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The Market for Biogas Plants in Japan and Opportunities for EU Companies

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List of Abbreviations

ANRE	Agency for Natural Resources and Energy
BOD	Biochemical oxygen demand
CHP	Combined Heat and Power
DS	Dry Substance
FIP	Feed-in Premium
FIT	Feed-in Tariff
GW	Gigawatts
ICT	Information and Communication Technology
JORA	Japan Organic Recycling Association
kWh	Kilowatt-hours
MAFF	Ministry of Agriculture, Forestry and Fisheries
METI	Ministry for Economy, Trade and Industry
MoEJ	Ministry of the Environment, Japan
MoF	Ministry of Finance
MSW	Municipal Solid Waste
MW	Megawatts
NGO	Non-Governmental Organisation
OCCTO	Organization for Cross-regional Coordination of Transmission Operators
PKS	Palm kernel shells
PV	Photovoltaic
RSB	Round Table for Sustainable Biomaterials
RSPO	Round Table for Sustainable Oil
SPC	Special purpose company
SS	Suspended Solids
T-N	Total Nitrogen
T-P	Total Phosphorus

1. Executive Summary

The share of electricity generation from renewable energy sources in Japan has increased steadily over the past 5 years. This applies in particular to photovoltaics (PV) and biomass. But the role of Biogas in Japan's energy mix, especially in comparison to other renewable energies such as solar energy, is still of little significance. Although the generation of biogas currently plays a subordinate role in Japan the biogas sector shows a positive development and current policy strategies illustrate the increasing importance of biogas production in Japan.

As the Japanese electricity market is now largely liberalised a growing number of local electricity companies are starting to sell energy to end-users. In many areas (rural and urban), there is a high interest from customers and new energy companies to offer "green" electricity. Besides the fluctuating renewable energies such as wind or photovoltaics (PV), especially biogas is a suitable renewable energy source to deliver a stable supply with "green" power and can in combination with other renewables provide balancing power source. For 2030, the Japanese government is aiming for a 22-24 % share of renewable energies in the electricity mix. Therefore, bioenergy is also expected to play an important role in the future.

In order to achieve this goal, the Japanese government introduced several strategies such as the 6th Strategic Energy Plan (expected to be released in 2021) with the aim of covering carbon through biomass, setting basic plans for biomass utilization in all prefectures and strengthening international competitiveness in the biomass sector. Also the Biomass Industrialisation Strategy" (already introduced in 2012) strives to industrialize and commercialize the use of biomass and to introduce efficient collection and transport systems. The "5th Strategic Energy Plan" (released in 2015) lists biomass as an important source of energy to stimulate regional economic activity, particularly in rural areas of Japan.

The support for the feeding of electricity produced from biomass has remained almost constant over the last 6 years, which means a good planning security for the economic operation of biogas plants in Japan. For biogas, this feed-in tariff is 39 JPY/kWh, which is approx. 0.31 €/kWh. Japan has also decided to introduce a feed-in-premium (FIP) scheme for renewable power sources from April 2022. The new mechanism will allow renewable power producers to sell their electricity in a spot market at a premium to wholesale prices.

Currently limited access in several (and especially rural) regions in Japan for renewable electricity generation plants to the electricity transmission grid is considered one of the main factors hampering the growth of renewable energy. But energy experts are increasingly pointing out that in particular the conversion of bioenergy (e. g. biogas, solid biomass) can be used very well for grid stabilization due to its flexibility in the generation of electricity and its permanent availability. Solutions to overcome this obstacle include recalculations of the current grid situation, reinforcements of the electricity networks, the introduction of smart grids and the controllability of biogas plants and thus their net strengthening effect. This requires above all a stronger cooperation between biogas plant and network operators as well as raising awareness in local and national policy.

In 2019, 221 biogas plants with a total capacity of approx. 85 MW were operating. Compared with some European countries (e.g. Germany with approx. 9,500 biogas plants and a total capacity of approx. 5 GW), this number seems to be very small. However, keeping in mind that the Japanese biogas market is still in its starting phase and current strategies of the Japanese government and subsidy programmes are going to pave the way for biomass technologies

as an important energy source for reaching the Japanese climate targets, the biogas market is expected to grow significantly within this decade.

Feedstock trends are shifting from the traditional livestock excreta and sewage sludge to a composite of the latter and food waste including industrial waste and food scraps. In urban areas there is a potential growth market within this sector.

The main substrates in Japan for use in biogas plants are:

- Food Waste: currently mainly collected in the food industry, restaurants, and (partly) by collection initiatives of municipalities
- Livestock manure: Livestock farming plays a major role in the Hokkaido and Kyushu regions, but also in some other parts of the main island Honshu. Currently (2019) 90 % of livestock manure in Japan is composted. If digested, livestock manure from cattle, pigs and poultry would have a high potential to generate electricity (with a potential of approx. 1.65 GW) and organic fertiliser as well. The total number of agriculture-based biogas plants in Japan is estimated at 100 facilities, of which around 70 are located in Hokkaido alone.
- Sewage sludge: Since May 2015, the obligation to recycle sewage sludge as fuel or fertiliser has been in place. Currently only 5 % of wastewater treatment includes fertilising of the sewage sludge. In 2018, 104 wastewater treatment plants operated biogas digesters.

The biogas market is characterised by two different types of fermentation processes, wet and dry digestion. Digesters in Japan tend to be small in size sometimes even with small capacities for a biogas plant power of 50 kW. One reason for these small sizes is the virtual absence of larger municipal solid waste processing biogas plants. Nearly 80 % of waste collected in Japan is incinerated rather than recycled. Another reason lies in the fact that several grid operators only allow electricity feed-in with a limited capacity for new biogas plants.

For European companies deciding to do business in Japan, there are four ways to set up operations: A sales agent (this could also be a Japanese partner), a representative office in Japan, establishing a Japanese branch or an incorporation. Especially for SMEs in the beginning, a partnership with a domestic player is a good way for a market entry. Such a partnership can take various forms: arrangements for the collection of feedstock arrangements, technology alliances, joint ventures or value chain alliances. Ideally, these partners belong to the biogas sector such as plant manufacturers (incl. planning service providers) and constructing companies. Many of these companies already utilize technologies and components made by foreign manufacturers for their biogas plants, as for example combined heat and power generators (CHP). These partners can also act as distributors for biogas plants as well as a local agent or distributor to sell in foreign markets. Trading houses are also considered as further potential partners.

For a successful market entry also a membership in associations e.g. joining the Japan Organic Recycling Association (JORA) is recommended in order to get contacts to multipliers from industry and municipalities in order to access an extensive network, including project developers, technology providers, consultants and engineers. Visits of expert fairs in the biomass sector (such as the regularly organised Biomass Expo fair) may be helpful to get in contact with potential customers and partners.

The legal framework of sustainability criteria for biomass fuels, compared for example to the EU, is still not sufficiently developed in Japan. many parts of the framework of sustainability criteria for biomass fuels are still in discussion. The current discussion focuses e. g. on new standards of environment, society, labour, and governance as well as on third party certifications giving a proof on supply chains of main products (such as bio-substrates, general wood, palm oil etc.) along the entire value chain. The Ministry for Economic, Trade and Industry (METI) has currently established a working group for discussing further assessment standards for sustainability because of the rapid increase of biomass fuel import since last few years.

For a market entry several steps are recommended as for example to enter into a partnership with domestic players. This is recommended not only for sales, installation and service/maintenance activities but also for dealing with Japanese regulations and standards as well as local and national subsidy programmes. Establishing contacts to biomass/biogas networks between farmers, local associations and authorities and Non-governmental organizations/associations can also be a recommendable step for successful marketing in Japan.

The utilisation of food waste possibly mixed with co-substrates from agriculture seems to be the most promising application for biogas plants. As a homogenous quality and composition of the substrates cannot be guaranteed and it may happen that in future other input substrates (possibly as co-substrates) may be used biogas plants should be flexible to accept a variety of input substrates as in most cases.

Besides electricity generation for feed-in also alternative options should be considered. Because in some regions of Japan grid operators may limit the power for feed-in, it also should be considered to use electricity and heat locally and only feed-in a part of the generated electricity. This also applies to the utilisation of heat (and possibly also for covering the cooling demand) for coverage of own consumption (not only for the biogas plant itself but also for surrounding potential consumers such as farms, industry, sewage plants, settlements etc.) In addition, the sale of fermentation residues as fertiliser (in many cases by saving disposal costs for the residues) can be a solution to improve economic efficiency of the biogas plant.

Biogas plant manufacturers from Europe should also consider that the agricultural land area available for crops (e. g. used as co-substrate together with cattle manure) is very small due to Japan's topographical situation. In addition, Japan has a small-scale farm structure, which results in smaller biogas plants (in average approx. 350-400 kW) in comparison e.g. to Europe. A still missing collection system for municipal bio-waste is also a barrier to market development. In the industrial (such as the food industry) or the gastronomic sector collecting systems for biowaste are already established or planned to be introduced in the near future.

This report, together with the basics about Japan and its political developments in the field of renewable energies, shows that it is possible to produce biogas profitably from different substrates such as food waste, manure or plant residues in Japan in the long term. It has clear ecological advantages over other disposal methods for food, like the form of waste disposal by incineration that is frequently used in Japan. In the long term, a significant expansion of the Japanese biogas market can be assumed, especially in regard to the climate policy pursued, since the technology of biogas production has an unspeakable positive added value for national electricity generation and in the future, when the expansion of wind power and PV in Japan is more advanced, also to provide balancing power.

2. Scope of the Report

The report shall give EU companies an overview on the biogas market in Japan and business opportunities as well as challenges.

In this report, the term “Biomass” includes organic material from plants, food or animals suitable to be used as fuel. “Biogas” means gaseous fuel, especially methane, produced by the fermentation of organic matter. Biogas includes biomethane from livestock manure, energy crops, crop residues and sewage.

After a short framing on the role of biogas in the energy mix, energy policy of Japan and other framework conditions for biogas utilization in chapter 3, the current market situation and technology trends are analysed in chapter 4. Relevant information for market access such as distribution channels, regulations and standards are described in chapter 5. The main market players are introduced in chapter 6. The potential and challenges for EU companies in the Japanese Biogas market are summarized in chapter 7, closing with some recommendations on market entry.

