Why don’t you work for the methanation of food waste?

August 2018

Food Industry Affairs Bureau, Ministry of Agriculture, Forestry and Fisheries

In the beginning (1): State of global warming

Food Industry Affairs Bureau, Ministry of Agriculture, Forestry and Fisheries

- The introduction of measures against global warming and renewable energy, such as the effectuation of the Paris Agreement and adoption of SDGs, has become a global trend amid the aggravation of adverse effects from global warming.
- Japan's goal of cutting greenhouse gas emissions by 80% by 2050 is unattainable through the extension of conventional measures. The state, local governments, business operators and citizens need to join hands and reinforce countermeasures.

Global developments

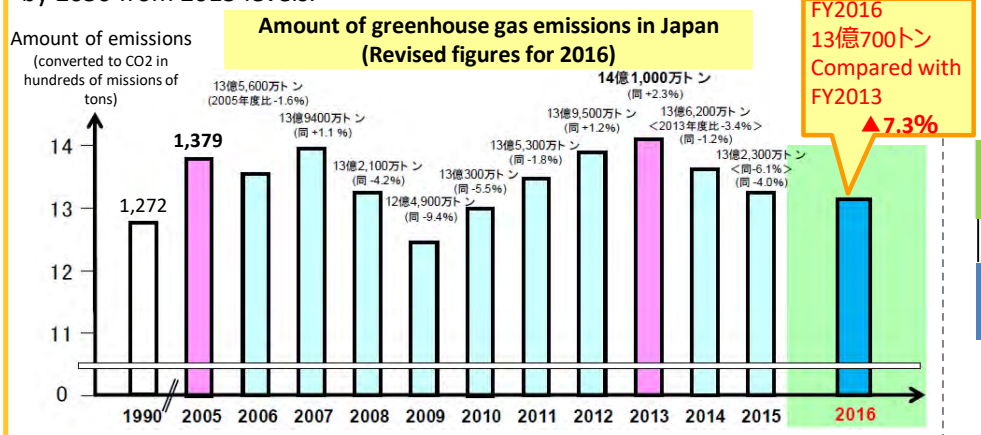
- **Effectuation of the Paris Agreement (2016):** A new legal framework of measures against global warming aiming to "limit the average global temperature rise to less than 2 degrees C above pre-Industrial Revolution levels."
- **Adoption of Sustainable Development Goals (SDGs) (2015):** The goals include "a sharp rise in the share of renewable energy in the global energy mix by 2030."

Japan's efforts

- **Plan for Combatting Global Warming (adopted at cabinet meeting in 2016)**

The plan calls for cutting greenhouse gas emissions by 26.0% in 2030 and by 80% by 2050 from 2013 levels.

Amount of greenhouse gas emissions in Japan (Revised figures for 2016)

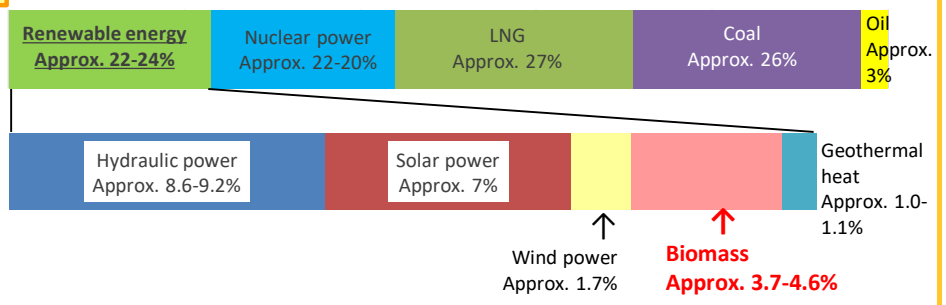


Source: The Ministry of the Environment's "Amount of Greenhouse Gas Emissions in FY2016 (Revised Figures)"

- **Long-Term Energy Supply and Demand Outlook**

Outlook for a rise in the share of renewable energy in the total amount of power generation to 22-24% in FY2030

Outlook for the composition of power sources in 2030



Source: Excerpts from the Ministry of Economy, Trade and Industry's "Long-Term Energy Supply and Demand Outlook" (July 16, 2015)

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In the beginning (2): Conditions surrounding business operators in Japan

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○ Business operators in the domestic industrial sector are subject to various legal duties concerning environmental measures and need to live up to them for the continuation of their operations.

○ Investors in the world are increasingly inclined toward taking into consideration business enterprises' greenhouse gas emissions and decarbonatization efforts in making investment decisions. From the viewpoint of social responsibility as well, the reduction of greenhouse gas emissions and introduction of renewable energy are important programs.

Duties of domestic business operators

Business operators in Japan are required to carry out duties, based on a variety of laws, such as

- **striving for energy saving**
- **adopting measures to cut greenhouse gas emissions**
- **Properly disposing of waste generated in business activities, and**
- **Promoting the utilization of recyclable food waste.**

[Reference]

○ **Act on Rationalizing Energy Use (energy saving law) and assessment system for classification of business operators**
Regular reports on the amount of energy used to the state and classification (S, A, B and C) of business operators based on the reports and inspection and guidance, etc. of business operators in B and lower classes.

○ **Act on Promotion of Global Warming Countermeasures (anti-warming law)**
Calculation of greenhouse gasses, mandatory reports to state, etc.

○ **Waste Management and Public Cleansing Act (waste and cleansing law)**
Obligation of properly disposing as own responsibility of waste generated from business activities

○ **Act on Promotion of Recycling and Related Activities for Treatment of Cyclical Food Resources (food recycling law)**
Food-related business operators who produce more than 100 tons of food waste, etc. per year report the amount of waste produced, means of reuse, etc. each fiscal year. The government announces the names of operators failing to take sufficient countermeasures and penalizes them.

○ Investors in the world use the presence or absence of measures against global warming at business enterprises as a criterion for investment judgment.

○ International NGOs are stepping up activities and actively approaching Japan.

RE100 RE 100
Partnership of enterprises seeking to source 100% of energy needs from renewable sources

CDP CDP
Organization sending questions to enterprise about measures against global warming to rate them.

SBT SCIENCE BASED TARGETS
Targets that recognize enterprises seeking to keep global temperature rises below 2 degrees C

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Importance of introducing renewable energy

○Renewable energy is any form of energy sustainably produced from renewable sources, such as solar, hydro, wind, geothermal and biomass (as defined by the International Renewable Energy Agency).

○Renewable energy can be used repeatedly as its sources do not run dry and it does not increase carbon dioxide in the air during the generation of electric power and use of heat. The adoption of renewable energy, therefore, is increasing as an alternative to fossil fuels that contribute to the battle against global warming.


