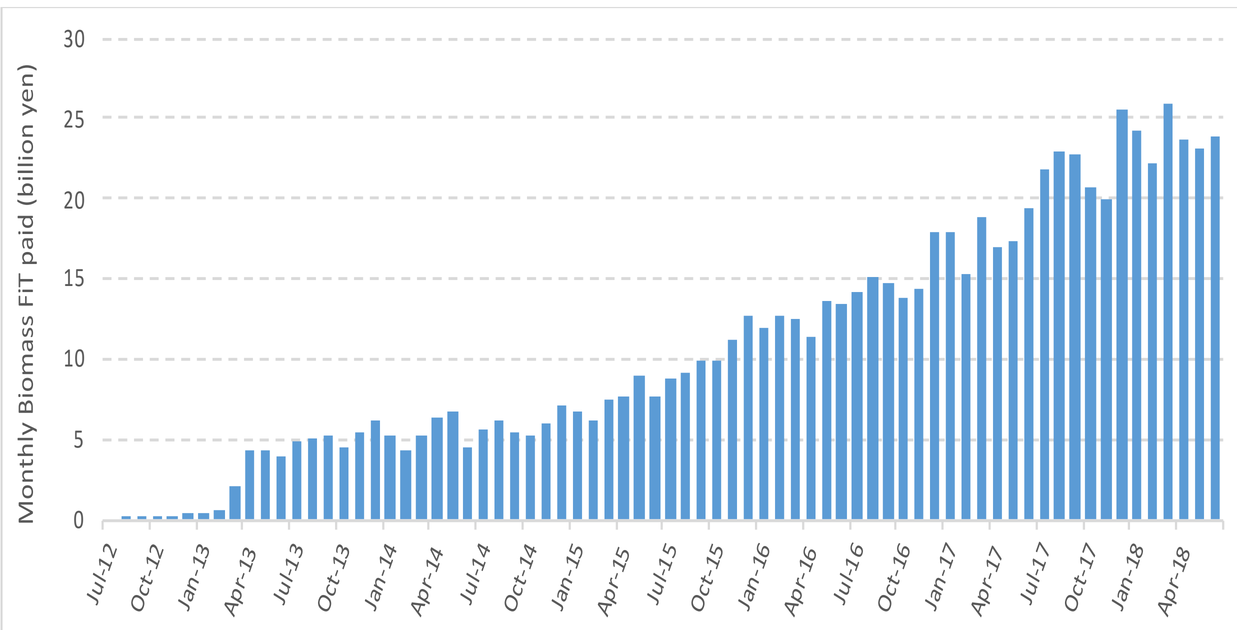

Figure 9. Monthly biomass FIT tariff paid

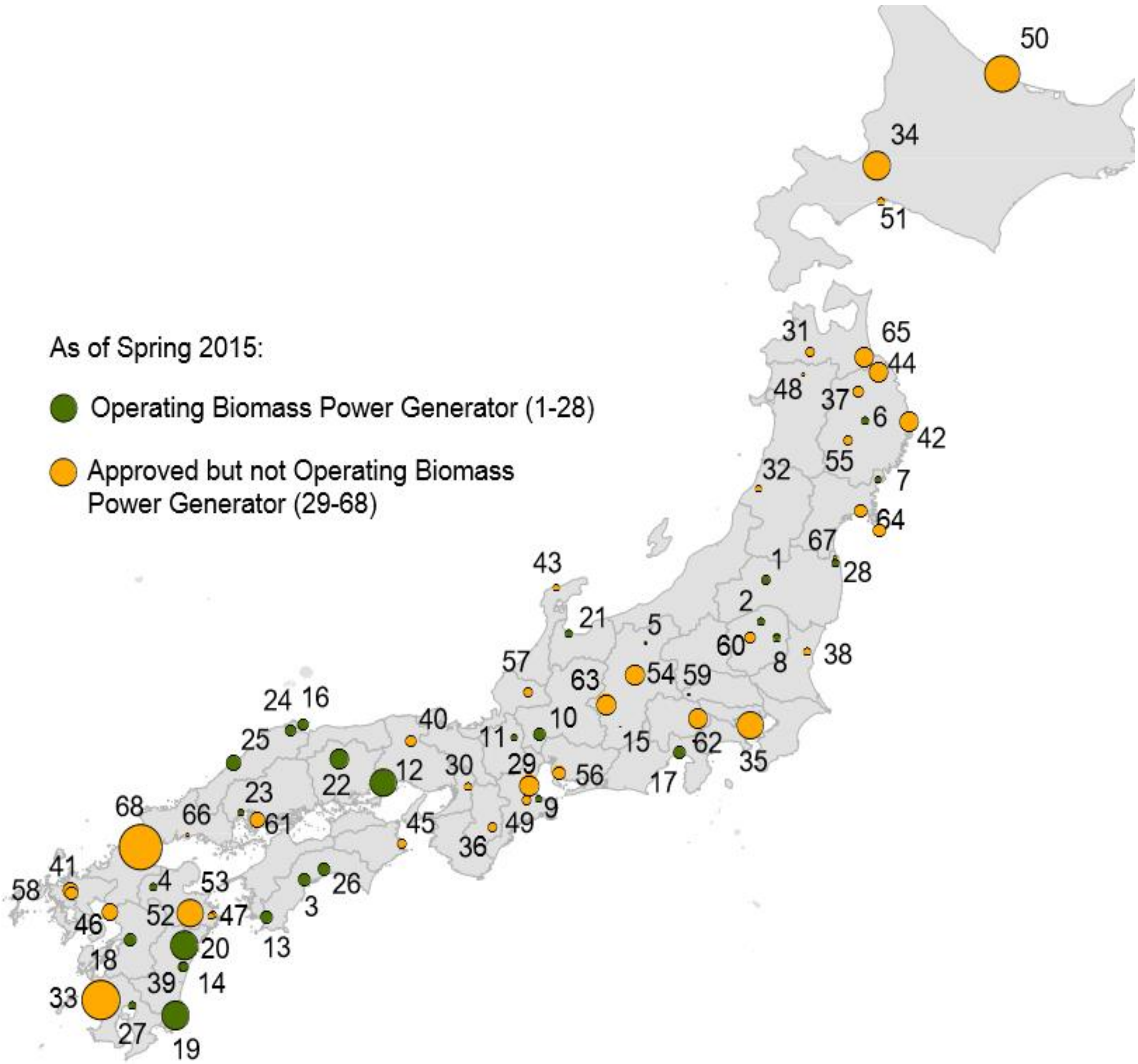

Figure 10. Existing and proposed woody biomass facility in Japan as of spring 2015

Figure 10 shows the map of biomass electricity plants (including co-firing plants) that were operating or had been approved for construction as of Spring, 2015. The size of the dots represents the capacity of the electricity generators at each location (larger dots represent larger energy production capacities). In addition, 40 new biomass electricity plants had been proposed (but had not yet received approval) to take advantage of the generous subsidies provided under the FIT program.