Information for this report was gathered from relevant publications and media (also in Japanese), e. g. publications by Japanese ministries, government bodies, research institutes, associations as well as expert journals, economic journals, company reports, company websites, press releases, newspapers and statistical websites. In addition, some interviews were conducted with Japanese experts in writing or via phone and web meetings.

3. Market Framework Conditions

a. Role of Biogas in Energy Mix

The share of electricity generation from renewable energy sources in Japan has increased steadily over the past 5 years. This applies in particular to PV and biomass, which accounted for 2.7 % of energy supply from Renewables in fiscal year 2019 (Figure 1). The installed capacity of biomass plants in Japan (with 4.5 GW in 2019) is still rather small compared with Solar PV (with a total of 54.6 GW), but has shown a steady increase during the three years (Figure 2).

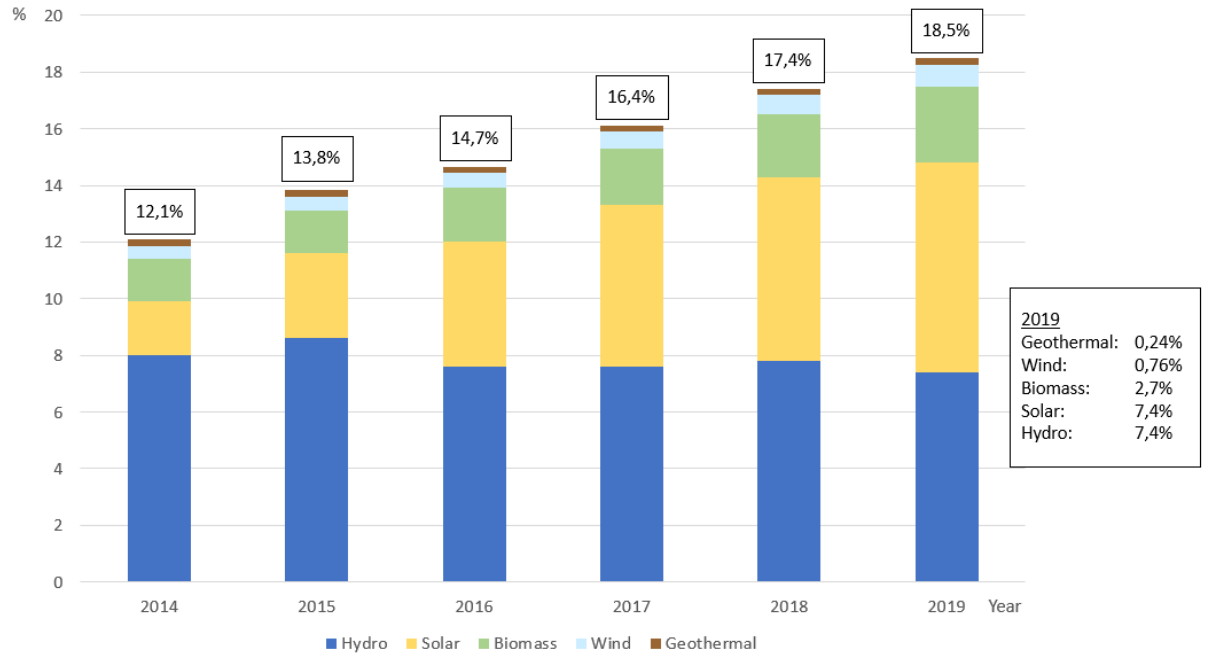

Figure 1: Share of Renewable energy supply in Japan[1]

[1] Based on: Institute for Sustainable Energy Policies ISEP (2020): "Share of Renewable energy supply in Japan".

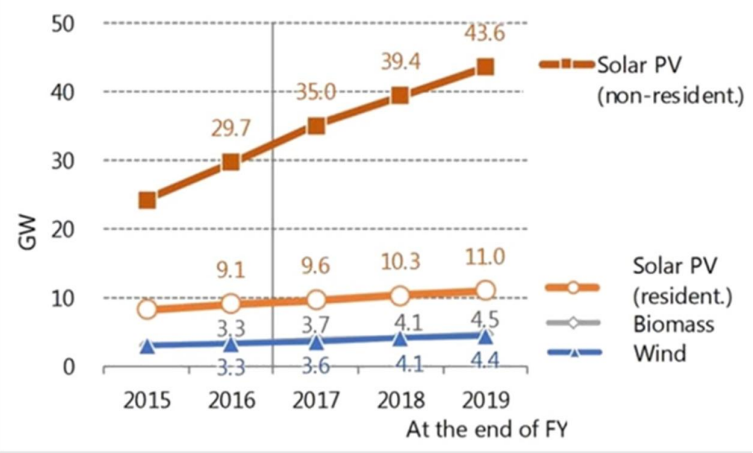

Figure 2: Cumulative installed capacity of renewable energy systems in Japan [2]

Biogas accounts for only around 1.5 % of biomass energy in Japan (see Figure 6 in chapter 4.a.), while the share is approx. 10 % in the EU.[3] In Japan, biogas is almost completely used for electricity generation only. By the end of fiscal year 2019, a total capacity of approx. 85 MW have been operating under the Feed-in Tariff (FIT) scheme[4] which is a 40 % increase compared with the 57 MW capacity operating under FIT scheme in 2016.[5] This positive development and current policy strategies and subsidies illustrate the increasing importance of biogas in Japan.

b. Political Strategy and Subsidies

5th Strategic Energy Plan (2018)

Since the Great East Japan earthquake and tsunami resulting in the meltdown of atomic powerplant in Fukushima in 2011, the Japanese government's strategy for shaping the energy mix has changed. The "5th Basic Energy Plan" of the Ministry for Economy, Trade and Industry (METI) issued in 2015 aims at a 22-24 % share of renewable energies in the electricity mix (Figure 3). In addition to PV and wind power, biomass is seen as an important future source of energy to stimulate regional economic activity, particularly in rural areas of Japan.[6] According to the "5th Basic Energy Plan", biomass is to contribute a share of 3.7 to 4.6 % in the electricity mix in 2030, which corresponds to a share of almost 20 % of the sum of all renewable energies. The 6th Strategic Energy Plan is currently under discussion and expected to be released in spring 2021.

[2] IEEJ (2018): "Economic and Energy Outlook of Japan through FY 2019".
[3] European Union (2020): "Brief on biomass for energy in the European Union".
[4] Biomass Industrial Society Network (2020): "Biomass White Paper 2020".
[5] ANRE (2016): 再生可能エネルギー導入拡大と バイオマス発電.
[6] Fuji Research Institute, Kitagawa H. (2015): "Rural Revitalization through Wood Biomass Energy".

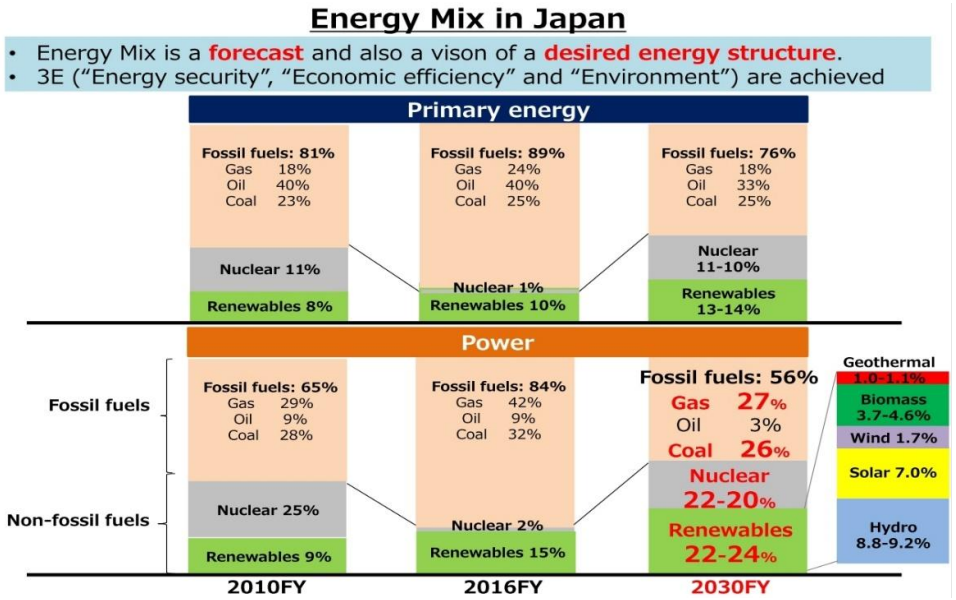

Figure 3: Energy Mix in Japan before and after the Fukushima disaster and 2030 expansion target[7]

Feed-in Tariff (FIT)

An important instrument for achieving the expansion goals is the Feed-in Tariff. The tariff paid for feeding electricity produced from biomass in the grid has remained almost constant over the last 6 years, which means a good planning security for the economic operation of biogas plants in Japan. The FIT for biogas is currently 39 JPY/kWh, which is approx. 0.31 €/kWh (Figure 4).

[7] University of Tokyo, GrasPP, Arima J. (2018): "Japan's Energy and Climate Strategy".