Solar

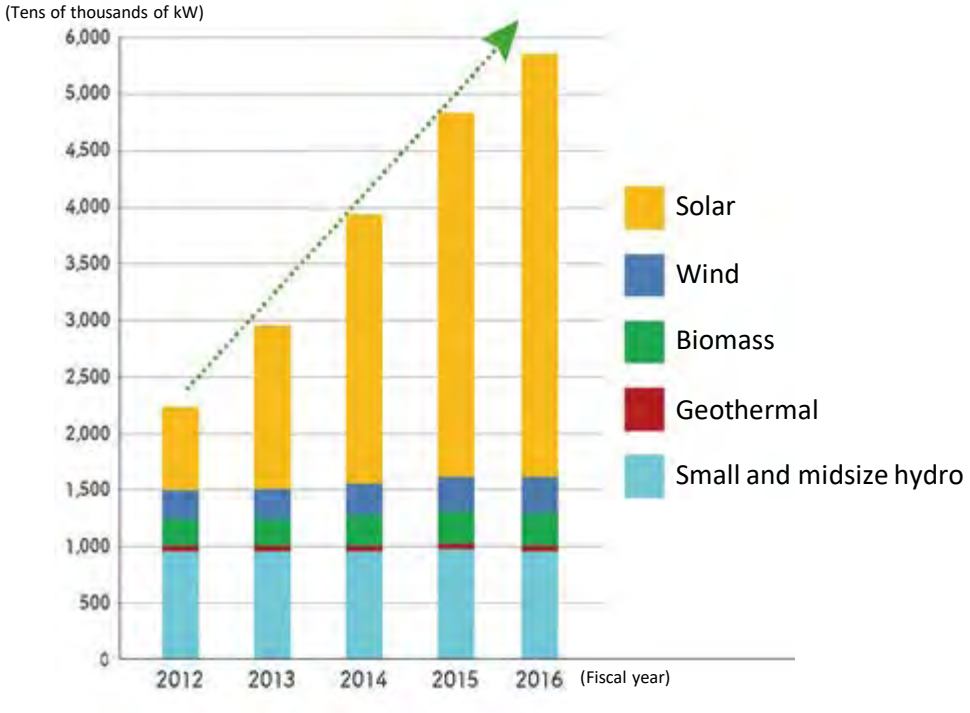

Wind


Geothermal


Small and midsize hydro


Biomass

○Changes in the capacity of renewable energy facilities in Japan (excluding large-scale hydro)



Source: "Feed-in-Tariff Purchase of Renewable Energy (Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, March 2018) Guidebook of Trading System, 2018 Version"

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Food waste is a useful source of energy

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Means of recycling food waste

Priority

- As fodder
- As fertilizer
- **Methanation**, etc.

- ○ Food waste is positioned as a "biomass" because it is an organic substance derived from animals and plants.
- ○ As a way of utilizing food waste as biomass, active efforts are underway to **produce biogas from it through methane fermentation (methanation) for use as energy (electricity and heat)**
- ○ Food waste is suitable for methanation as it generates an extremely larger amount of biogas than other biomasses.
- ○ Food waste from the restaurant industry is often inapplicable to recycling for the use of fertilizer and fodder due the difficulty of separation by categories, raising questions about hygiene management. The waste is better suited for methanation which does not require so strict separation as in the case of fertilizer and fodder.
- ○ Japan has adopted a feed-in-tariff system to promote the introduction of electricity deriving from biomasses.

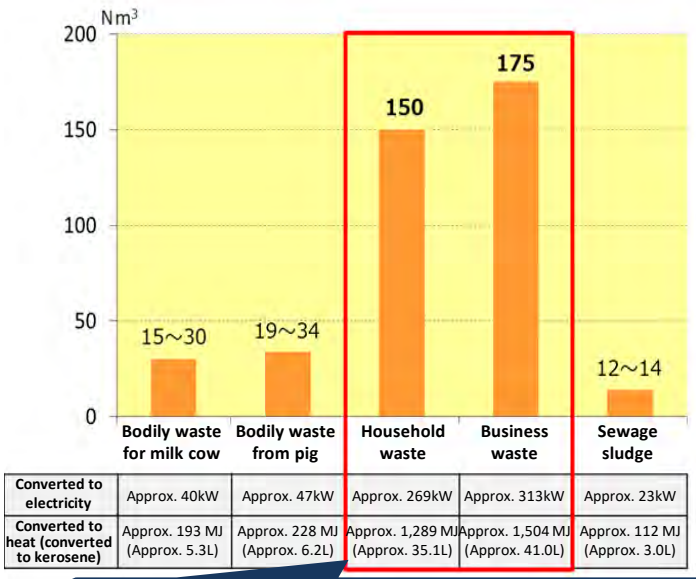
Main use of biomass

○Conventional use
- Fertilizer and fodder
- Fuelwood

○Application to energy
- Conversion to electricity and heat
- Conversion to fuel

○Application to material
- Material
- Material for chemical products

Amount of biogas produced per ton of material



	Bodily waste for milk cow	Bodily waste from pig	Household waste	Business waste	Sewage sludge
Converted to electricity	Approx. 40kW	Approx. 47kW	Approx. 269kW	Approx. 313kW	Approx. 23kW
Converted to heat (converted to kerosene)	Approx. 193 MJ (Approx. 5.3L)	Approx. 228 MJ (Approx. 6.2L)	Approx. 1,289 MJ (Approx. 35.1L)	Approx. 1,504 MJ (Approx. 41.0L)	Approx. 112 MJ (Approx. 3.0L)

Food waste has a great potential for biogas generation!

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Merits of using food waste as energy source