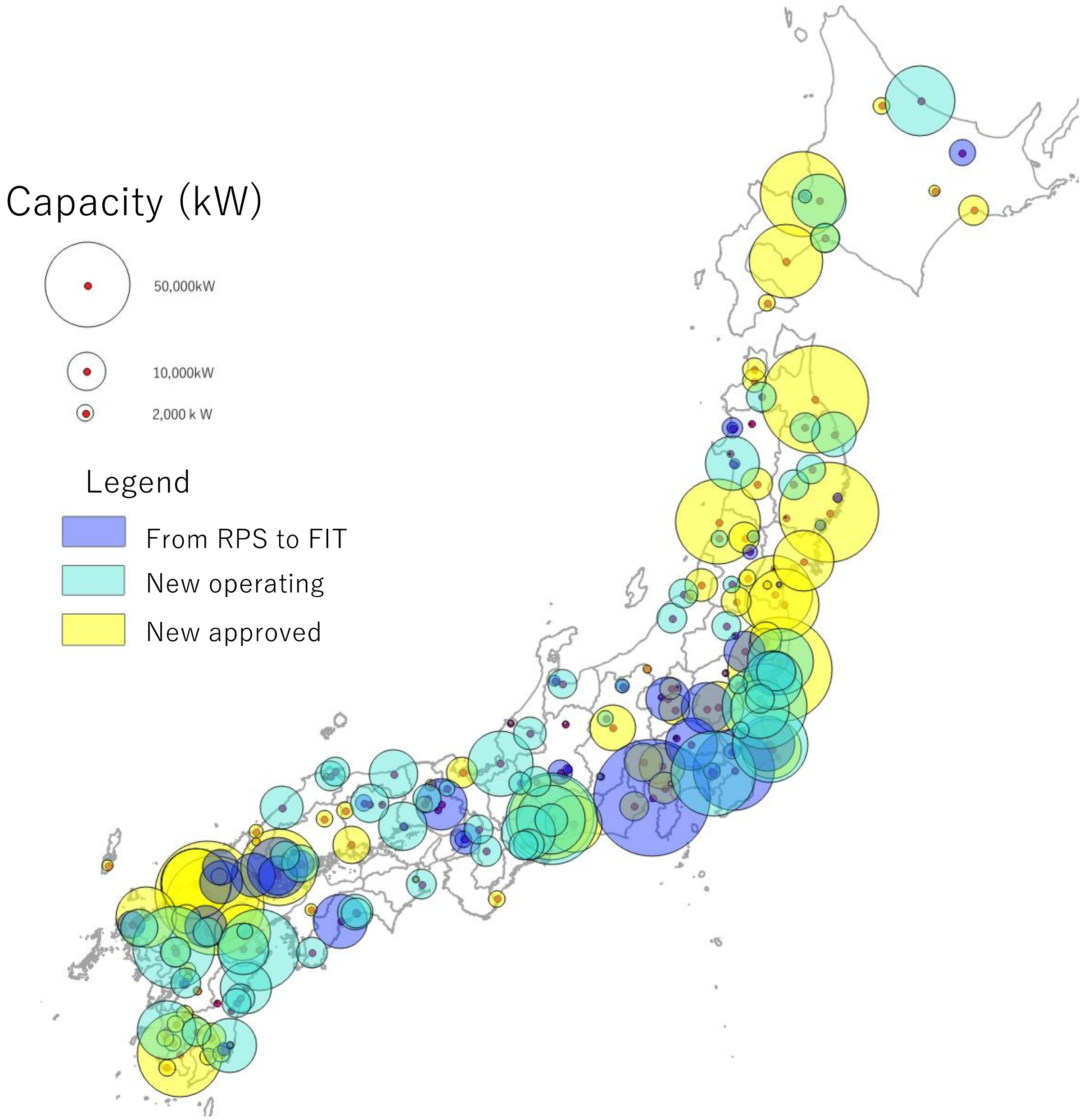

Figure 11. Operating, preparing and other woody biomass power plants as of September 2017
(Source: JWBA 2018)

Figure 11 shows the location of each of the biomass electricity plants (including co-firing plants) and projects as of September 2017 based on the database maintained by the Japan Wood Energy Company (2017). Note that the total number of biomass energy projects jumped from 68 projects in mid-2015 to 223 projects by the middle of 2017. Similar to Figure 10, the size of the dots represents the capacity of each electricity generator. The blue dots represent the woody biomass power plants that were operating in May 2017 whereas the red dots represent the woody biomass power plants that are expected to begin operating in the near future. The gray dots represent biomass power plants that have been approved under the FIT program but for which there is no information publicly available, indicating that these projects are not planning to begin operating in the near future or they have not disclosed any information regarding their operation.

A more detailed summary of the biomass electricity plant data through 2018 is shown in Table 2. By the end of 2013, only five biomass plants were operating (3 fueled by forest thinnings and 2 by ordinary wood) with a total operating capacity of 42,665 kW). An additional 25 biomass plants were approved in 2013 with an additional production capacity of 499,995kW. By the end of 2014, 15 new biomass plants had begun operating with an operating capacity of 60 kW (including one plant that utilized recycled wood) while 47 biomass plants which had been contracted under the Renewables Portfolio Standard (RPS) program were transferred to the FIT program (note that we do not include these biomass plants with those that were initially contracted under the FIT program). Also, in 2014 an additional 75 biomass power plants were approved with an operating capacity of 979,834 kW. By the end of 2015, 38 new woody biomass plants were operating with 334,660 kW capacity while 46 biomass plants contracted under the RPS program were transferred to the FIT program. In 2015, an additional 133 biomass power plants were approved with an operating capacity of 2.6 MW. Finally, 56 new woody biomass plants began operating in 2016 with a production capacity of 568 kW while an additional 46 biomass plants transferred from the RPS program to the FIT program. In 2016, 196 new woody biomass power plants were approved for operation by METI under the FIT scheme, with a total capacity of approximately 3.7 GW. In 2019, 319 new woody biomass power plants were approved for operation by METI under the FIT scheme, with a total capacity of approximately 8 GW.