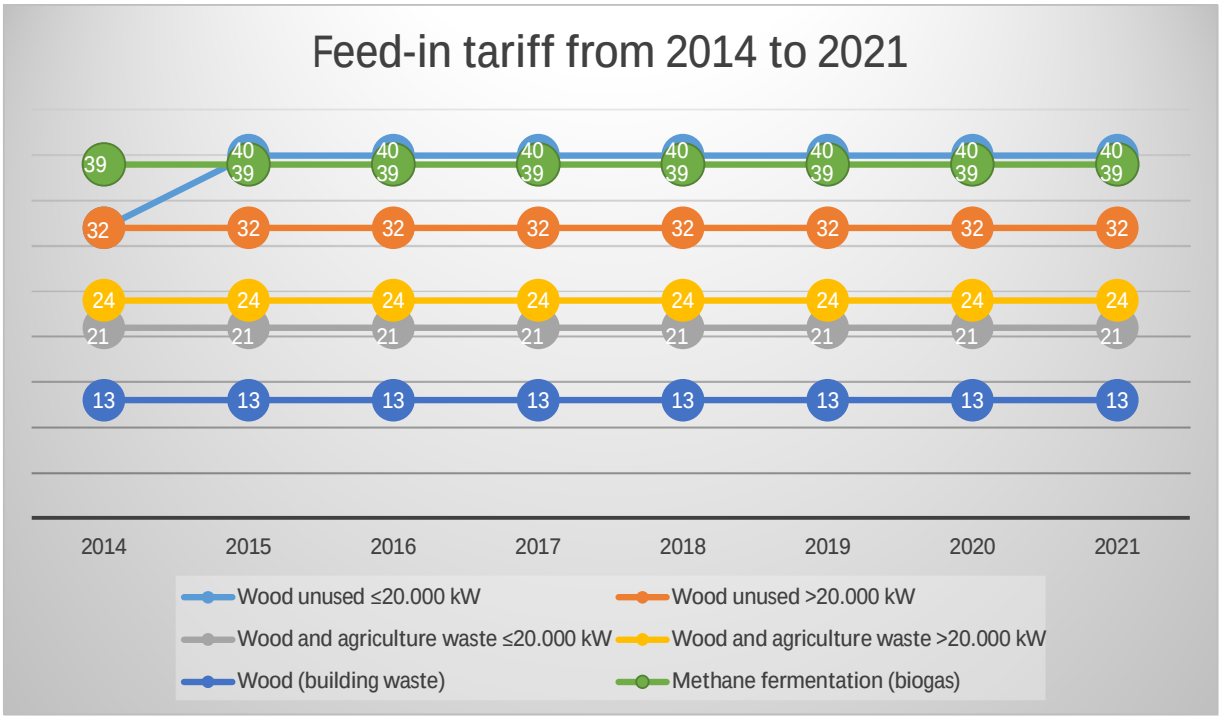

Figure 4: Feed-in tariff in Japan for electricity generated from Biomass for the years 2014 to 2021[8]

The model for the FIT system in Japan was the "Erneuerbare-Energien-Gesetz" (Renewable Energy Sources Act), short EEG, in Germany. Same as in the EEG, the FIT is paid over a period of 20 years. A major difference to the German EEG, however, is that the FIT is paid regardless of the use of the heat generated. In Germany, combined heat and power use is a precondition to become eligible for the FIT for biomass.

Japan has decided to introduce a feed-in-premium (FIP) scheme for renewable power sources from April 2022. The new mechanism will allow renewable power producers to sell their electricity in a spot market at a premium to wholesale prices. This is aimed to expand renewable power capacity without subsidiaries, encourage competition and reduce the cost burden on consumers under the current FIT system. But the market-based program will probably exclude biomass, as well as geothermal and small-scale hydro and solar power projects, which will continue to be financed by the existing FIT system.[9]

[8] Based on ANRE (2020): 固定価格買取制度 and JETRO (2015): "Japan's Biomass Market Overview".

[9] Shulman Advisory (2020): "FIT, FIP and the Future of Renewables in Japan".

Biomass Utilization Plan (MAFF)

According to the basic plan of the Ministry of Agriculture, Forestry and Fisheries (MAFF) for biomass utilization, there are three goals to be achieved until 2025.[10]

(1) Realizing Circular Society
   - Covering 2.6 million metric ton of carbon through biomass
   - Setting utilization targets of each biomass sector
(2) Revitalization of farming and fisheries
   - Setting basic plans for biomass utilization in all prefectures as well as in 600 districts (one third of the whole districts in Japan)
(3) Strengthening international competitiveness
   - Aiming the market growth to 500 billion JPY

Biomass Industrialization Strategy (2012)

The "Biomass Industrialization Strategy", already introduced in 2012, comprises various initiatives for the industrialization and commercialization of biomass use. The strategy also includes the recycling of waste biomass through efficient collection and transport systems, the introduction of management systems in agriculture and forestry to ensure a stable supply of raw materials for producers, the introduction of a collection system for food waste by category and the promotion of recycling through methane gasification, conversion to solid fuels and combined use of sewage sludge and livestock excreta.

In the field of sewage sludge recovery, the promotion of recycling via bio-gasification, combined use with other types of biomass (e. g. food waste) and the production of solid fuels in sewage treatment plants (in the form of regional biomass recovery centres) is planned.[11]

Biomass Industry Cities

Since 2013, seven Ministries in Japan have chosen “biomass industry cities” and the total number of selected districts reached 94 in 2020.[12] These municipalities make effort not only to achieve energy self-efficiency, but also to revitalize local economies and industries. The list of districts is available on the website of MAFF:

https://www.maff.go.jp/j/shokusan/biomass/b_sangyo_toshi/attach/pdf/b_sangyo_toshi-98.pdf

Half of the districts are concentrated in northern part of Japan.

[10] MAFF (2020): “Basic Plan for the Promotion of Biomass Utilization”.
[11] MAFF (2016): “Basic Plan for the Promotion of Biomass Utilization“.
[12] Ikeyama Shigeyoshi of MAFF (2020): “Biomass Industrial City”.

c. Obstacles for biogas utilization

i. Obstacles in planning and grid access

The current limited access to the electricity transmission grid for renewable electricity generation plants is considered as one of the factors hampering the growth of renewable energy in Japan. In several regions of Japan large utilities that also own the transmission grid regularly refuse to buy electricity from solar, wind and biomass plants because of a lack of free capacity in the grid.

In Japan, grid connection is approved according to a "first come, first served" principle, regardless of the type of electricity source (renewable energy or large fossil fuel power plants). Accordingly, the transmission capacity of the electricity grid will be ensured in the order applications are submitted. Even if the planned and built power generation is not in operation, the capacity is included in the calculation. In order to assess whether there is still free capacity in the power lines, the situation of a power failure must also be taken into account. For this reason, the maximum transmission capacity with two transmission lines is only 50 % (with three or more transmission lines, this can be up to 70 %). Among other reasons, in some cases this situation prevents the connection of renewable energy installations. Several renewable energy suppliers are still waiting to be connected.[13]

Another possible obstacle is that several grid operators only allow electricity feed-in with a limited capacity for new biogas plants. In some regions, for example, only biogas plants up to a power of 50 kW can be connected to the public grid.[14]

Planners of Biogas plants are increasingly pointing out that in particular the conversion of bioenergy (as biogas and solid biomass) can be used very well for grid stabilization due to its flexibility in the generation of electricity and its permanent availability. This makes it increasingly difficult for grid operators to refuse or delay the grid connection.[15]

In order to significantly increase the supply of energy from renewable sources - as advocated in the government's Basic Energy Plan - both the government and the energy industry must maximize the efficient use of the transmission grid. As a first measure to strengthen and stabilize the Japanese transmission grid in the future, the independent "Organization for Cross-regional Coordination of Transmission Operators" (OCCTO) was founded in 2015. This is responsible for monitoring and controlling the supply and demand of electricity. Its duties include planning work in order to sustainably promote interregional interconnection and frequency conversion (as for the electricity grid Japan uses 2 different frequencies: 50 Hz in Eastern Japan and 60 Hz in Western Japan). Other solutions include the introduction of smart grids and the recalculation of the grid situation. In the Tohoku (Aomori, Akita, Iwate) region, up to 60 % more intake capacity is expected to be used for feed-in to the public electricity grid.[16] In addition, the extension of an existing

[13] ANRE (2018): 再エネの主力電源化を実現するために.
[14] World Biogas Association (2019): “Market Report Japan”.
[15] Interviews in December 2020 with experts from the biogas sector in Japan and Germany.
[16] Agora Energiewende (2019): “Integrating renewables into the Japanese power grid by 2030”.

transmission line between the Tohoku region and Hokkaido allowing the transportation of additional 300 MW electrical power from renewable energy sources in Hokkaido to larger demand centres in Tohoku and Tokyo.[17]

ii. Other obstacles

Digesters in Japan tend to be small in size. The average installed capacity of electricity generation plants is 350 kW, which is smaller when compared to some of the other industrialized countries as for example in the EU. One reason is that there are almost no larger municipal solid waste processing biogas plants. Nearly 80 % of waste collected in Japan is incinerated rather than recycled.

Biogas plant manufacturers from Europe should also consider that Japanese livestock feedstock largely depends on imports as agricultural land area available for crops is small. Only dairy cattle farmers in Hokkaido harvest grass and corn from their own grounds. Approx. 60 % of cattle farms and almost 1/3 of all biogas plants in Japan are located in Hokkaido.[18]

Another fact to be considered is that digestate in most places in Japan needs further treatment: solids are composted while nitrogen and phosphorus are removed from the liquids before they are released to rivers or public sewers.

The largely missing collection system for municipal bio-waste and the industrial sector already heavily developed by Japanese companies are also a barrier to market development in the Japanese biogas sector.

[17] Genscape International (2019): “Is the New Capacity on the Hokkaido-Tohoku Interconnector Having an Impact on Power Prices?”.
[18] The Japan Association of Rural Solutions for Environmental Conservation and Resource Recycling: “Database for biomass utilization technology information”.

4. Market Situation

a. Volume

As Figure 5 shows, the installed capacity of bioenergy plants shows an almost steady annual increase of approx. 11-13 % since the year 2014.