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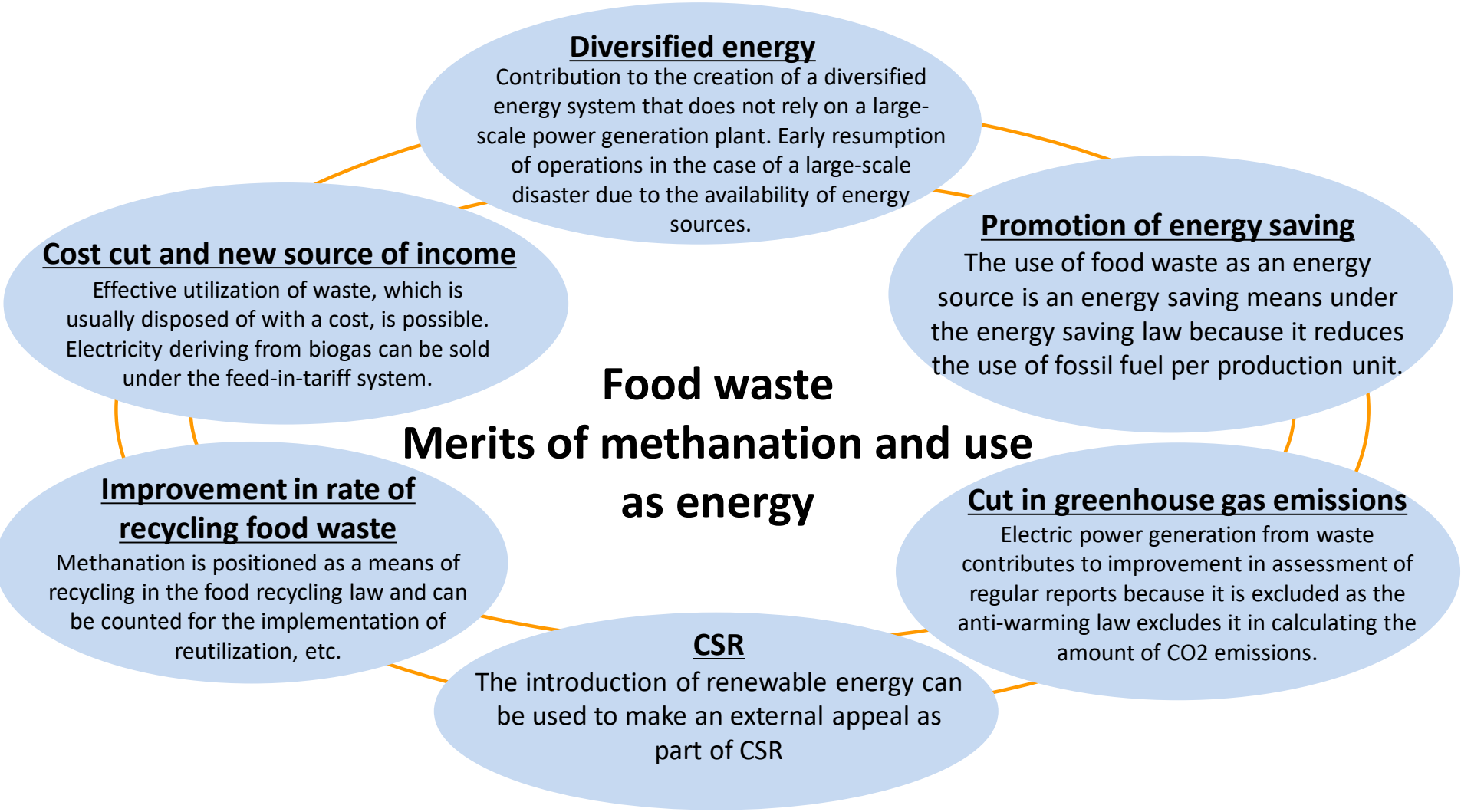
○ Use of food waste as an energy source through methanation helps improve the assessment of various reports business enterprises are required to submit. It may also lead to other merits such as cutting the cost of disposing of food waste and securing a new source of income.



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What is methane fermentation?

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○ “Methane fermentation” is a technology that produces a “biogas” principally composed of methane (CH4) by means of microorganisms, using bodily waste from livestock, food waste, residual agricultural products, etc. as material. The produced gas can be used as energy because heat and electricity are generated by combusting the gas.

○ “Digestive fluid” produced simultaneously can be used as fertilizer because it contains many fertilizer components. (In case the fluid is not used as fertilizer, it usually needs to be treated as discharged water with a cost.)

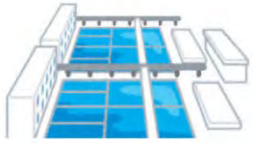
Biomass

Bodily waste from livestock

Food waste

Residual farm products

Sewage sludge



Methane fermentation

○ When **biogas**, as material, is warmed in an anaerobic condition (or in the absence of oxygen), microorganisms decompose organic substances and biogas is produced by methane-producing bacteria.

Biogas contains 60% CH4 and 40% CO2.

Example of methane-producing bacteria

○ **Digestive fluid**, which is left after the extraction of biogas from the material, contains many fertilizer components (nitrogen, phosphoric acid and potash)

Biogas

Digestive fluid

Use as energy

(1) **Electric power generation** by gas engine and power generator

(2) **Supply of heat and electricity** using waste heat from power generation

(3) **Supply of heat** by gas boiler

Use as fertilizer

Digestive fluid

Dispersal over farmland

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(Reference) Examples of methanation facilities

Material

Receiving and preprocessing equipment

Receiving equipment

Preprocessing equipment
(Removal of foreign substances)

Substances unsuitable for fermentation

(Disposed of as waste)

Methane fermentation facility

Desulfurization equipment

Gas holder

Methane fermentation tank

Facility for use as energy

Electric power generation facility

Boiler facility

Electricity

Heat

Solid

Facility for use as fertilizer

Aerobic fermentation equipment
(composting equipment)

Fertilizer Bedding

Digestive fluid storage

Liquid fertilizer

Solid-fluid separation equipment

Fluid

Sterilization equipment

Digestive fluid

Facility for treatment of digestive fluid
(Water treatment facility)

Discharge to river
Discharge to sewage

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Utilization of feed-in-tariff system

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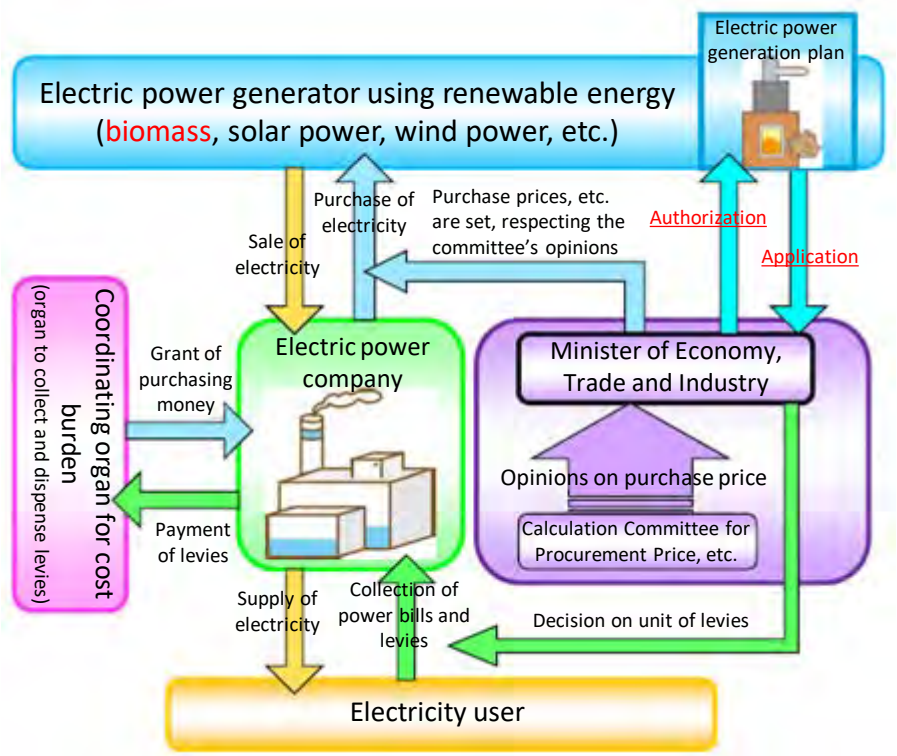
- Sale of electricity generated by gas from methane fermentation is possible under the feed-in-tariff (FIT) system. A power generation plan, authorized between FY2018 and FY2020, makes it possible to sell electricity for 39 yen/kWh (before tax) for 20 years.
- The purchase price (procurement price) and period (procurement period) are examined by the Calculation Committee for Procurement Price, etc., based on the state of renewable energy introduced, cost data and others, and are determined by the Minister of Economy, Trade and Industry by taking the committee's opinions into consideration.