Based on the trends in this data it is possible to make several observations regarding biomass energy and the new FIT program. First, the generous subsidies provided to the biomass industry have been spectacularly successful in expanding the energy production capacity in this sector, with the numbers of both operating and approved facilities growing quickly over time. Second, while it appears that the vast majority of the growth in the biomass energy sector between 2013 and 2018 has been in the ordinary wood biomass sector rather than the unutilized wood biomass sector based on the total approved energy production capacity (19 GW versus 2.3 GW), the actual amount of energy production capacity is only slightly higher in the ordinary wood sector (1.71 MW versus 1.16 GW). Third, the average size of a biomass energy production facility within the ordinary wood sector is substantially larger than in either the unutilized wood or recycled wood sectors, Table 3. Fourth, many experts in the energy and forestry sectors doubt whether the supply of domestic unutilized wood (branches and thinnings) or imported ordinary wood (pellets and PKS) is sufficient to meet the demand of this rapidly growing sector.

Table 2. Approved and operating biomass facilities under FIT

	Unutilized Wood	Ordinary Wood	Recycled Wood	Other Waste	Methane Gas
		By December 2013			
Total Approved (#)	12	13	3	25	39
Total Operating (#)	3	2	0	14	15
Total Approved (kW)	150,380	349,615	43,870	165,050	7,578
Total Operating (kW)	12,900	29,765	0	74,950	1,818
		By December 2014			
New Approved (#)	43	28	4	52	76
New Operating (#)	9	5	1	24	38
From RPS to FIT (#)	7	10	30	160	29
New Approved (kW)	324,997	643,460	11,377	257,795	18,481
New Operating (kW)	30,011	30,075	317	67,784	7,829
From RPS to FIT (kW)	9,588	73,800	332,011	705,972	11,209
		By December 2015			
New Approved (#)	58	72	3	70	125
New Operating (#)	25	11	2	39	60
From RPS to FIT (#)	7	10	29	159	29
New Approved (kW)	390,927	2,194,979	11,060	221,826	42,511
New Operating (kW)	187,661	137,699	9,300	125,036	15,752
From RPS to FIT (kW)	9,053	73,800	331,916	701,892	11,201
		By December 2016			
New Approved (#)	76	115	5	90	181
New Operating (#)	36	18	2	60	89
From RPS to FIT (#)	7	10	29	157	29
New Approved (kW)	420,859	3,212,449	36,950	251,499	65,071
New Operating (kW)	284,356	273,769	9,300	174,657	25,868
From RPS to FIT (kW)	9,053	73,800	331,916	699,670	11,201
		By December 2017			
New Approved (#)	114	340	6	90	231
New Operating (#)	51	28	2	75	121
From RPS to FIT (#)	7	10	29	152	28
New Approved (kW)	506,538	11,306,217	87,450	249,405	91,976
New Operating (kW)	317,321	570,172	9,300	215,035	39,050
From RPS to FIT (kW)	9,053	73,800	332,516	692,186	10,101
		By December 2018			
New Approved (#)	110	193	6	98	210
New Operating (#)	62	44	4	85	151
From RPS to FIT (#)	7	10	29	148	27
New Approved (kW)	483,566	7,747,571	88,406	331,332	79,393
New Operating (kW)	338,497	874,790	14,006	241,194	51,552
From RPS to FIT (kW)	10,650	109,696	340,093	675,405	10,460

Continued on next page

		By December 2019			
New Approved (#)	127	192	5	117	221
New Operating (#)	70	56	5	98	182
From RPS to FIT (#)	7	11	30	148	27
New Approved (kW)	501,156	7,471,408	85,690	391,590	85,332
New Operating (kW)	385,424	1,290,655	85,690	289,336	62,645
From RPS to FIT (kW)	18,633	201,720	386,159	688,954	10,460

Table 3. Average energy production capacity of approved and operating biomass facilities under FIT

	Unutilized Wood	Ordinary Wood	Recycled Wood	Other Waste	Methane Gas
		By December 2013			
Ave Approved Capacity (kW)	12,532	26,893	14,623	6,602	194
Ave. Operating Capacity (kW)	4,300	14,883	n/a	5,354	121
		By December 2014			
Ave Approved Capacity (kW)	7,558	22,981	2,844	4,958	243
Ave. Operating Capacity (kW)	3,335	6,015	317	2,824	206
		By December 2015			
Ave Approved Capacity (kW)	6,740	30,486	3,687	3,169	340
Ave. Operating Capacity (kW)	7,506	12,518	4,650	3,206	263
		By December 2016			
Ave Approved Capacity (kW)	5,538	27,934	7,390	2,794	360
Ave. Operating Capacity (kW)	7,899	15,209	4,650	2,911	291
		By December 2017			
Ave Approved Capacity (kW)	4,443	33,254	14,575	2,771	398
Ave. Operating Capacity (kW)	6,222	20,363	4,650	2,867	323
		By December 2018			
Ave Approved Capacity (kW)	4,396	40,143	14,734	3,381	378
Ave. Operating Capacity (kW)	5,460	19,882	3,502	2,838	341
		By December 2019			
Ave Approved Capacity (kW)	3,946	38,914	17,138	3,347	386
Ave. Operating Capacity (kW)	5,506	23,047	17,138	2,952	344