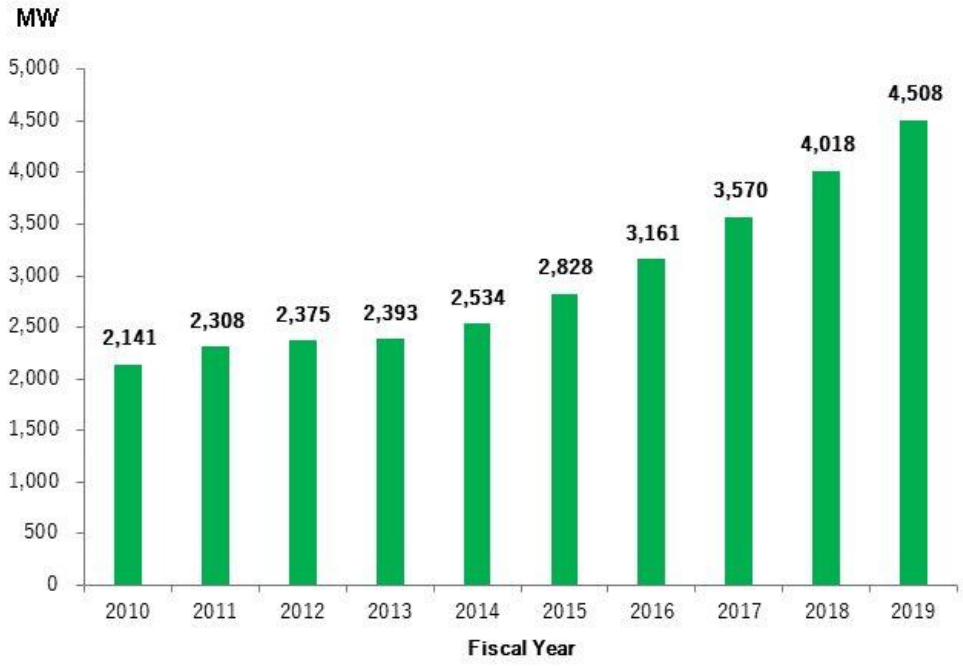

Figure 5: Installed Capacity of Bioenergy in Japan[19]

The market research institute Fuji Keizai determined an annual growth rate of the market for biogas plants in Japan of approx. 10% for the years 2018-2020.[20]

In 2019, there were 221 biogas plants with a total capacity of approx. 85 MW approved under the FIT scheme.[21]

With the aim to introduce more biomass and to ensure a stable procurement and sustainability a growth from 3.5 GW (2017) up to 7.3 GW (2030) installed power for biomass use is expected by METI. The expected increase of Biogas capacity is even higher (from 0.05 GW in 2017 up to 0.16 GW in 2030) (see Figure 6).

[19] Renewable Energy Institute based on METI, ANRE (2020): "Status of the special law on usage of new energy by electric companies in FY2013" and METI, ANRE (2020): "Website for the information disclosure on Feed-in-Tariff".
[20] Deutsche Industrie- und Handelskammer in Japan (2017): "Zielmarktanalyse Japan 2017" based on Fuji Keizai Group (2015).
[21] Based on Biomass Industrial Society Network with data from ANRE (2020): "Biomass White paper 2020".

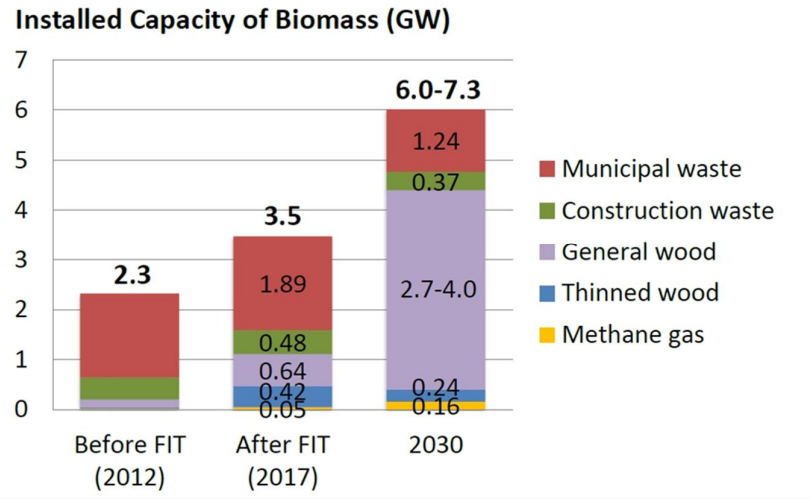

Figure 6: Installed capacity for biomass utilization[22]

b. Market Developments and Trends

i. Main Applications in Japan

As a first application, anaerobic sludge digestion in Japan began in 1932, and is now used in more than 300 sewage treatment plants industrial wastewater treatment.[23] After the Biomass Nippon Strategy started in 2002 the utilisation of livestock wastes for digestion became popular, followed by the treatment of food wastes and the organic fraction of Municipal Solid Waste (MSW).

Currently feedstock and application trends in Japan are shifting from the traditional livestock excreta and sewage sludge, to a composite of sewage sludge and food waste including industrial waste and food scraps. High-rise buildings with "urban biogas systems" that recycle food waste are being implemented. This is seen as a potential growth market within the sector.

Food Waste:

Back in 2009, only about 27 % of the total food waste was collected and used in Japan. Now, most of the waste from food production is processed into fertiliser and feed.

However, Japan wastes around 6.5 Million Tons of Food Per Year.[24] Based on a survey conducted by MAFF, 20 % of waste found in garbage is considered to be food waste.[25]

[22] ANRE, Yamazaki, T. (2018): "Japan's Renewable Energy Policy".
[23] Li Y., Kobayashi T. (2010): "Applications and New Developments of Biogas Technology in Japan".
[24] Nippon.com (2018): "Mottainai!" Japan Wastes Around 6.5 Million Tons of Food Per Year".
[25] Skinner, M., Zenbird (2019): "Japan's food waste problems and solutions".

In order to reduce unused food waste and to recycle it, the Act on the Promotion of the Recycling of Recyclable Food Resources, known as Food Recycling Act, was enacted in 2000 (revised in 2007: According to this act food waste is to be recycled primarily as raw materials for animal feed and fertilizer; The Act was again revised in 2015 with the goal to further reduce the amount of food waste produced and enhance recycling [animal feed, fertilizer, methane]).[26]

Food waste is also part of the Japanese Biomass Industrialization Strategy that includes (among others) measures to promote bio-gasification technologies, the creation of a food-waste collection system, the implementation of recycling through methane gasification, solid fuel conversion and combined utilization with sewage sludge and animal waste, as well as application of FIT scheme.

By means of the methanation of food waste, which is less suitable as feed or fertilizer, the utilization rate was aimed to increase from 27 % in 2009 to 40 % in 2020.[27]

Of 170 registered food waste recycling plants in Japan, 108 are only composting the waste, followed by 55 for animal feed production.[28] According to the Japanese Ministry of the Environment (MoEJ), 42 biogas plants are operating using food waste from households and industry.[29]

Food waste is not generally collected and treated separately in Japan. But in the food industry, restaurants, municipalities, etc., an extensive system of food waste collection and recycling has been established. The Japanese Food Waste recycling law limits the food recycling method to feed, fertilizers, fuel (biogas and carbonization) and oils & fats.

Food waste from the restaurant industry is often not applicable to recycling for the use of fertilizer or animal feed due the difficulty of separation by categories and hygiene management. This kind of waste is better suited for methanation which does not require a strict separation for further use. Food waste is suitable for methanation as it generates an extremely larger amount of biogas than other biomasses such as manure. By cutting the costs of disposing of food waste It may also lead to new sources of income for restaurants and food industry.

When it comes to municipal waste, Japan generally only distinguishes between flammable and non-flammable waste. Several communities in Japan now started with collection systems for domestic food-waste. A few examples are:

1) Toyama Green Food Recycle (https://tgfr.net/) in Toyama City[30]
- food waste max. 40t per day from:
    - 15,000 households
    - 140 supermarkets, convenience stores, hotels
    - 70 manufacturing plants

[26] EU-Japan Centre (2015): “Waste Management and Recycling in Japan”.
[27] MAFF (2012): “Reference 6 Biomass Policies and Assistance Measures in Japan”.
[28] World Biogas Association (2019): “Market Report Japan”.
[29] MoEJ: 全国のメタンガス化施設リスト.
[30] MoEJ, Food Recycling Committee (2013): メタン発酵技術による食品リサイクル; Toyama Green Food Recycle (2021): 食品廃棄物を資源エネルギーに変える; MoEJ: 先行導入事例その３：富山市の取組み.

Generation of Biogas:

- Ø electricity generation: approx. 600,000kW/year
- Ø gas sales to neighbouring Mitsubishi Rayon chemical plant
- Ø sales of fertilizer

2) Hokkaido Pref., Kita-Hiroshima City [31]
- food waste 17t per day
- sewage sludge from water treatment plant 131 t/day

Co-digestion with mixing of sewage sludge with approx. 13 % of kitchen waste (weight ratio to sludge) doubled the methane output compared to the use of pure sludge.

Livestock manure:

In 2016, about 87 % of Japan's annual production of 81 million t waste from farm animals was recycled, mostly by composting. In regions with too much waste to be composted, the aim of the Japanese government is to intensify the production of biogas through methanation in the future. 2019 about 90 % of livestock manure in Japan was composted. If digested, livestock manure from cattle, pigs and poultry would have a potential to generate 1.65 GW of energy for the farms in addition to the organic fertiliser. The total number of agriculture-based biogas plants in Japan is estimated at 100, of which around 70 are located in Hokkaido.[32]

Sewage sludge:

Since May 2015, the obligation to recycle sewage sludge as fuel or fertiliser has been in place in Japan. Approximately 63 % of the sewage sludge produced is used as building material in construction or as fertilizer. Therefore, besides promoting the efficient utilization of biogas, the Japanese government also aims to promote recycling of excess sewage sludge into biogas, also to foster the circulation of resources in the region and to revitalize them.[33] Despite the promotion activities of the Japanese government in 2018, only 104 or 5 % of the approx. 2,200 wastewater treatment plants in Japan have been operating biogas digesters.[34]

It is estimated that in total 93 MW of energy could be generated from adding on digesters to sewage treatment plants.

ii. Main Processes in Japan

In Japan both wet and dry digestion processes are used. While wet systems operate at low solid contents (<10 – 20 % of dry substance (DS)), dry systems operate at high solids (20 –> 40 % DS). The wet fermentation process is more complex and needs a higher amount of investment. On the other hand, the material flow is larger which leads to a higher

[31] MoEJ - Food Recycling Committee (2013): メタン発酵技術による食品リサイクル.
[32] World Biogas Association (2019): "Market Report Japan".
[33] MAFF (2016): "Basic Plan for the Promotion of Biomass Utilization".
[34] World Biogas Association (2019): "Market Report Japan".

throughput rate and a better efficiency. Wet digestion plants show improved energy balance and economic performance compared to dry systems. However, dry digestion plants offer several benefits, including greater flexibility in the type of feedstock accepted, shorter retention times and reduced water usage.