What is the FIT system?

A system under which electric power companies buy electricity generated by renewable energy at a set price for a set period.



Procurement prices and procurement periods (concerning biomass) for FY2018 to FY2020

Kinds of biomass		Procurement price Per 1kWh	Procurement period
Methane fermentation gas (via biomass)		39 yen plus tax	20 years
General waste and other biomasses (direct combustion of residual food products, edible oil waste, etc.)		17 yen plus tax	
Wooden biomasses ※1 ※2 via thinned timber	Less than 2,000kW	※3 40 yen plus tax	
	More than 2,000kW	32 yen plus tax	
Biomass of general timber	Less than 10,000kW	24 yen plus tax	
	More than 10,000kW	入札制	
Biomass liquid fuel		入札制	
Construction material waste		13 yen plus tax	

*1 Wooden biomass via thinned timber is treated the same as construction material waste without certification based on the "Guidelines for Certification of Wooden Biomass for Use in Electric Power Generation."
*2 Biomass, accompanied by harvesting of agricultural products, is included.
*3 Undecided for FY 2019 and FY2020.

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What must be known before methanation?

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○ Following steps are required for methanation.

(1) Application for permission and authorization (2) Agreement with local community
(3) Confirmation of grid (for sale of electricity)

(1) Application for permission and authorization

If permission and authorization are necessary for the treatment of waste, they need to be obtained as a priority step.

- Separate licenses for general waste and industrial waste processing operations (*) and permit for the construction of waste processing facilities are needed from authorities concerned (each prefectural or municipal government in charge).

*No license as a waste processing operator is necessary for processing waste from own food-related businesses. The license is necessary if waste, collected from other business operators, is processed together with waste from own operations.

*Enough studies with a plant maker and other business enterprises concerned should be made as specialistic and technical documents, etc. are necessary.

(2) Formation of agreement with local community

As methane fermentation facilities are waste processing facilities, their construction may be delayed or have to be scaled back, among other possible troubles, if it starts without agreement with the local community. Efforts are needed to form agreement with the local community through such steps from the initial stage of planning as consultation with the local government and continuous communication with residents like holding of meetings to explain the business plan.

(Examples of matters needing attention)

- At the state of construction: dust, noise, vibration, increase in traffic (construction vehicles), etc.
- At the stage of operation: odor, increase in traffic (transportation vehicles), etc.

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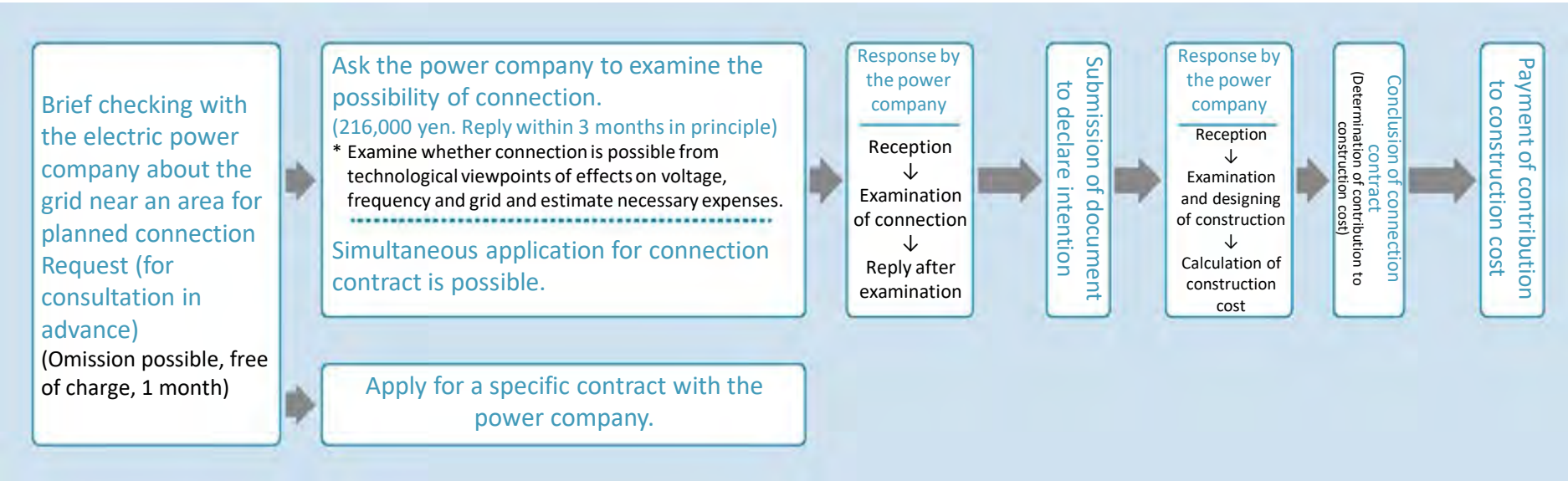
What must be known before methanation?

(3) Confirmation of grid

Selling electricity under the FIT system makes it necessary to check with an electric power company to confirm whether the power generation plant is in an area whether it can be hooked up to its grid.

○ Flow of procedures for connection with grid



Excerpts from "Feed-in-Tariff Purchase of Renewable Energy (Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, March 2018) Guidebook of Trading System, 2018 Version"
http://www.enecho.meti.go.jp/category/saving_and_new/saiene/data/kaitori/2018_fit.pdf

☆Refer to the guidebook for detailed information on the procedure.