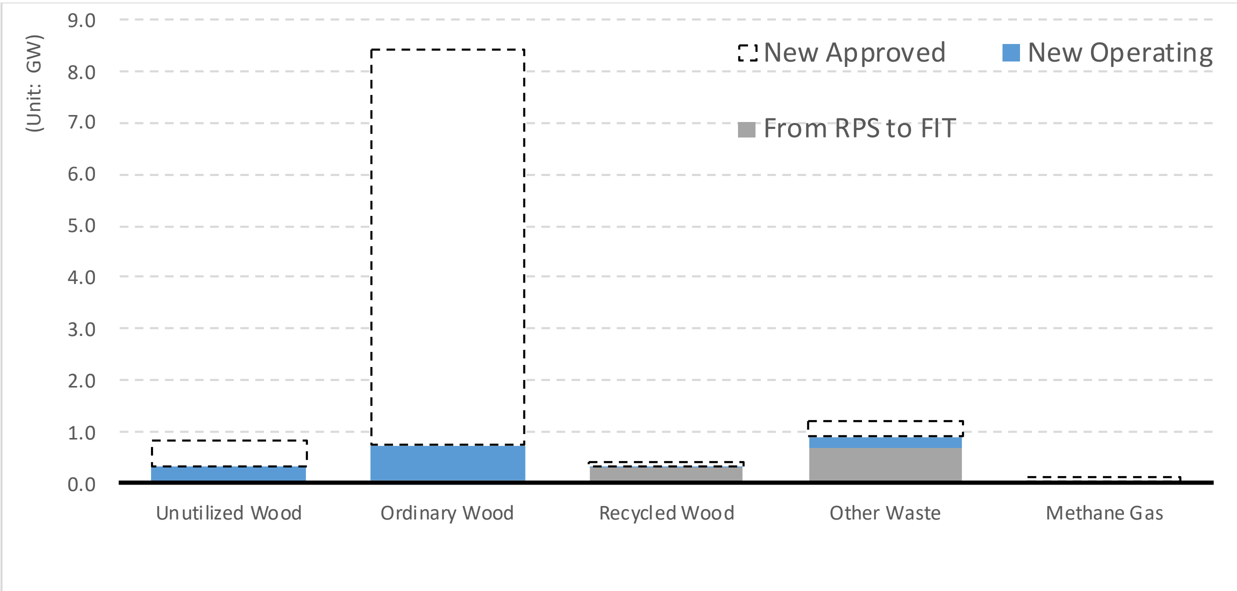

Figure 12. Installed capacity of biomass power plants under FIT as of June 2018

In order to visually emphasize the relationship between the number of operating biomass power facilities and those that have been approved but are not yet operating, consider the information presented in Figure 12. By June 2018, METI had approved 7.6 GW of biomass energy capacity in the ordinary wood sector (115 new power plants) while the actual energy production within this sector totaled just 0.7 GW from 36 new plants. The data presented clearly suggests that a huge volume of raw material will be required in order to bring the new facilities on-line, most of which will likely have to be imported in the form of wood pellets, PKS or palm oil.

Biomass Generator Operation

There is a wide variety of biomass electricity generators currently operating or planning to begin operations all across Japan, especially in rural areas. Biomass generating facilities range from large scale coal-biomass co-firing plants to biomass facilities co-located with wood manufacturing companies fueled by wood waste and sawdust to small-scale heat/electricity co-generators that utilize a wide variety of fuels (Aikawa, 2017). Since the types of these operations can be completely different it is very difficult (if not impossible) to generalize about the biomass bioenergy sector. However, some researchers have completed case studies that might help to understand the state of woody biomass operations in Japan (Aikawa 2017; Ikeya 2015; Taki et al. 2015).

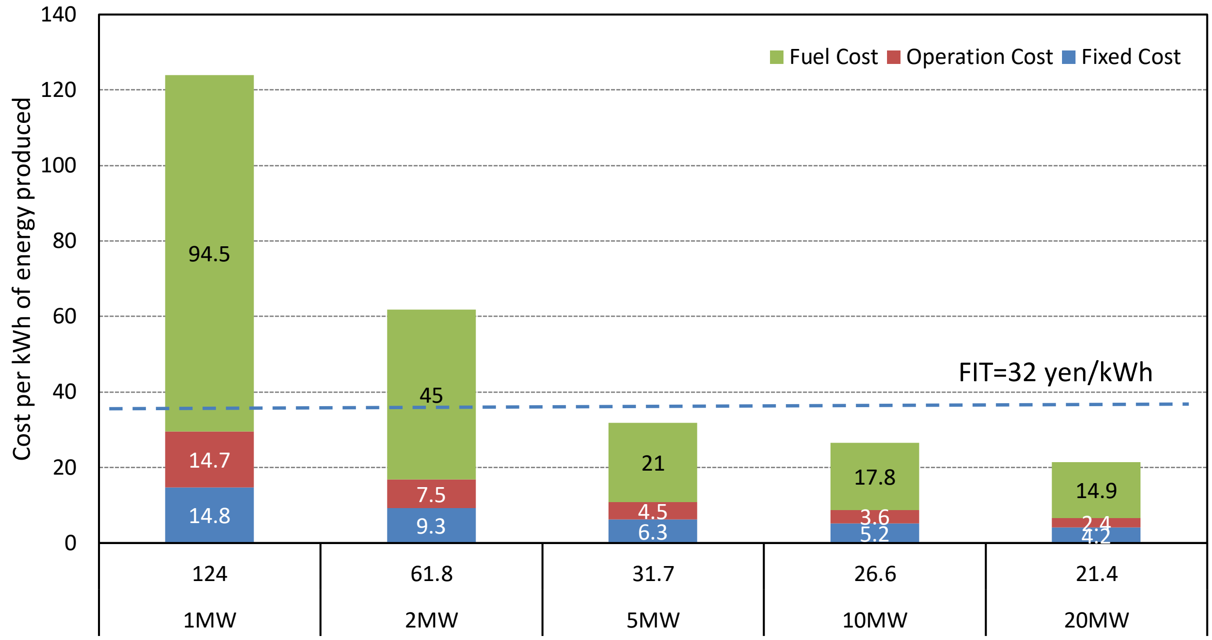

Figure 13. Woody biomass plant electricity generation simulated cost structure, by size of facility

Taki et al. (2015) simulated the cost structure of biomass power generators based on their size (amount of energy produced). Their analysis showed that all of the costs of operation (fuel costs, operating costs and fixed costs) decreased substantially as the scale of energy production increased, Figure 13. Their analysis also showed that when a company's biomass generator capacity reached 5 MW, it was able to generate a profit under the 32 yen energy tariff established by the FIT program. For 2 MW power facilities, their analysis suggested that these companies may be profitable only if they are able to sell both electricity and heat while 1 MW power facilities would not be profitable even in a co-generation situation. Based partly on this analysis, METI decided to increase the FIT tariff provided to small-scale biomass plants from 32 yen/kWh to 40 yen/kWh in April 2015. The most important take-away message from this analysis is that electricity production has obvious economies of scale although it is important to emphasize again that contracting a sufficient volume of woody biomass becomes more and more important (and difficult) as the size of the biomass facility increases.