An example of a dry process as it is used in Japan for biogas production from both industrial and municipal waste treatment facilities is the Kurita DRANCO PROCESS™ which operates with the first vertical, dry methane fermentation technology to be applied in Japan. It accepts diverse waste ranging from garbage and wastepaper from households, food waste and used paper from office to organic residue and industrial waste, enabling higher levels of energy recovery than with the existing technology. Vertical dry methane fermentation enables stable treat of wastepaper which has low water content and is difficult to treat with existing methane fermentation. An example of a biogas plant operating with this process is given in the following chapter (Ayagawa-cho plant).

iii. Plant examples

Wet fermentation process

J Biofood Recycling Yokohama Plant

J Bio Food Recycle Co. Ltd, a member of the JFE Engineering Group, started operation of a biogas plant near its headquarters in Yokohama City in August 2018. J Bio Food Recycle collects food waste from stations and station buildings of the East Japan Railway Company (JR East). With a throughput of approx. 50 - 80t per day, food waste is fermented in the plant to biomethane, which is used for electricity generation via gas engines. The nominal output of the plant is 1.8 MW. It is expected to generate approximately 11,000 MWh of electricity, which is equivalent to the consumption of 3,000 households per year. Under the FIT system, the company sells excess electricity to Urban Energy Corporation (Yokohama, Kanagawa Prefecture), a new electricity company that is also a wholly owned subsidiary of JFE Engineering Corporation.[35]

[35] JFE Engineering (2017): "JFE Kankyo Enters Food Recycling Business - Start of First Cooperation with JR East Group"; Bioenergy International (2017): "JR East to produce biogas from food waste".

Dry fermentation process

Ayagawa-cho Plant, Kagawa

A dry fermentation plant was completed by Fuji Clean Co., Ltd. 2018 in Kagawa Pref. (Shikoku Island). The plant is using the Kurita Dranco process as described in the section above. Food and household waste, as well as animal excrements, sewage sludge and paper waste are fermented at a daily volume of 73 tons. Two gas CHPs generate a total electrical output of 740 kW.

The reactor is Japan's largest vertical dry methane fermentation reactor (3,000 m^3). The plant can be used for approx. 150 Nm^3 of biogas per ton of waste. Fuji Clean expects that the adoption of the technology will reduce CO_2 emissions by 10,000 tons per year.

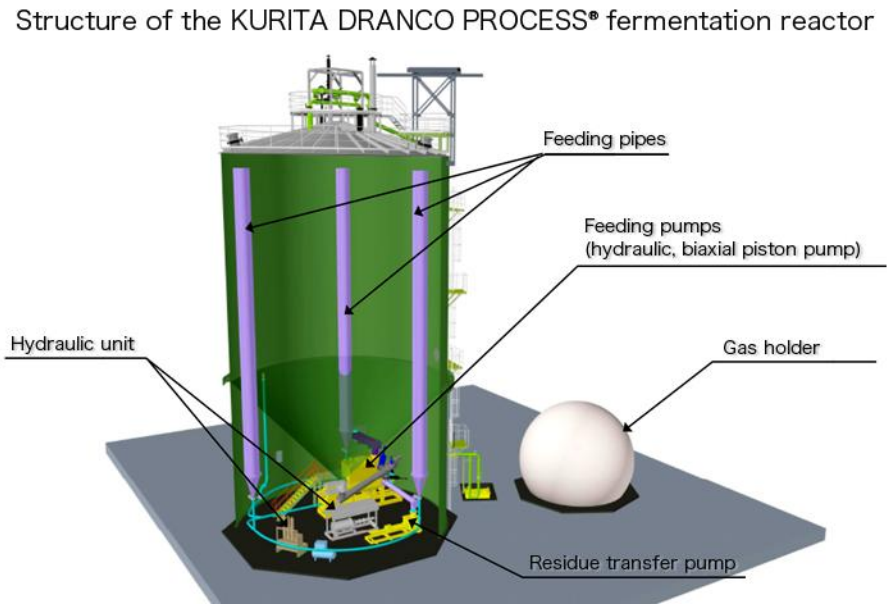

Figure 7: Kurita Dranco Process [36]

5. Market Access

a. Market access conditions

Market entry has been facilitated after the Japan-EU Economic Partnership Agreement (EPA) came into force in February 2019. The EPA removes the vast majority of the € 1 billion of duties paid annually by EU companies exporting to Japan. Once the agreement is fully implemented, Japan will have scrapped customs duties on 97 % of goods imported from the EU.[37]

When it comes to importing machinery into Japan, the importing company does not require any specific licenses or operating permits. For the European company that wants to export to Japan, it is recommended to register with the respective European Commission customs office as a registered exporter (REX): https://customs.ec.europa.eu/rex-pa-ui/html/manual/rex___create_pre_application.html#

In this way, the declaration of origin for plant components can be drawn up, if it meets the original. In the agreement between the EU and Japan on an economic partnership (EU-Japan EPA), a declaration of the origin of a registered exporter is provided as proof of preference when exporting from the EU.[38] It is recommended to check the current

[36] Kurita (2017): "Japan's Largest Dry Anaerobic Digestion Reactor Accepted for the Promotion of the Use of Biomass Energy".
[37] European Commission (2019): "EU-Japan trade agreement enters into force".
[38] Zoll (2019): "Das Freihandelsabkommen mit Japan tritt am 1. Februar 2019 in Kraft".

export regulations and procedures at the German customs office research.[39] More information and a list of custom brokers available depending on the arrival port/airport in Japan can be obtained from the Japan Customs Brokers Association (JCBA): http://www.tsukangyo.or.jp/profile/english.html.

The EU-Japan EPA Helpdesk can also provide further information: https://www.eu-japan.eu/epa-helpdesk

To benefit from Japan-EU Economic Partnership Agreement (EPA) preferential tariff rates, the product to be exported need to be originating in Japan or the EU. More detailed information on the Japan-EU Economic Partnership Agreement is given at the European Commission's website at https://trade.ec.europa.eu/doclib/docs/2018/july/tradoc_157116.pdf.

Public tenders:

As in most other countries, Japan requires a public tender for regional as well as international projects, which are subject to the rules of the World Trade Organisation. This means that even the simplest project must include a construction company or consortium in addition to the owner.

A selection of databases: for public tenders in Japan:

- TED (Tenders Electronic Daily)
- Tender Notice Portals at the EU-Japan Centre: https://www.eu-japan.eu/government-procurement/tender-monitoring-informations/tender-notice-portals

Foreign exporters will need to establish and maintain a strong business relationship with local partners to succeed in Japan. Companies hoping to enter the Japanese market should visit the country frequently to cultivate contacts and to better anticipate business conditions (see "recommendations" in chapter 7c).

While Japan has implemented strict entry restrictions for European countries due to the ongoing Covid-19 pandemic, some arrangements are being developed with several countries in Asia, which may make a visit from those countries feasible.[40] The actual entry restrictions to Japan can be seen on the website of Ministry of Foreign Affairs in Japan: https://www.mofa.go.jp/p_pd/pds/page22e_000910.html.

It has been often said that business cost in Japan is higher than other countries and it could be a market barrier for foreign companies. However, in the last three decades, the Japanese government reduced the national standard corporation tax rate from 40% to 23.2%.[41] The effective tax rate for corporations is approximately 30%, and this is almost the same level as for example Germany.

Further information about the Japanese taxation system is available on the website of the "EU-Japan Tax & Public Procurement Helpdesk" (https://www.eu-japan.eu/japan-tax-public-procurement-helpdesk).

[39] Zoll: "Unternehmen", refer to: https://www.zoll.de/DE/Unternehmen/unternehmen_node.html.
[40] International Trade Administration, U.S. Department of Commerce (2020): "Japan - Country Commercial Guide".
[41] Ministry of Finance in Japan (2020): 法人課税に関する基本的な資料.

b. Distribution channels

Japanese biogas plant providers use their contacts to regional/local administration or to feedstock suppliers. They are often part of a company group such as Mitsubishi or Tsuchiya and can make use of the synergies within the group to successfully diversify their business.

There several foreign biogas plant manufacturers active in Japan (such as PlanET Biogastechnik / Germany, HoSt / The Netherlands or OWS / Belgium). Most of them have their own subsidiary or are cooperating with a partner in Japan (see 6.a.ii.).

Especially for the beginning, a partnership with domestic players is a good way to get started. Such a partnership can take various forms: feedstock arrangements, technology alliances, joint ventures, value chain alliances. Ideally, these partners belong to the biogas sector such as plant manufacturers (that also offer planning services) and constructing companies. These partners can also act as distributors for biogas plants.

For foreign companies deciding to set up an own business in Japan, there are basically four ways to set up own operations as shown in the table below.

	Sales Agent	Representative office	Japanese branch	Incorporation	
				Kabushikigaisha	Godogaisha
Limitation of activities	-	Sales activities are not allowed	No	No	No
Registration	Not required	Not required	Required*	Required	Required
Party to contract	-	Parent company**	Itself***	Itself	Itself
Tax obligation	-	-	Itself	Itself	Itself (no pass-through)
Disclosure of Financial Information	-	Not required	Not required	Not required	Not required
Limitation of liabilities of shareholders (interest holders)	-	-	No	Yes	Yes

Table 1: Ways to set up operations in Japan (source: Japan Industry News, "Market Entry and Incorporating in Japan", 2015)

Trading houses are also considered as potential distribution partners. Although the traditional trading houses in Japan are still considered primarily as commodity traders, these companies have undergone major restructuring. In recent years they have developed completely new foundations for their business, some of which include the bioenergy sector. A selection of important trading houses is given under 6 b "Suppliers".

It could be also useful to approach local companies in the Japanese market and ask them to include your products (e.g. components for a biogas plant) into their portfolio.

Membership in associations (e. g. JORA - Japan Organic Recycling Association) can provide contacts to multipliers from industry and municipalities and access to an extensive network, including project developers, technology providers, consultants and engineers.

c. Regulations & Standards

i. Regulations

The table below lists up some other regulations which apply to the set-up and use of biogas plants.