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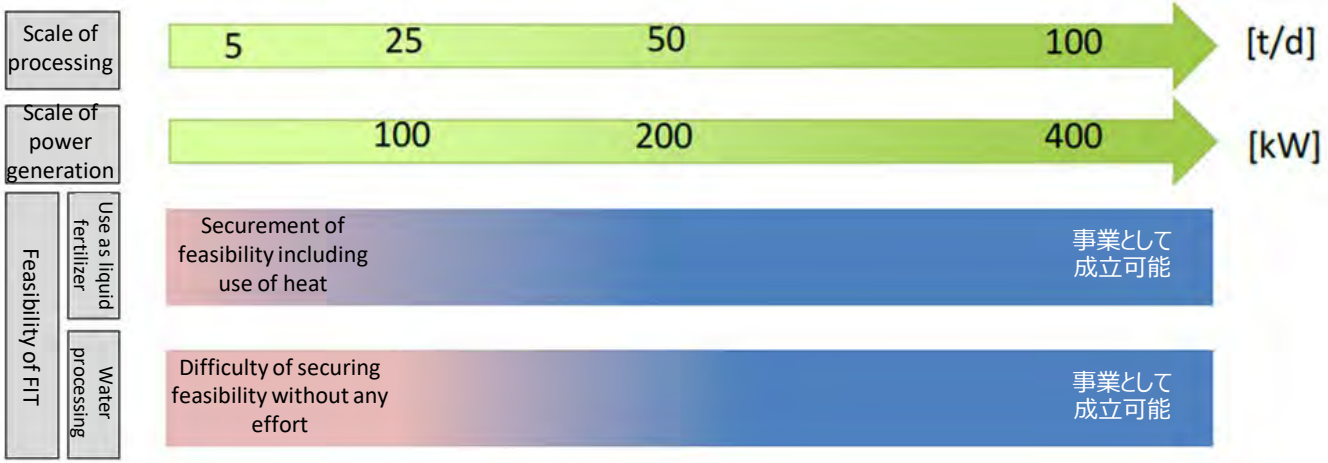
To make project economical

○ As the construction of methanation facilities is often costly, the following points should be taken into account to make the project economical.

- It is useful to examine the following four points at the stage of planning.

(1) Selection of machines	Check whether machines have functions matching the purpose and scale of the project (check whether they have high levels of functions, etc.)
(2) Quality and quantity of material	Grasp material for use (Check whether the scale of facilities matches the quality and quantity of material for use, etc.)
(3) Creation of added value	Creation of added value utilizing business environments, etc. (whether to make use of heat waste, etc.)
(4) Cost cut	Efforts to cut cost utilizing business environments, etc. (whether digestive fluid can be used in neighboring farmland as fertilizer to cut the cost of processing discharged water)

(Reference) Yardstick for making the methanation of food waste economical as business (feasibility)



Source: "Terms and Guidelines for Introduction of Locally Independent System for Biomass Energy" (September 2017, New Energy and Industrial Technology Development Corporation (NEDO))

- As public awareness of facilities for the utilization of biomass is still limited, the procurement of construction funds from financial institutions may not go smoothly. It is thus useful to consider using a public-private fund or reducing the risk of loans by concluding a comprehensive agreement of the local government.

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Summary

- While the fight against global warming has become a pressing task not only for Japan but also for the rest of the world, domestic business operators as well as those overseas need to promote anti-global warming and other environmental measures for the continuation of businesses.
- Food waste from food-related business operators in Japan is an effective source of renewable energy. The use of food waste as energy through methanation not only helps improve the assessment of various reports enterprises are required to submit but also has the possibility of leading to economic merits such as income from the sale of electricity.
- In implementing methanation, it is necessary to work out a business plan while considering such matters as acquiring necessary permission and authorization, forming agreement with the parties concerned, confirming the situation of connection to a grid, how to ensure the economic efficiency of operations, etc. For more information, refer to specific cases and related links.

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Specific cases of methanation of food waste: Table of contents

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Case 1-(1) Kirishima Shuzo Co.

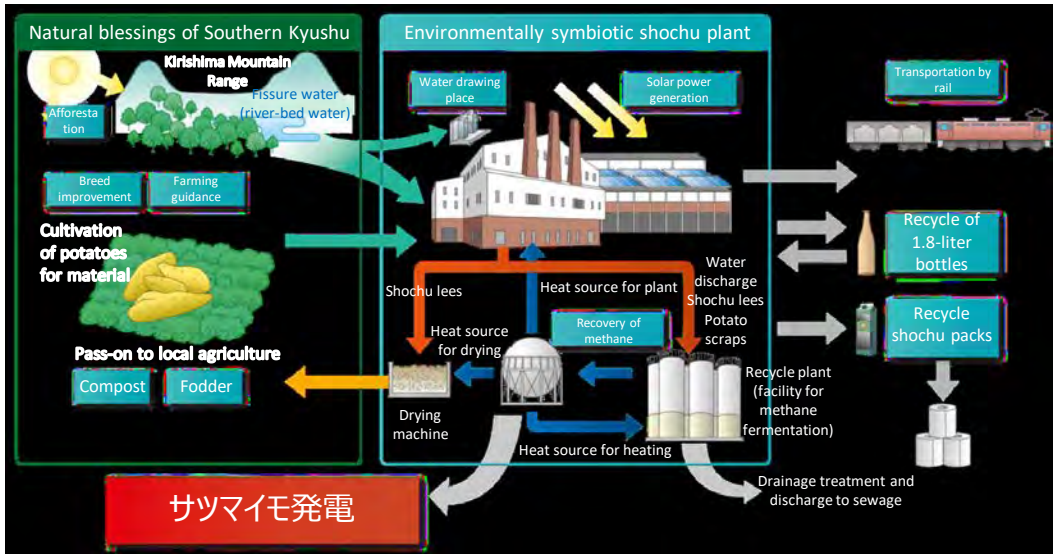
- ○ Program started following a ban on the dispersal of lees, left after the distillation of shochu, on fields.
- ○ Production of biogas through methane fermentation using lees and potato scraps left in the distilling process of shochu
- ○ Kirishima uses biogas as fuel for its own boilers. Electricity generated by surplus biogas in excess of the own use is sold through the FIT system and posts a revenue of 240-250 million yen.

Summary of facilities

- ■ Start of operation: Methanation and fertilization: 2006
  Supply of biogas: 2011
  Power generation with sweet potatoes: 2014
- ■ Total project cost: approx. 7 billion yen
- ■ Volume of processing: shochu lees approx. 650 tons/day
  Potato scraps approx. 10 tons/day
- ■ Equipment using biogas: power generators
  735kW x 1 unit, 585kW x 2 units
- ■ Yearly power output: Approx. 8.5 million KWh
- ■ Use of electricity: FIT sale
- ■ Digestive fluid: Solid: Used as material of fertilizer
  Liquid: Drainage treatment

Features of program and facilities

- ■ Cut in CO2 emissions
  Use of biogas, generated at the recycle plant, as fuel for boilers at the own plant, cuts CO2 emissions by about 3,000 tons
- ■ Revenue from sale of electricity
  Revenue of 240-250 million yen by selling some 6.5 million KWh, nearly twice as much as initially planned
- ■ Zero emission
  At the expanded plant of the corporate headquarters, biogas covers 46% of the total annual consumption of fuel. It is also seeking to realize zero emission through a recycling program using the solid portion of digestive fluid as material for fertilizer in order to eliminate waste.



Operation flowchart

Recycle plant

Biogas engine power generator

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Case 1-(2) Aleph Inc.