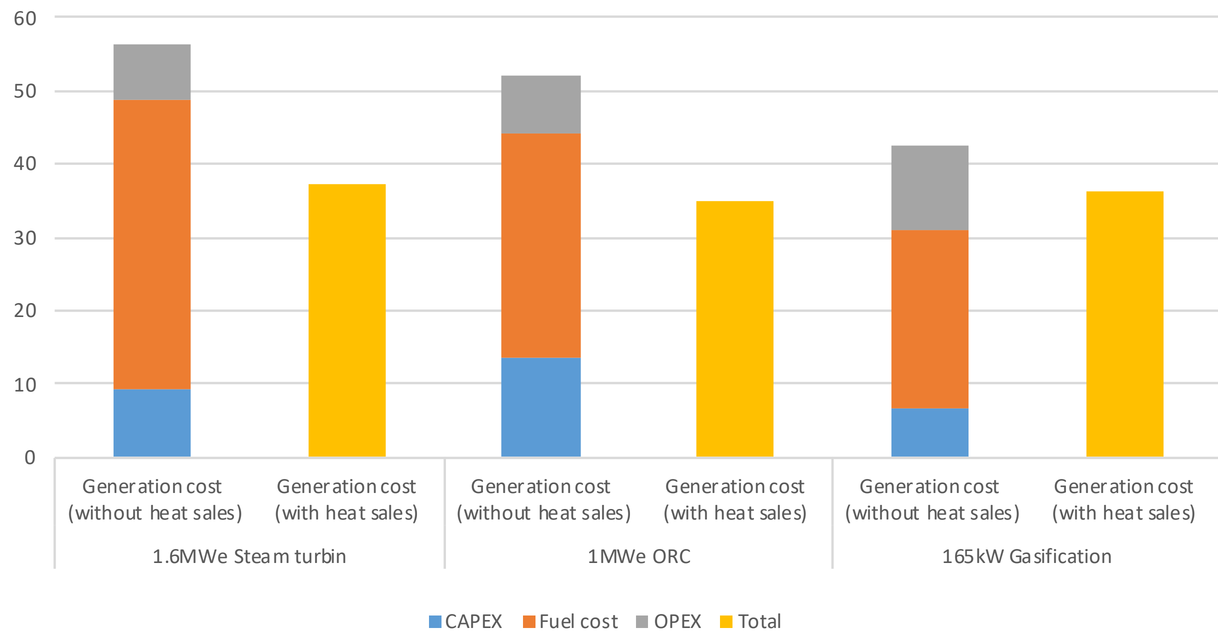

Figure 14. Electricity cost by small biomass generators: empirical results (JWBA, 2016)

Ikeya (2015) conducted a series of empirical case studies of the financial feasibility of operating three different types of small-scale (2 MW or smaller) biomass co-generating plants, including: a) a 1.6MW steam turbine, b) a 16.5 kW gasification plant, and c) a 1 MW Organic Rankine Cycle (ORC) power plant, Figure 14. The total cost per kWh of energy produced was 56.2 yen, 42.6 yen, and 52.2 yen, respectively. None of these small power plants was able to generate a positive cash-flow by relying solely on the FIT subsidy of 32 yen/kWh. However, these types of plants can also sell heat (assuming that 60% of the heat produced can be recovered for sale and that the revenue generated from the sale of this heat is 10.8 yen/kWh). When the additional revenue derived from the sale of the heat was included in the analysis (the solid orange bar), the results suggest that all of the small-scale co-generating technologies would become profitable. The results derived from this analysis further emphasize the fact that scales of economy strongly influence the profitability of biomass generators.

Biomass Supply

Within the biomass electricity sector, companies would prefer to utilize unutilized domestic wood (thinnings) whenever possible to maximize the tariff they receive under the FIT program. However, limited availability and the high cost of purchasing and transporting unutilized domestic wood is always a problem, particularly in rural areas and areas where competition for forest residues is high. For example, the cost of transporting thinnings is relatively high and the heat content of forest thinnings, especially in D-zai logs, is relatively low. Anecdotal information suggests that some biomass plants are beginning to purchase other grades of logs including A, B and C-zai, by claiming that these logs are derived from selective harvest operations. In this way they are able to obtain higher quality logs with a higher heat content while still qualifying for the 40 yen/kWh FIT tariff for unutilized wood (typically only allowed for D-zai logs and forest residuals) rather than the lower 24 yen/kWh FIT tariff that is applied to ordinary wood (the typical FIT program classification applied to A, B and C-zai logs).

According to Ando (2014), the total economic supply of unutilized domestic wood in Japan was projected to be approximately 4.12 MMT in 2016 whereas the demand for unutilized domestic wood was projected to exceed 4.27 MMT. By 2017 it is widely expected that the economic supply of unutilized domestic wood will be insufficient to meet the rapidly growing demand for unutilized domestic wood within the biomass sector. Consequently, Japanese biomass generators will need to supplement their raw material supply with ordinary wood (either domestically sourced logs, imported chips and pellets or PKS). The long-term 2030 METI energy forecast indicates that Japan will generate 240 MW of power from unutilized wood and an additional 2.74-4 GW from ordinary wood. As noted earlier in Table 4, the total power generating capacity of the ordinary wood energy sector under the FIT program has already reached 3.2 GW although 0.35 MW of energy was actually being generated by the end of December 2016. In order to achieve METI's goal, Japan needs to access between 55 and 80 million m^3 of ordinary woody biomass in order to meet its goal of generating 2.74-4 GW of energy. This volume of woody raw material is extremely large, particularly given the fact that Japan already imports about 50 million m^3 of wood mainly for use in the construction and paper manufacturing sectors. If METI's forecast is accurate, then this suggests that Japan's wood imports may double or triple by 2030, despite the fact that the massive FIT tariffs (subsidies) provided to develop the bioenergy sector were primarily designed to increase the demand for domestic wood materials and increase Japan's wood self-sufficiency ratio.

One of the most important sources of ordinary "wood" biomass for large-scale co-firing biomass plants in Japan is currently palm kernel shells (PKS) imported primarily from oil palm plantations in Indonesia (77.9%) and Malaysia (22.1%). While PKS was a minor feed ingredient in the past, virtually all PKS imported into Japan is currently used for biomass power generation (Aikawa 2017; USDA FAS, 2019b; USDA FAS, 2020). Since the FIT biomass program was initiated in 2013, PKS imports into Japan have skyrocketed, growing from 26,000 MT in 2012 to 131,000 MT in 2013, 244,000 MT in 2014, 470,000 MT in 2015 and 761,000 MT in 2016, almost doubling every year since 2013, Figure 15. In 2019, Japanese imports of PKS reached a record 1.64 million tons.

PKS is relatively inexpensive and contains enough energy density to be used in co-firing coal plants. PKS is especially attractive since it can be mixed with coal without changing the grinding equipment used in coal-fired power plants. In addition, PKS can be stored outdoors without special protection from the elements without deteriorating. Both of these factors are serious disadvantages when compared to using wood chips and pellets to help co-fire coal plants. The bioenergy sector has claimed that using PKS as an energy source is sustainable since PKS are an industrial waste generated during the production of palm oil and if not utilized for bioenergy feedstock is simply discarded at the oil palm processing facility where the waste shells pollute the ground water. Based on this logic, METI approved PKS as a sustainable material as required under the FIT program. Recently, however, some environmental groups have expressed concern that the skyrocketing demand for PKS in Japan is contributing to an unsustainable expansion of the oil palm estate and helping to drive deforestation in tropical countries.