	Law/Regulation	Overview	Responsible Authorities	Wood	Live-stock	Food
Before in-stallation	Waste Management and Public Cleansing Act	A business or facility that transports and deals with industrial biowaste is required to be authorized by local governors.	MoEJ	X	X	X
	Act on the Appropriate Treatment and Promotion of Utilization of Livestock Manure	Livestock waste treatment facilities with certain scales are required to comply with building standards.	MAFF		X	
	Act on Promotion of Recy-cling and Related Activities for Treatment of Cyclical Food Resources	Food related businesses are re-quired to control, reduce and recycle food waste.	MAFF			X
	Electricity Business Act	Powerplants over a certain scale are required to be authorized by local governors. In case of using boilers, technicians must be elected.	METI	X	X	X
	Act on the Rational Use of Energy	Energy consumption must be re-ported regularly.	METI	X	X	X

	Law/Regulation	Overview	Responsible Authorities	Wood	Live-stock	Food
	Air Pollution Control Act	There are standards for facilities over a certain scale.	MoEJ	X	X	X
	Noise Regulation Law	Dito	MoEJ	X	X	X
	Vibration Regulation Act	Dito	MoEJ	X	X	X
	Act on Improvement of Pollution Prevention Systems in Specified Factories	Responsible persons for pollution prevention must be selected.	METI	X	X	X
	Industrial Safety and Health Act	Qualified persons are required in facilities with boilers over a certain scale.	MHLW	X	X	X
	Fire Service Act	Qualified persons are required in facilities with fuel storages over 400L.	Fire and Disaster Management Agency	X	X	X
	Heat Supply Business Act	In case of supplying heat over a certain scale(21GJ/h), it is required to be authorized by METI.	METI	X	X	X
	Disaster Prevention Plan	in the guideline for thermal power plants based on the disaster prevention plan, it is written that each part of devices of thermal power plants (including biomass plants) must be constructed not to damage their functions seriously and to continue the operation also in case of an earthquake	Cabinet Office, METI	X	X	X
During Operation	Water Pollution Prevention Act		MoEJ	X	X	X
	Offensive Odour Control Act		MoEJ		X	X
	Fertilizer Regulation Act		MAFF		X	X

Table 2: Overview of main regulations being relevant for installation and operation of biogas plants in Japan[42]

[42] NEDO (2017): "Biomass Energy Introducing Guidebook 4th Edition in 2017".

ii. Standards

Sustainability Criteria of biomass fuels:

Compared with the U.S. and the EU, the framework of sustainability criteria for biomass fuels has not yet been sufficiently established in Japan. METI has currently established a working group for discussing further assessment standards for sustainability because of the rapid increase of biomass fuel import since last few years. The interim report of the working group in 2019 shows the overview of the discussion:

- Need to clarify standards of environment, society, labour, and governance which third party qualifications should meet.
- Third party certifications must permit supply chains of main products (e.g., general wood, palm oil) from plantation to powerplant, and for by-products (e.g. Palm kernel shells - PKS) supply chains from production site as fuel to powerplants.
- In addition to RSPO (Round Table for Sustainable Oil), RSB (Round Table for Sustainable Biomaterials) is also accepted as certification. Other frameworks such as ISPO (Indonesian Sustainable Palm Oil) are also being considered as certification.[43]

Standards for Methane Gas :

Dependent on facilities, restricted substances of methane gas must be purified. Reference values of concentration in each facility are listed below.

	Hydrogen Sulfide (ppm)	Ammonia (ppm)	Nitrogen (vol%)	Water (vol%)
Boiler	<10	<0.2g/㎥	No restriction	<15
Gas Engine	<10	<50	No restriction	Only necessary minimum
Micro Gas turbine	<20	No restriction	No restriction	Only necessary minimum
Fuel cell	<2	<1	<0.1	Unsaturated
Natural gas Vehicle	1-10	<1-10	No restriction	
Town gas	0.65<		1.0<	

Table 3: Reference values of concentration of restricted substances in gas for different facilities[44]

[43] METI (2020): バイオマス発電の持続可能性の論点について.

[44] MoEJ (2017): "Manual for Preparation for Methane Gas Facilities".

Standards for Digestate:

Digestate from biogas plants is used for agriculture, discharged to public sewer or rivers after necessary purifying treatments. The standards for public sewerage can be seen in the table below. For rivers, standards vary from region to region.

There are no special restrictions on the use of digestate as fertilizer in Japan. Additional fertilisers are sometimes needed, e. g. phosphorus. In the liquid phase, the discharge of fermentation residues requires appropriate treatment in a wastewater treatment plant, which is based on the requirements of the wastewater standards of the Water Pollution Prevention Act. This includes, among others, compliance with the following parameters: BOD <600 mg/l; SS <600 mg/l; nitrogen content <240 mg/l.

pH		5-9
BOD	mg/L	Less than 600
SS	mg/L	Less than 600
T-N	mg/L	Less than 240
T-P	mg/L	Less than 32

BOD: biochemical oxygen demand
SS: Suspended Solids
T-N: Total Nitrogen
T-P: Total Phosphorus

Table 4: requirements of the wastewater standards of the Water Pollution Prevention Act [45]

Offensive odours:

There are regulations for odours from biomass or other plants. A certain odour intensity (e.g. 2.5 odour intensity within six grades) must not be exceed at the borders of the site.[46]

[45] based on MOEJ (2014): 平成 26 年度廃棄物系バイオマス利活用 導入促進事業委託業務 .

[46] MoEJ: 廃棄物処理施設の発注仕様書作成の手引き.

6. Major players

a. Competitors

i. Japanese planners and manufacturers of Biogas plants (selected)

No.	Company	Website
1	Cornes AG Corporation	http://www.cornesag.com/english/
2	Chubu Ecotech Co., Ltd.	http://www.ecotec-compo.com/index.html
3	Daiki Ataka Engineering Co., Ltd. *since 2014 merged with Hitachi-Zosen*	https://www.hitachizosen.co.jp/products/business/plant/upper_lower/index.html
4	Ebara Corporation	http://www.ebara.co.jp/en/
5	Ebara Jitsugyo Co, Ltd.	https://www.ejk.co.jp/english/
6	Hitachi Zosen Corp	https://www.hitachizosen.co.jp/english/products/products055.html
7	IHI Corporation	https://www.ihi.co.jp/en/
8	JFE Engineering Corporation	http://www.jfe-eng.co.jp/en/index.html
9	Kajima Corporation	https://www.kajima.co.jp/english/welcome.html
10	Kawasaki Plant Systems Co, Ltd. *belongs to Kawasaki Heavy Industries since 2011*	https://global.kawasaki.com/en/
11	KobelcoEco Solutions Co., Ltd.	https://www.kobelco-eco.co.jp/english/
12	Kubota Corporation	http://www.kubota-global.net/
13	Kurimoto technos	http://www.kurimoto.co.jp/global-kurimoto.php

	since 2009 cooperation Kurimoto and METAwater	https://www.metawater.co.jp/eng/
14	Kyowa Exeo Corporation	https://www.exeo.co.jp/en/
15	Maezawa Industries, Inc.	http://www.maezawa.co.jp/en/index.html
16	Meidensha Corporation	https://www.meidensha.com/index.html
17	Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.	https://www.mhiec.co.jp/
18	Mitsubishi Kakoki Kaisha, Ltd.	http://www.kakoki.co.jp/english/index.html
19	Mitsui Zosen E&S Holdings Co,.Ltd.	https://www.mes.co.jp/english/business/environment/power_plant/detail758.html
20	Nihon Facilio Co., Ltd.	https://www.j-facilio.com/
21	Nippon Coke & Engineering Co., Ltd.	https://www.n-coke.com/en/index.html
22	Nippon Sharyo, Ltd.	https://www.n-sharyo.co.jp/index_e.html
23	Nippon Unitec Co. Ltd.	http://nipponunitec.com/
24	Obayashi Corporation	https://www.obayashi.co.jp/en/
25	Osaka Gas *developed 2011 compact biogas plant for food waste together with Daiki Axis*	https://www.osakagas.co.jp/en/index.html
26	Sanki Engineering Co., Ltd.	https://www.sanki.co.jp/en/
27	Shisetsu Kougyou Co., Ltd.	http://www.skk.ne.jp/
28	Swing Engineering Corporation *Alliance of Ebara Corp., JGC Corp. and Mitsubishi Corp. established in 2010*	https://www.swing-w.com/eng/products/systems&equipment/w24.html
29	Sumitomo Heavy Industries, Ltd	http://www.shi.co.jp/english/index.html
30	Taisei Corporation	https://www.taisei.co.jp/english/
31	Takuma Co., Ltd.	https://www.takuma.co.jp/english/index.html
32	The Japan Steel Works, Ltd.(JSW)	https://www.jsw.co.jp/en/index.html
33	Tsuchiya Dairy Equipment Mfg. Co.	http://tsuchiyanoki.com/

34	Yanmar Co., Ltd.	https://www.yanmar.com/global/

Table 5: Selection of Japanese engineering companies and manufacturers of Biogas plants and components[47]

ii. Foreign planners and manufacturers of Biogas plants (examples)

No.	Company	Website	Partner company / branch in Japan	Website
1	Bert Energy GmbH	https://bert-energy.com	Benears Co. Ltd	http://www.be-nears.co.jp/
2	Bekon GmbH	https://www.bekon.eu/en/	SUN EARTH CO., LTD.,	https://www.sun-earth.jp
3	BTA International GmbH	http://www.bta-interna-tional.de/en/home.html	Hitachi Zosen Corpora-tion	https://www.hi-tachiz-osen.co.jp/eng-lish/prod-ucts/prod-ucts055.html
4	BTS Biogas	https://www.bts-bio-gas.com/en/	BTS Biogas K.K.	
5	EnviTec Biogas	https://www.envitec-bio-gas.com/	RENAGEN Inc. (cancelled its activities in Biogas business)	
6	Enspar	https://www.enspar.de/en/	Aquas corporation	https://www.aquas.co.jp/
7	Erich Stallkamp ESTA GmbH	https://www.stallkamp.de/en/	S.K.T Inc.	http://www.sktincorp.com/
8	HoSt	https://www.host.nl/en/bio-gas-plants/	Techno System	https://techno-sys.jp/en/en-ergy
9	Lipp	https://www.lipp-sys-tem.de/?lang=en	Nippon Unitec Co., Ltd,	http://nippon-unitec.com/

[47] Research by ECOS GmbH (2020)

10	Krieg & Fischer	https://www.krieg-fischer.de/en/biogas-plants	ECO HEART Inc.	http://www.ecoheart.com/
11	OWS	www.ows.be	Kurita Water Industries	https://www.kurita.co.jp/english/
12	PlanET Biogastechnik	https://planet-biogas.com/en/	Tsuchiya Dairy Equipment MFG Kyoei Corporation Ltd.	http://tsuchiyanoki.com/facilities https://www.kyouei-kk.com/
13	Schmack Biogas (Viessmann Group)	https://www.schmack-biogas.com/	Cornes Biogas, subsidiary Cornes & Company	https://www.cornesag.com/english/ https://www.cornesag.com/product/biogas/biogas/biogas/feature.html

Table 6: Selection of foreign engineering companies and manufacturers of Biogas plants and components[48]

[48] Research by ECOS GmbH (2020)

b. Suppliers

At many biomass plants in Japan, the main biomass-specific components utilize technologies and products made by foreign manufacturers, e. g. turbine, CHP.[49] The increase of installed powerplants after FIT has caused strong dependency on import of biomass fuels.