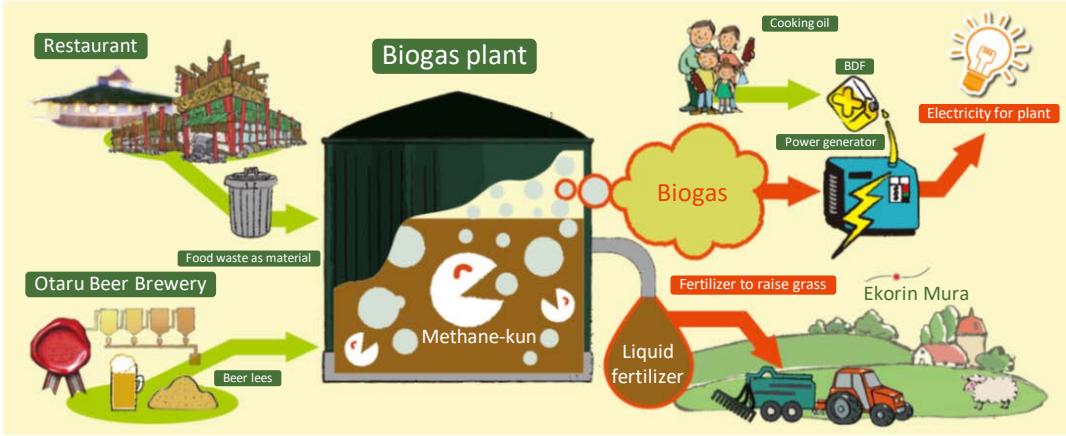
- ○ Methanation of food waste from Bikkuri Donkey and other restaurants and beer lees from a brewery
- ○ Generate electricity using produced biogas and BDF, fuel of recycled edible oil, and use it for private use. Digestive fluid is dispersed as liquid fertilizer on grassland of own Ekorin Mura farm raising sheep.
- ○ Realization of a program to recycle own waste for self-sufficiency in food, fertilizer and energy

Summary of facilities

- ■ Start of operation: 2004 (restart after revamping in 2014)
- ■ Total project cost: approx. 100 million yen (including revamping cost)
- ■ Volume of processing: Food waste: approx. 0.1 tons/day
  Beer lees: approx. 0.6 tons/day
- ■ Equipment using biogas: Power generator 30kW x 1 unit
- ■ Yearly power output: approx. 145,000kWh
- ■ Use of electricity: Private use (approx. 80%) and FIT sale (approx. 20%)
- ■ Digestive fluid: Used as liquid fertilizer at Ekorin Mura (own farm)
  Volume of dispersion: Approx. 600-800 tons per year (40-45 tons/ha)

Features of program and facilities

- ■ Waste processing
  Cut of approx. 90% in the cost of processing waste discharged from shops and beer brewery
- ■ Use of digestive fluid
  Dispersion mainly in May to October after grass cutting (partial dispersion in autumn to prolong the pasturing period). Effective in improving the constituent of grass, volume of yield, etc., resulting in a revenue increase of more than 25,000 yen per ha.
- ■ Private use of electricity
  Approx. 40% cut in the purchase volume of electricity
- ■ Operation of the biogas plant generates a margin gain of approx. 4.5 million yen per year through such merits as a cut in the cost of processing industrial waste, power contribution amount, use of liquid fertilizer, etc.



Operation flowchart

Storage tank equipped with fermentation functions

Power generator using a mixture of biogas and BDF

Scene of dispersing digestive fluid

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Case 1-(3) Shimonoseki plant of Maruha Nichiro Corporation

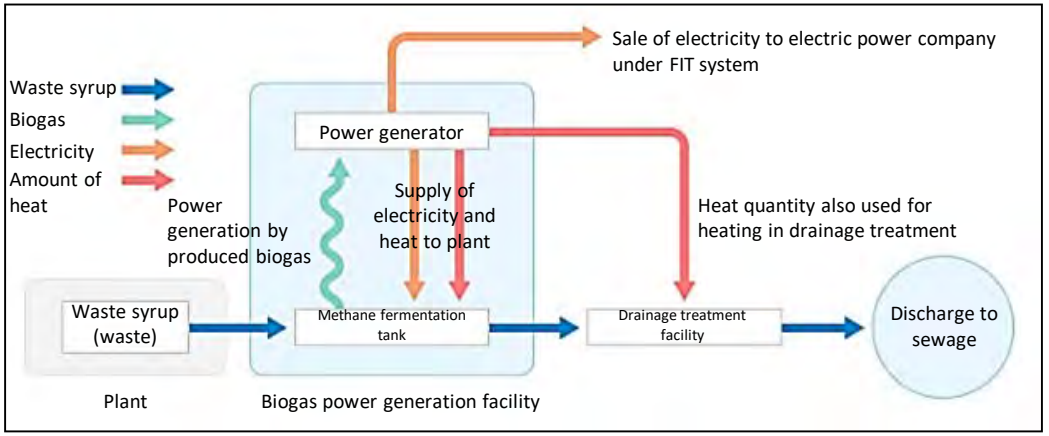
○ The Shimonoseki plant, the company's principal factory of cup jellies, engages in biogas power generation, using waste syrups as material. Almost all waste syrups are processed for power generation.
○ The plant sells electricity to an electric power company through the FIT system and has achieved a sharp cut in the cost of processing waste.

Summary of facilities

- Start of operation: 2013
- Total project cost: Approx. 100 million yen
- Yearly processing volume: Waste syrup: Approx. 1,100 tons/year
  Ground meat: Approx. 230 tons/year
- Equipment using biogas Power generator: 25kW x 1 unit
- Yearly sale of electricity: 170,000 kWh
- Use of electricity: Private use and FIT sale
- Use of heat: Private use (regulating and fermentation tanks)
- Digestive liquid and drainage treatment

Features of program and facilities

- Fundraising:
  Utilization of "Yamaguchi Prefecture's subsidy for reducing the amount of waste and promoting recycling projects"
- Operation plan
  Joint tests on decomposition processing of waste syrups and methane fermentation with local enterprise for about six months
- Cogeneration
  Heat discharged when electricity is generated is used to heat processing facilities
- Efforts to improve the efficiency of producing biogas
  Addition of ground fish meat, produced in the process of ground fish meat products, started in 2015 for efficient use of the plant. Production of biogas has increased due to the use of ground meat containing protein.



Operation flowchart

Full view of facilities

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Case 1-(4) Cooperative Association of Hiroshima Food Industrial Complex

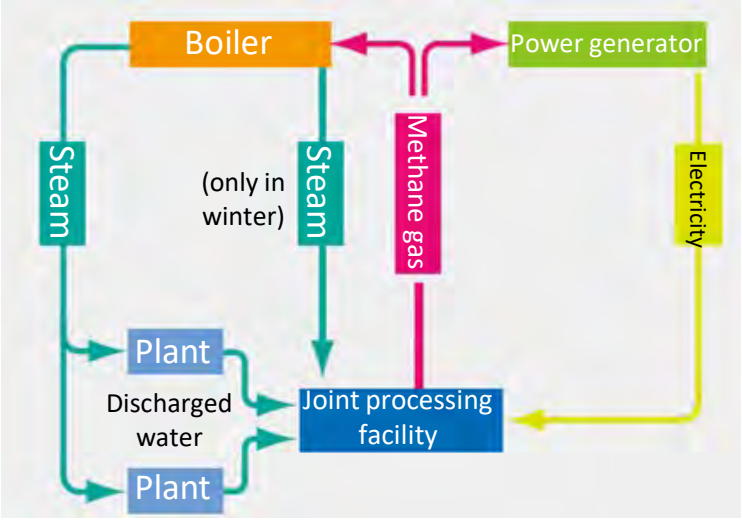
- The association consists of 19 food-related enterprises which jointly manage drainage treatment and joint cold storage facilities.
- The association produces steam in a biogas boiler, using methane generated in a drainage treatment facility, and receives fees for supplying it to member enterprises' plants. The association has thus reduced the cost of fuel and introduced a power generator on a trial basis (for private use of electricity).