Can PKS satisfy the demand for the operating and approved biomass energy generators in Japan? Energy experts in Japan note that it is impossible for PKS to solve the supply problem on its own. Indonesia and Malaysia are the two largest producers of PKS in the world and the main suppliers of PKS to Japan. In 2018 their total annual production of PKS was only 10.3 and 4.8 million MT, respectively (FAOSTAT 2019). These volumes are too small to satisfy the total raw material demand in the bioenergy sector although PKS can be an important component of the overall biomass supply equation.

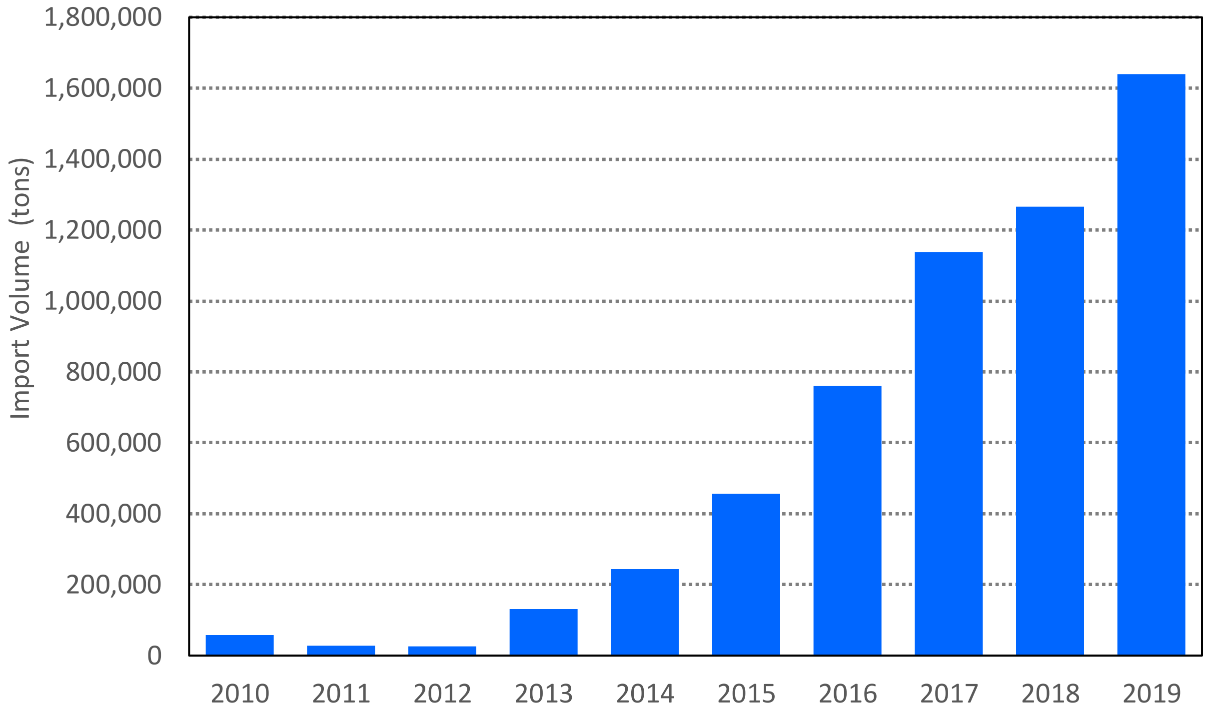

Figure 15. Palm kernel shell imports to Japan (HS code: 2306.60-000)

Another potential woody biomass supply is densified wood pellets. Japan produced about 120,000 MT of wood pellets in 2013, almost double the volume produced in 2009 (Figure 16). The Japanese pellet industry is largely composed of small pellet producers with an average annual production volume of 842 MT in 2016. Total wood pellet production was 129 MMT in 2019 from 149 wood pellet manufacturers. As shown in Figure 16, there has been almost no increase in the volume of pellets produced, or the number of pellet manufacturers in Japan, since the introduction of the new FIT program in 2013. This is interesting given the huge subsidies that the Japanese government is providing to expand the use of woody biomass produced from domestic wood as well as the strong increase in the demand for imported wood pellets Figure 17.

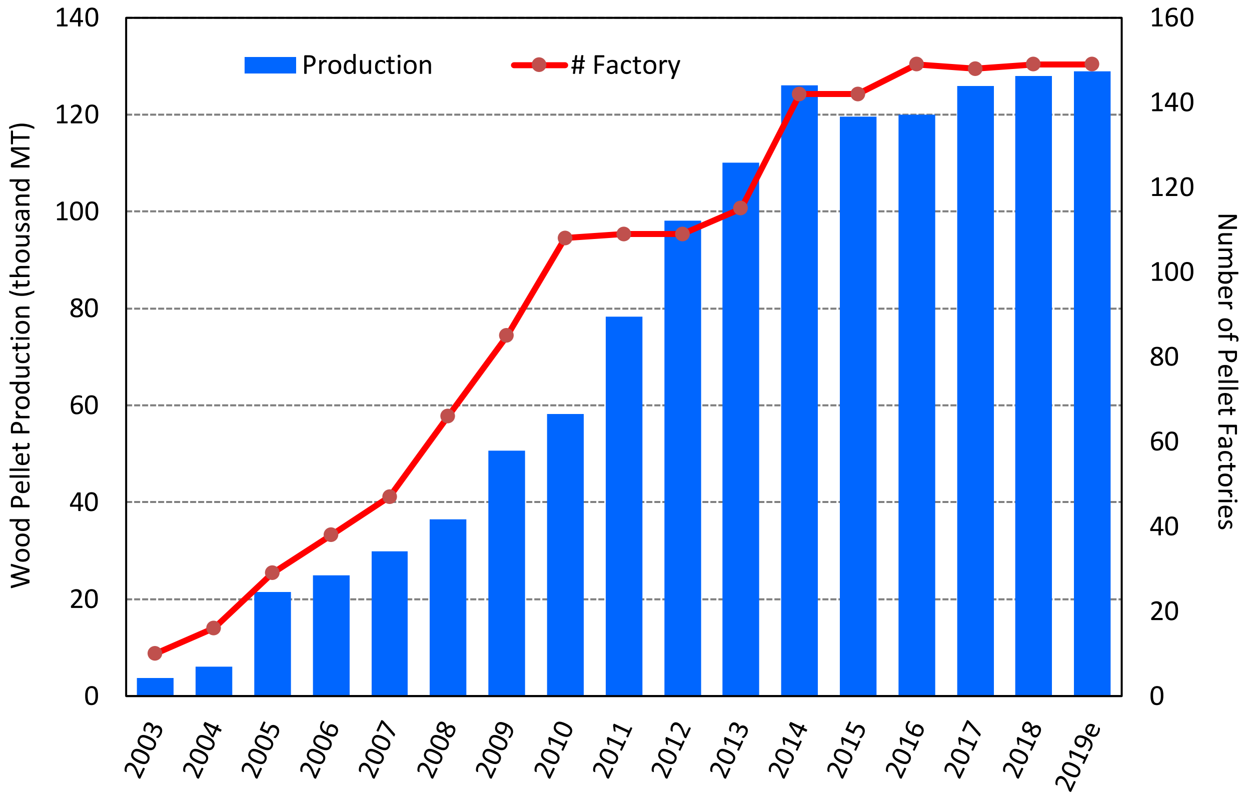

Figure 16. Japanese domestic wood pellet production: production volume and the number of factories