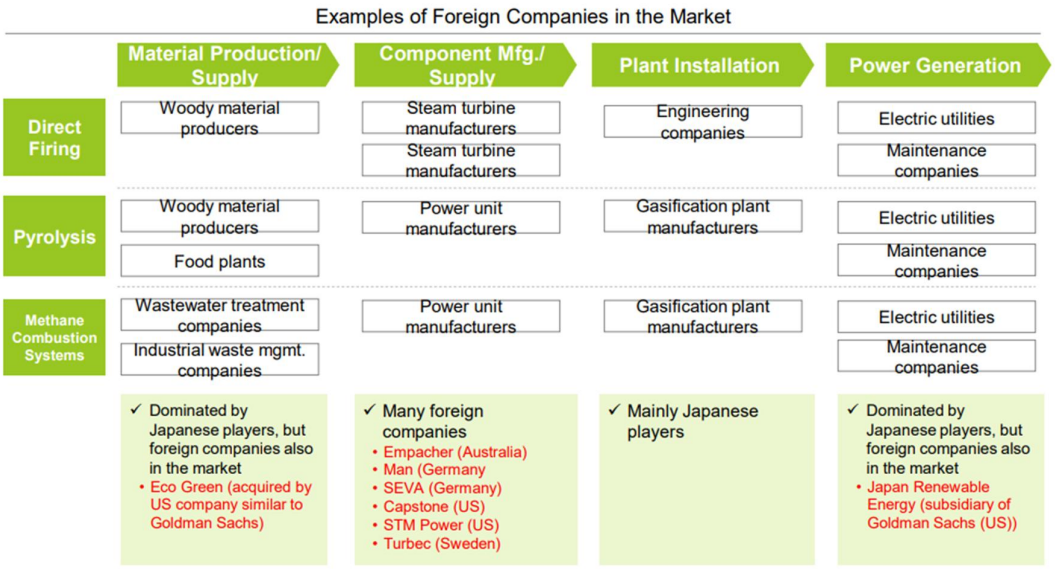

Figure 8: Companies involved in biogas plant manufacturing and operation [50]

The following tables give a few examples of Japanese companies acting as suppliers in the biomass market:

i. Trading companies

General trading companies, known as Sogo Shosha in Japanese, have been expanding their import businesses of biomass fuels since last few years.

[49] JETRO (2017): "Market Report Renewable Energy".
[50] JETRO (2017): "Market Report Renewable Energy".

Company	URL
Itochu Corporation	https://www.itochu.co.jp/en
Sumitomo Corporation	https://www.sumitomocorp.com/en/jp
Sojitz Corporation	https://www.sojitz.com/en/
Toyota Tsusho Corporation	https://www.toyota-tsusho.com/english/company/
Marubeni	https://www.marubeni.com/en
Mitsubishi Corporation	https://www.mitsubishicorp.com/jp/en
Mitsui & Co.	https://www.mitsui.com/jp/en/index.html

Table 7: Selection of general trading companies in Japan, also active in the field of biomass technologies[51]

ii. Manufacturers of fermentation tanks

Company	URL
Fuji Clean	https://www.fujicl.com/company, https://www.fujicl.com/new/biomass (in Japanese, more detailed information)
Voice	https://vioce.jp/en/
Hypotech Inc	http://hipotech.co.jp/ products: http://hipotech.co.jp/renewable/product03/product7/index.php#catego_nav_top http://hipotech.co.jp/renewable/product03/

Table 8: selection of Japanese manufacturers and builders of digesters[52]

[51] Research by ECOS GmbH (2020)
[52] Research by ECOS GmbH (2020)

iii. Manufacturers of dryers

Company	URL	Company
Okawara	http://okawara-mfg.com	Rotary Dryers, Fluid bed dryers (among others)
Taiki Technos	http://taiki-techno.co.jp	Rotary Dryer
Hilde	http://hilde.co.jp	Dryer for wood, technical cooperation with a German company (Robert Hildebrand) since 1955
Yamato Sanko MFG Co., LTD	http://yamato-sanko.co.jp/english/	Wide variety of dryers for many applications

Table 9: Selection of Japanese manufacturers of dryers, suitable for biomass[53]

iv. Manufacturers of CHP systems

There are only a few Japanese manufactures of CHP on the Japanese market, foreign manufacturers (most of them come from Germany, Austria, Czech Republic, Finland, and the U.S) are dominating players.

Company	URL	Company
Technis	technis.jp	Cooperation with 2G (Germany)
Forest Energy	https://forestenergy.jp	Cooperation with Cortus Energy (Sweden), Syncraft Engineering (Austria) and sales contract with Volter (Finland). Business tie-up with NTT Anode Energy Corporation since 2020
Spanner	http://www.holz-kraft.jp/home_jp.html	Japanese Corporation of Spanner Re2 GmbH (Germany)
Komatsu	https://home.komatsu/en/	CHP system in Awazu Factory in Ishikawa prefecture
Kawasaki Heavy Industries	https://global.kawasaki.com/en/	
Icross	http://www.icross.co.jp/	Small-size CHP for woody biomass plants
ZE Energy	http://www.ze-energy.net/english/	CHP system in Nagano prefecture

Table 10: Selection of Japanese manufacturers of CHP systems, suitable for biomass[54]

[53] Research by ECOS GmbH (2020).
[54] Research by ECOS GmbH (2020).

v. Manufacturers of Microturbines

Yanmar	https://www.yanmar.com/jp/
IHI Power Systems Co, Ltd.	https://www.ihi.co.jp/ips/english/index.html
Ebara Corporation	https://www.ebara.co.jp/en/index.html

Table 11: Selection of Japanese manufacturers of microturbines, suitable for biomass [55]

c. Customers

i. Municipalities

Since 2013, seven Ministries in Japan have chosen "biomass industry cities" and the total number of selected districts reached 94 in 2020. These municipalities make effort not only to achieve energy self-efficiency, but also to revitalize local economies and industries. The list of districts is available on the website of MAFF. Half of the districts is concentrated in the northern part of Japan.[56]

ii. Food industries

In order to reduce the food waste and utilize it (see chapter 4 b i) them, food industries have been paying more attention to biogas plants. Some examples are:

- Fujidelica Quality, company for prepared food in Matsuyama prefecture, installed a biomass plant using its own vegetable scraps in its factory.
- Asahi announced to produce all cans of "Asahi Superdry" by using electricity from biomass plants from May 2020. (though food residue is not used as fuels.)
- 'J Bio Food Recycle' established by JFE Engineering Corporation with the cooperation of wholly-owned subsidiary, JFE Kankyo Corporation, started a joint project with East Japan Railway Company and JR East Environment Access for using industrial and food wastes from public facilities such as station buildings and meat manufacturing plants, with 80 ton per day of food waste treated in biogas plants by fermentation. This project began as a food recycling business by converting to biogas beginning in August 2018.[57]

[55] Research by ECOS GmbH (2020).

[56] MAFF (2020): バイオマス産業都市について.

[57] DNA India (2018), "Japan generates electricity by recycling 80 ton per day of food waste"

iii. Farmers

After implementation of the Act on the Appropriate Treatment and Promotion of Utilization of Livestock Manure in 2004, livestock farmers face the need of utilization of the manures. Against the backdrop of it, biomass projects focusing on livestock farmers as partner or consumer has been under progress.

- Biomass power plants from chicken manures by Jumonji Chicken Company; Approx. 40 t manures per day are supplied by the company and affiliated chicken farmers. Generated electricity is supplied also for Tokyo Metropolitan Area.[58]
- Biostock which was established in Hokkaido by NTT East Japan and Biomass Research & Development in 2020 will supply small sized biogas plants with ICT technologies and introduce a monthly paying system for livestock farmers (currently applying for patent) (https://www.biostock.co.jp/)

Several Japanese Biogas plant manufacturers have a special focus on biogas generated from livestock wastes (see chapter 6.a.i.):

- Mitsui E&S Environment Engineering Co., Ltd. (a wholly owned subsidiary of Mitsui E&S Engineering Co., Ltd.) for example completed the "Miyama City Biomass Center construction work" awarded from Miyama City, Fukuoka Prefecture in November 2018. This facility ferments regional garbage, manure and septic tank sludge, and uses "biogas-derived renewable energy (electricity and heat) in the field" to create "rings" of resource circulation in the area.[59]
- A smaller company specialized on Biogas generation from livestock manure is Tsuchiya Dairy. An example of their plants realized is given on their homepage at http://tsuchiyanoki.com/

d. Associations & Research Institutes

i. Associations

- JARUS (The Japan Association of Rural Solutions for Environmental Conservation and Resource Recycling)
  http://www2.jarus.or.jp/biomassdb/instinfolist00.html
- JORA (Japan Organics Recycling Association)
  https://www.jora.jp/
- BPA (Biomass Power Association)
  http://www.bpa.or.jp/

[58] Norinshukin Research Institute (2017): 地域一体となった"産地運営"と鶏糞バイオマス発.