Summary of facilities

- Start of operation of methane-using equipment: 2011 (biogas boiler and power generator)
- Cost of introducing methane-using equipment:
  Installation of steam pipes, etc.: Approx. 15 million yen
  Purchase of used power generator: Approx. 3 million yen
- Volume of processing: Water discharged from plant: 1,000 tons/day
- Equipment using biogas: Power generator 34kW x 1 unit
- Use of electricity: Private use
- Use of biogas: Generate steam in biogas boiler and supply it to member enterprises' plants for fees
- Digestive liquid: drainage treatment

Features of program and facilities

- Effective use of existing facilities
  Program to utilize methane gas produced in existing anerobic drainage treatment facility
  Utilization of the Environment Ministry's "FY2009 support program for credit creation for reduction and absorption of greenhouse gas emissions" for laying steam pipes.
- Cost cut via cogeneration
  Member enterprises have cut fuel costs as the use of steam, produced by the biogas boiler, has enabled them to reduce the operation of their fuel oil boilers. They also cut power bills by a total of nearly 15 million yen thanks to power generation from October 2011 until March 2018.



Operation flowchart

Drainage treatment facility

Anaerobic reaction tank

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Case 1-(5) Nakata Foods Co.

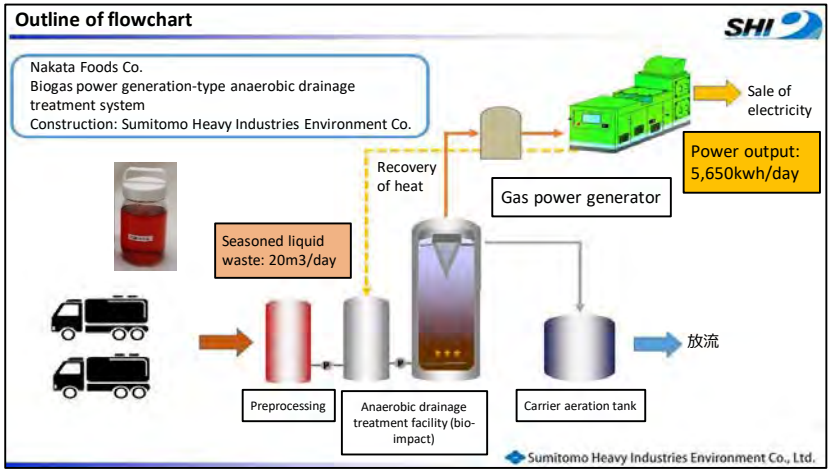
- ○ The treatment of seasoned liquid waste, generated in the process of producing “umeboshi” (Japanese salt plums) is costly and has been a headache for processors for a long period of time.
- ○ Nakata planned to introduce a biogas power generation-type anaerobic drainage treatment system, using seasoned liquid waste, as suggested by a local waste disposer. The system is planned to begin operation in January 2019.
- ○ The project will settle the problem on a region-wide basis by accepting seasoned liquid waste from other local umeboshi processors as well.

Summary of facilities

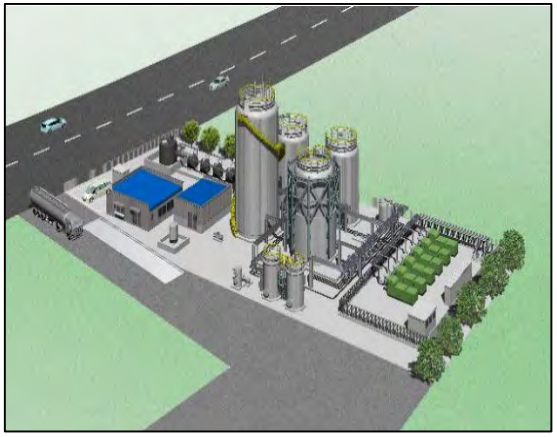
- ■ Start of operation: January 2019 (planned)
- ■ Total project cost: Approx. 1 billion yen
- ■ Processing volume: Industrial waste: 20 tons/day (planned)
  Seasoned liquid waster generated from own plant and other local umeboshi processors
- ■ Equipment using biogas: Power generator 60kW x 6 units
- ■ Yearly power generation: 2 million kWh
- ■ Use of electricity: FIT sale
- ■ Digestive liquid: Draining treatment (use of public sewage system)
- ■ Facility operator and manager: Miyaso Chemical Co.
- ■ Design and construction: Sumitomo Heavy Industries Environment Co.

Features of program and facilities

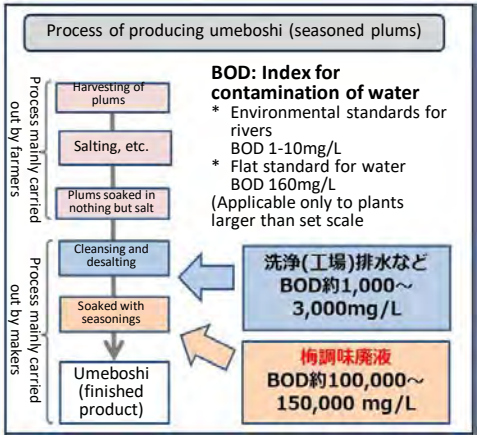
- ■ Tie-up with local community
  Nakata held a session jointly with the Wakayama prefectural government, Kamitonda town office and Miyaso Chemical Co., proposer of the project, to explain the treatment of seasoned liquid waste to local people.
  The project is designed to make the treatment efficient by processing seasoned liquid waste not only from Nakata’s own plant but also from other local umeboshi processors and create new energy deriving from ume, a local specialty. It will seek to further promote the ume industry and the recycling of foodstuffs.
- ■ Improvement in food recycling rate
  Utilization of seasoned liquid waste, the recycling of which has been difficult, is expected to bring the rate of recycling to 100% after the facility begins operating.
- ■ Economic merits
  The cost of processing waste, such as spending on waste liquid neutralization and other agents, is expected to drop by 40%. Sale of electricity is projected to log a revenue of some 80 million yen a year.