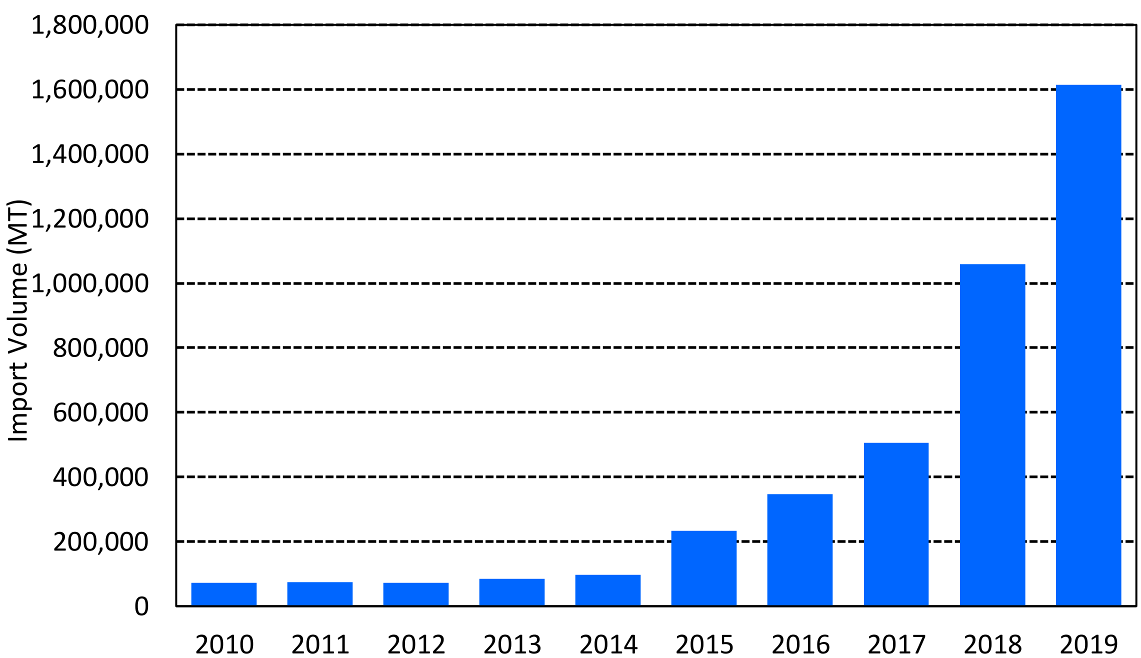

Figure 17. Annual Japanese wood pellet imports

As demand for wood raw materials has exceeded the domestic supply and as more biomass power plants began to come on-line, the demand for imported wood pellets has grown rapidly since 2014, Figure 17. In the past, Japan imported wood pellets primarily from Canada. However, the growing demand for wood pellets in Japan, combined with supply constraints in Canada, has provided an opportunity for new wood pellets suppliers in Japan. As a result, Vietnamese exports of wood pellets to Japan have skyrocketed since 2017 and Vietnam eclipsed Canada as the largest wood pellet supplier to Japan in 2019, Figure 18. Wood pellet import prices have declined consistently since the introduction of the new FIT program led to increased demand in Japan. Between 2013 and 2019, the average price of imported wood pellets dropped from $242/MT to $174/MT. Much of this price decline has been driven by lower cost imports from Asian countries, especially Vietnam. For example, the average price of wood chips imported from Canada and Vietnam in 2019 was $185/MT and $165/MT, respectively.