[59] Mitsui E&S Group (2019): "Environmental Preservation - INTEGRATED REPORT 2019".

ii. National Institutes

- Forest Research and Management Organisation
  https://www.ffpri.affrc.go.jp/en/index.html
- Riken, Center for Sustainable Resource Science, Biomass Research Platform Team
  http://biomass-platform.riken.jp/index_en.html
- National Institute of Advanced Industrial Science, Biomass Refinery Research Center
  https://www.aist.go.jp/index_en.html
- Japan International Research Center for Agricultural Sciences
  https://www.jircas.go.jp/en

iii. Universities

- Tokyo University of Agriculture and Technology
  https://www.tuat.ac.jp/en/
- Tokyo University, Collaborative Research Center for Energy Engineering
  https://www.energy.iis.u-tokyo.ac.jp/index.html;
  Newsletter (in Japanese): https://www.energy.iis.u-tokyo.ac.jp/newsletter/newsletter002.pdf

e. Installers/Operators

Local enterprises, municipalities, forest industries, and non-governmental organisations (NGO) are often installers of biomass plants. In typical renewable energy project financing transactions, a project owner is also a special purpose company (SPC). An SPC acquires ownership or leasehold of the project site, builds, and operates power generation facilities, and receives the electricity sales proceeds from a utility company under the power purchase agreement.[60] A few of the examples of projects by SPC are listed below:

- Tomakomai Biomass Power Co., Ltd.
  Stockholder: Mitsui&Co, Sumitomo Forestry, Hokkaido Gas Co., Ltd., Iwakura Corp.
- Hokkaido Biomass Energy
  Stockholder: Mitsui & Co, Hokkaido Electricity Power Company
- Aichi Kaba gun Biomass Energy
  Stockholder: Marubeni, SB Energy, Chubu Electric Power

[60] Anderson Mori, Tomotsune (2019): "Renewable energy project development in Japan".

f. Service and maintenance

The following table gives a few examples of major companies in Japan offering service and maintenance for plants using renewable energies which includes biogas plants.

Mitsui & Co. Foresight Ltd.	https://www.mb-f.co.jp	E. g. round-the-clock manned monitoring service, emergency response, regular control of power plants
JFE Technos	https://www.jfe-technos.co.jp/	Regular control of powerplants
Nippon Steel Engineering	https://www.eng.nipponsteel.com/english/	One stop service from construction to after maintenance

Table 12: selection of major companies in Japan offering service and maintenance for plants using renewable energies [61]

7. Market Potentials and Recommendations

a. Potentials

The International Energy Agency (IEA Bioenergy) expects that there will be a reassessment of bioenergy in Japan. This is also reflected in Japan's long-term climate protection strategy, which was presented in June 2019. The goal is to increase bioenergy in Japan by almost five times by 2030.

The market potential for the possible biogas production depends (among other facts) on:

- The uncertain future production and composition of biowaste.
- The next political decisions on the promotion or recycling of bio-waste.
- The possible technical performance of the biogas plants that can be installed and the possible areas for this.
- The proportion of all food waste that can be developed for fermentation.
- The openness of the Japanese policy, energy distributors and society to the expansion of biogas plants.
- The willingness of the network operators to expand the grid connections and connect biogas plants to the network.

Due to a high-level FIT for electricity, generated by biogas, disposal costs will be avoided e. g. for food and other biowaste. The possible remuneration, even with regard to higher necessary investment costs, is very positive.

[61] Research by ECOS GmbH (2020).

As European companies have years of experience and can supply innovative technology, such as plants that enable alternating operation with different input substrates, biogas plant manufacturers from Europe will find a wide field of potential applications for biogas technology in Japan.

Current remaining obstacles, such as the still existing regional restrictions of the electrical power for feed-in (see chapter 3 c i), can be largely eliminated in the future by improving the controllability and flexibility of the biogas plants thus strengthening their grid stabilizing effect. This requires above all a stronger cooperation between biogas plant and grid operators as well as corresponding support from policy makers.

b. Challenges

Waste producers are often far away:
This implies a necessary establishment of a transport network which sometimes involves considerable effort and additional costs. However, it may be an advantage that the establishment of such a transport network can also have an influence on the delivered substrate by encouraging improved waste separation on site and sensitising the parties where the food is produced to the issue of biogas and renewable energies. If one forms a network or concludes partnerships beforehand, the transport network can also be used for other tasks, thus minimising costs.

Waste separation must first be realized:
In some cases access to feedstock sources (e.g., food waste or livestock manure) must be developed as a first step. In this case, communication with the local community, waste producers, network operators, authorities and other persons is necessary for the operation of a biogas plant. Therefore, access to local decision makers and some lobbying might be necessary, which can hardly be sone without a local partner.

Poor substrate quality:
Plant operators have to be trained, not only regarding technical aspects of the biogas plant but also the selection of usable substrates. The composition and quality of substrates may change during the operation period and, if the plant operator is not experienced or if the operator is not properly trained, biogas production may decrease.

Technology must be adapted to new market as for example:

- different voltages, and partly also different net frequencies have to be considered. The grid connection must be clarified with the electricity supplier before the application for FIT is submitted to METI. It should also be noted that in Japan there are still some regions such as Hokkaido and Kyushu with capacity bottlenecks in the power grid. Here possibly additional costs are incurred if the network operator decides in a specific individual case that the network must be expanded.
- components such as digestion tanks must fulfil safety regulations for earthquakes. This means that, compared to European standards, it must first be clarified whether special reinforcements especially for digestion tanks or materials (such as stainless steel which is for example more flexible than concrete) should be considered.

Other possible challenges may be:

- Still a partly monopoly structure of electricity grid operators makes connection more difficult
- Possibility of lack of acceptance (e. g. odour nuisance)
- Tough bureaucracy and legal restrictions, high quality standards, different regulations must be followed
- Higher investment and construction costs
- High company taxation
- Detailed information on specific topics such as standards, regulations and approval procedures, as well as websites of SMEs and authorities, is often only available in Japanese.
- Japanese business culture makes decision-making in Japanese companies often rather slow and involves a much longer time frame.

c. Recommendations

i. General recommendations for a market entry:

Market structures in Japan are quite similar to those in Europe but cultural and formal aspects should be considered when entering the Japanese market. Basically, it should be noted that in Japan:

- a market entry through partnership, by partnering with domestic players is probably the most promising. Such a partnership can take various forms: feedstock arrangements, technology alliances, joint ventures, value chain alliances (also see chapter 5: Market Access). Not only for sales, installation and service/maintenance activities but also for dealing with Japanese regulations and standards as well as to benefit from local and national subsidy programmes. A Japanese partner can be of great help here, knowing the local market, local challenges, legislation, standards and certification procedures. A partnership will also help to adapt products and services to the needs and target group of the Japanese market.

- Similar to most of the European countries such as Germany, in Japan high standards and many laws must be fulfilled and certification procedures must be passed.

- Contacts to biomass/biogas networks between farmers, local associations and authorities and NGOs and associations could be very useful for building up market activities in Japan.

- Before entering the Japanese market, it is recommended to use of consulting services in Europe (EU Japan Centre, JETRO, etc.) or private companies offering consultant services for entering the Japanese market in order to get an overview on the market potential, cross-cultural differences, potential partners, etc.

- In addition to being present on site through an office and personal meetings, it is also important to participate in events and visit or exhibit at trade fairs.

- For a product to be successful in Japan, it must be of a very high quality and must be adapted to the market, the circumstances and expectations.

- Patience and perseverance are needed: From the first contact to the conclusion of first contracts and the initiation of first business activities in Japan it may well take several years.
- regular contact and visits to the Japanese partner are important for a successful partnership.

Attending industry events is a great way to succeed in entering the Japanese market and enables foreign companies to:

- Get several networking opportunities
- Get to know the market, its main actors and your competitors
- Find potential customers, partners, and projects
- Learn about the latest technologies and competing products

For Biogas business for example the following fairs could be attractive to visit:

- Biomass Expo Osaka
- Biomass Expo Tokyo
- REIF Fukushima

Beside trade fairs also the use of expert media (for expert articles or advertising) such as magazines, newsletters in Japanese language could be an efficient way to promote the products. Beside translators, also the Japanese partner company could be helpful for creating advertisements or presentations being attractive for Japanese costumers.

ii. Systemic considerations and recommendations

The utilisation of food waste, possibly mixed with co-substrates from agriculture, seems to be the most promising application for biogas plants. Networks for collecting food waste from industries, restaurants and even chains of convenience stores already exist and will be extended in the near future. In several communities in Japan collection systems for domestic food waste have started and also for these networks a further expansion can be expected.

For the design of the complete system (e. g. input substrates, biogas plant, heat and electricity generation, fermentation residues) it is recommended to consider the following issues:

- Biogas plants should be flexible to accept a variety of input substrates as in most cases a homogenous quality and composition of the substrates cannot be guaranteed and in the future other input substrates (possibly as co-substrates) may be used.
- Installation and operation of the biogas plant should be easy and not too time consuming as personnel costs in Japan are high.
- For the system design not only electricity generation for feed-in should be considered. Although the FIT for electricity generated from biogas is quite high in Japan, grid operators may limit the power for feed-in and it may be difficult to operate small biogas plants economically efficient. In such cases, consideration should be given to using electricity and heat locally and only feeding-in part of the electricity generated.

For example the generated electricity could be used for own consumption for the respective facility (food industry, farm, sewage plant, etc.) or sold directly to third parties.

- For utilisation of heat also a coverage of own consumption should be considered, not only for heat but also for cooling demand.
- In Japan agricultural land area available for crops (e. g. used as co-substrate together with cattle manure) and farmland structure is small. Therefore, compared with European plants, many biogas plants in Japan tend to be small (in average approx. 350-400 kW) as well.
- A still missing collection system for municipal bio-waste is a barrier to market development. In the industrial (such as food industry) or the gastronomic sector collecting systems for biowaste are already established or planned to be introduced in the near future.
- Above that it also should be considered that fermentation residues that otherwise have to be disposed (with possible additional costs) can be sold as fertiliser and may replace expensive mineral fertilisers

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