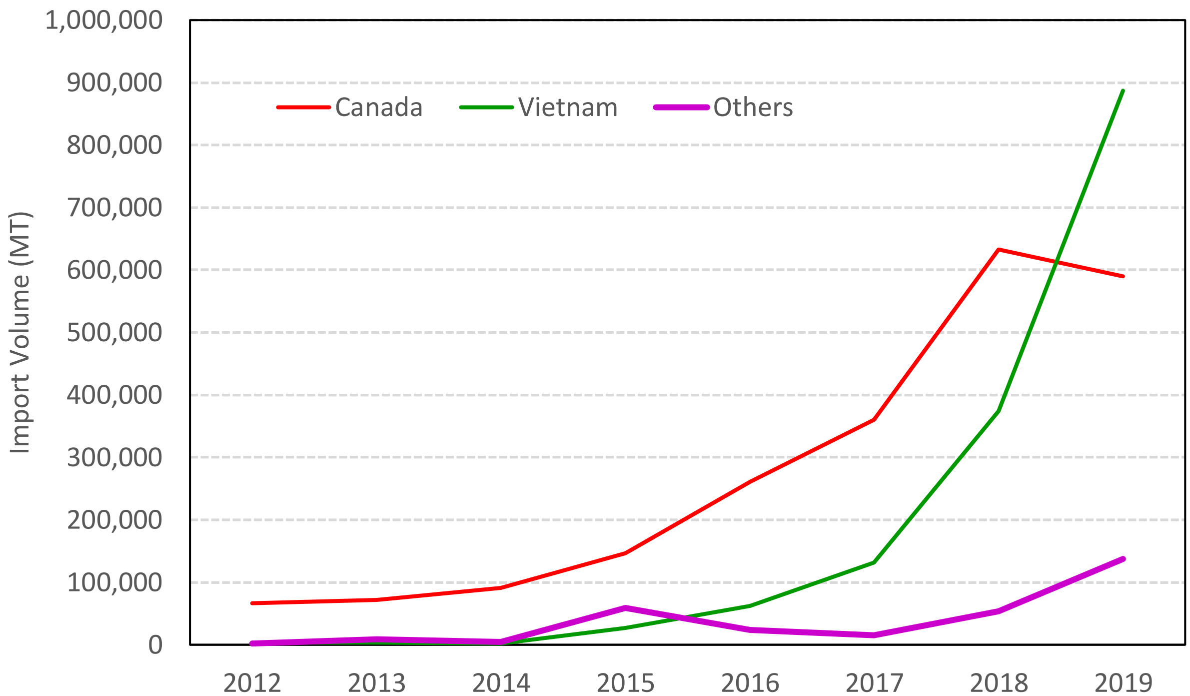

Figure 18. Major suppliers of Japanese wood pellet imports

Industry experts predict that demand for wood pellets in Japan will greatly exceed the domestic production capacity (Okamoto 2016; Aikawa 2017). Given the relatively high price of domestic wood pellets (about 40 yen/kg as per Okamoto, 2016), demand for imported wood pellets is expected to continue to increase. For example, there are 40 new coal plants expected to start operations in the near future, of which 25% are expected to be co-fired using wood pellets. To date, US exports of wood pellets to Japan have been relatively minor, despite the fact that the US is the largest exporter of wood pellets in the world. US wood pellet production has increased dramatically in the US South in response to strong demand in Europe, particularly in the UK. Given the strong long-term demand for wood pellets in Japan, the wood pellet export sector could represent a promising new market opportunity for the forest products industry on the US west coast where there is currently little wood pellet manufacturing capacity.

The recent expansion of coal fired energy plants also provides export opportunities for new types of wood energy products such as torrefied wood pellets. Japanese coal-fired plants are typically owned by large electricity companies or other large players who have been expanding their production capacity following the deregulation of the electric power sector. Many of these companies are looking to co-fire coal with biomass in an effort to alleviate environmental concerns in Japan and to qualify for the FIT tariff program. Large co-firing coal power plants prefer not to use regular (white) wood pellets because they are difficult to grind using their current grinder technology, their heat content is relatively low and they need to be stored in covered facilities to prevent degradation from exposure to the elements. In addition, the grinder technologies used by Japanese coal plants are not suitable for PKS.

One option that has attracted much attention in Japan is black, or torrefied, wood pellets. Torrefaction is the process of roasting wood or other biomass material at high temperatures in an oxygen-deprived environment. This process removes moisture from the wood while changing its chemical composition. The torrefied wood can be ground and processed through a pellet mill to create more energy dense and durable torrefied pellets. Torrefied pellets are a preferred option for coal fired power plants because torrefied pellets burn similar to coal, making them an easy replacement for coal in power plants originally designed to use only coal. Additionally, torrefied pellets do not require coal plants to invest in additional equipment, such as new grinders or storage silos. For example, a recent industry report noted that a coal power plant recently tested torrefied wood pellets and experienced minimal fouling when co-firing with a 70%-30% mix of torrefied pellets to coal while the same plant experienced severe fouling when co-firing industrial (white) wood pellets in excess of 10% (New Biomass, 2018). Another advantage of using torrefied pellets is that they are hydrophobic and do not decompose when exposed to the elements, so they are easier to store at power plants. In general, black pellets contain 20% more heat content than white pellets and cost about 20% more than white pellets. They are more than 70% easier to crush, weigh less and have a similar caloric heat value to coal while generating fewer emissions. Finally, the transportation costs for black pellets are lower because they are less bulky than many other types of biomass feedstocks (e.g., wood chips).

New Trend and Uncertainty

While biomass demand in Japan is expected to continue increasing in the future, there are some uncertainties. The largest factor that could influence the demand for biomass energy is related to the restarting of the nuclear power plants which could change the price dynamics within the Japanese power sector. Following the closure of virtually all nuclear power plants between 2011 and 2013, the power industry announced plans to build a large number of coal power plants, many of which would include co-firing coal with biomass to reduce their environmental impacts. In April 2017, the KEPCO power company announced the conversion of their Aioi Power Station’s 2nd plant in Hyogo Prefecture (currently using heavy crude oil with a 0.375 MW generating capacity) to woody biomass with a 0.2 MW capacity (which will be one of the largest woody biomass power plants in the world). KEPCO entered into a joint venture with Mitsubishi Corporation to ensure a steady supply of woody biomass. However, while the FIT program currently provides tariffs for coal/biomass co-firing plants, some industry experts suspect that METI may change this soon. Since adapting coal plants to co-firing plants requires less investment than new woody biomass plants, there is speculation that METI may reduce the FIT tariffs for co-firing power plants. Thus, there is much uncertainty now regarding FIT tariffs for the coal/biomass energy sector and it is very difficult to forecast how, or if, METI will modify the FIT program and its support for coal/biomass co-firing power plants in the future. Changes in the FIT program could very well change the demand for woody biomass in Japan.

3. Conclusions

Following the Tohoku earthquake and Fukushima nuclear meltdown in 2011, Japan introduced a Feed-in tariff (FIT) program to develop the renewable energy sector and investment is shifting toward the biomass sector. In order to increase the demand for domestic wood and help revitalize rural mountain communities, the Japanese government and the Forestry Agency have developed and implemented strategies designed to promote and subsidize the expansion of woody biomass energy. Developing this new industry is currently an on-going activity and it is likely that success in this area would greatly increase the demand for woody biomass, exceeding the domestic supply of woody biomass (including forest thinnings) and thereby provide new opportunities for wood exporters.

Huge opportunities for imported chips and wood pellets. According to the energy mix outlook, the Japanese woody biomass sector will generate between 2.7 – 4 MW of electricity by 2030. Meeting the demand for woody biomass in this sector will require approximately 20 – 30 million MT of additional woody biomass, an amount that far exceeds the domestic supply available in Japan. Currently, Japan primarily imports wood pellets from Vietnam and Canada. While imports from China and Southeast Asia have increased substantially since 2015, there are concerns about whether wood pellets from this region are produced from a sustainable resource as required under the FIT program. In contrast, woody biomass produced in the US and Canada is sustainable and would qualify for the tariff for ordinary wood under the current FIT program (USDA FAS, 2019a; USDA FAS 2020). Given this situation, exporting wood chips, white pellets and torrefied (black) pellets represents a strong new market opportunity for the US forest products industry.

Opportunity for lower quality wood and logs in Japan. Historically, Japan has purchased high quality logs and lumber from the US (i.e., J-grade). Given the growing demand for woody biomass and cross laminated timber panels (which can be manufactured using lower quality lumber) in Japan, there exists a possibility to expand exports of lower quality logs and lumber. This is particularly true now that the price of smaller diameter domestic sugi logs has begun increasing in Japan. In addition, due to additional revenue generated through the FIT program, the value of large logs exported to Japan may increase since Japanese sawmills can benefit from the revenue derived from burning sawmill residues for energy.

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