Flowchart of biogas power generator



Full view of facilities (drawn image)



Umeboshi production process

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Case 2-(1) Makinohara Biogas Electric Power Generation Plant

Food Industry Affairs Bureau, Ministry of Agriculture, Forestry and Fisheries

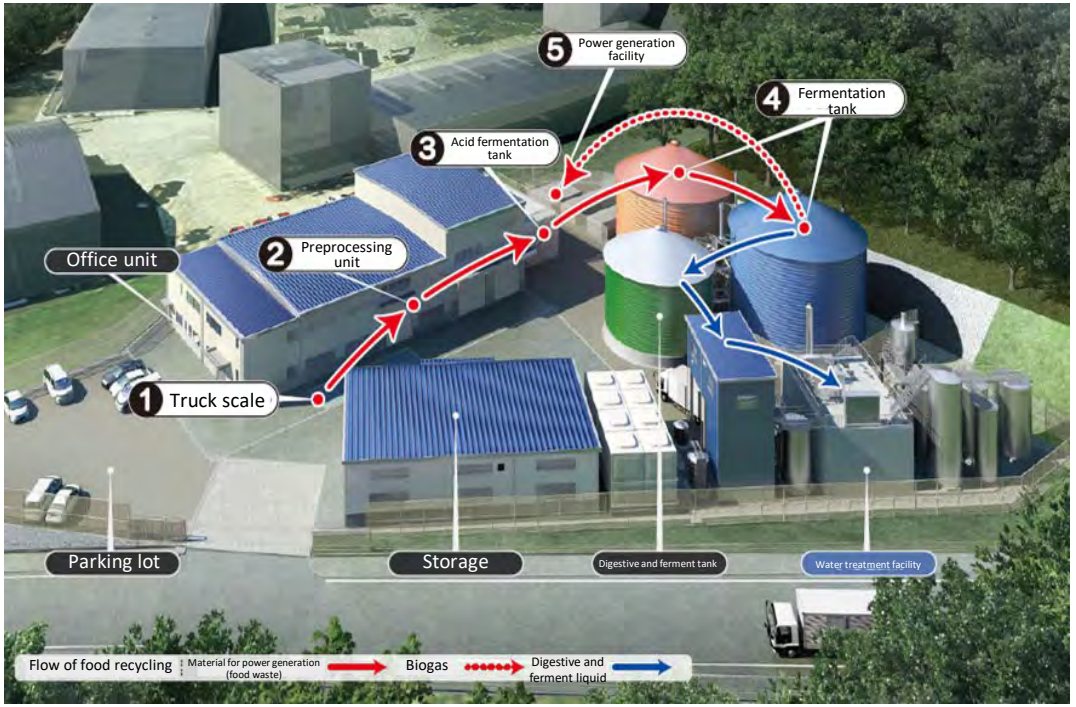
- ○ “Makinohara Biogas Electric Power Generation Plant” is a biogas power generation facility mainly using food waste from food production factories, etc., as material.
- ○ Construction of the plant, as its feature, was wholly financed by private-sector funds through a project finance scheme. It has contributed to the vitalization of local economic activities by farming out its construction and management to local enterprises as much as possible.
- ○ The project has been worked out in cooperation with the Makinohara municipal government, which has been promoting the use of biomass, and sought to form agreement with the local community through careful and repeated coordination. It thus has established favorable relations with the local community, such as local farmers’ proposal to utilize digestive liquid produced as a byproduct of their work.

Summary of facilities

- ■ Start of operation: March 2017
- ■ Total project cost: Approx. 2 billion yen
- ■ Volume of processing: Industrial waste: 80 tons/day (collection of fees from those discharging waste)
  (Residuals from animals and plants, sludge, waste acid, waste oil and waste alkali)
- ■ Equipment using biogas: Power generator 325kW x 2 units
- ■ Use of electricity: Private use and FIT sale
- ■ Digestive liquid Solid: Sale as fertilizer (outsourced)
  Liquid: Water treatment
  *Studying local farmers’ proposal for use as liquid fertilizer
- ■ Project planning and management: Archaea Energy
- ■ Operation: Genesis

Features of program and facilities

- ■ Fundraising
  Private-sector funds in full via project finance
- ■ Construction and management:
  Outsourced to local enterprises as much as possible
- ■ Formation of agreement
  More than 30 sessions were held for explanation to local people in cooperation with the city office. Talks on an individual basis and visits to advance facilities were conducted when necessary.
- ■ Process of treatment
  The process of acid fermentation (as seen in the right figure 3) is included in the preprocessing stage of methane fermentation to stabilize the state of material.



施 設 全 景

Inside preprocessing unit

Acid fermentation tank

Methane fermentation and digestive liquid tank

Power generator

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Case 2-(2) Senami Biomass Energy Plant of Kaisei Inc.

Food Industry Affairs Bureau, Ministry of Agriculture, Forestry and Fisheries

- ○ The company produces biogas through methane fermentation, using food waste, etc. gathered at a spa town in Murakami City, Niigata Prefecture, where it has a plant. It sells biogas, taking advantage of the FIT system.
- ○ Surplus heat is used to warm greenhouses for cultivation of tropical fruits. Digestive fluid is used as fluid fertilizer for cultivation of rice, etc.
- ○ Establishment of a food recycle group with enterprises discharging food waste

Summary of facilities

- ■ Start of operation: 2012
- ■ Cost burden: Self-payment (100%
- ■ Volume of processing: Approx. 4.9 tons/day
  Food residuals (Approx. 90%)
  Organic sludge deriving from food (Approx. 10%)
- ■ Equipment using biogas: Power generator 25kW x 1 unit
- ■ Use of electricity: FIT sale (authorized in 2012)
- ■ Use of heat: Private uses (fermentation tank and greenhouse)
  30,000 kcal/h (claimed by maker)
- ■ Digestive fluid: Used as liquid fertilizer and for production of compost
- ■ Sources of food waste: Hotels, inns, food supermarkets and food factories

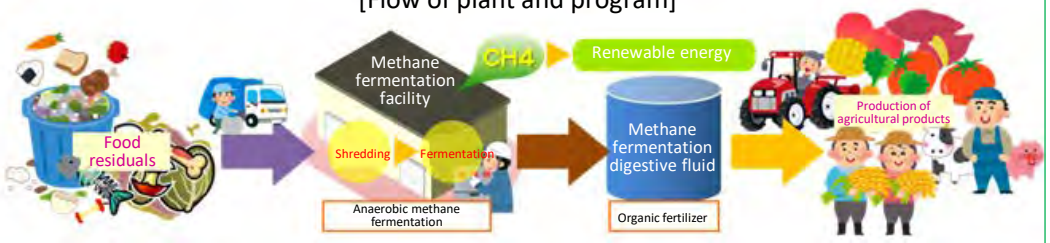
Features of program and facilities

■ Food recycling group

Establishment of food recycling group under the following scheme

- Kaisei Inc. collects and transports food residuals from spa lodging facilities, food supermarkets, food factories, etc. in and around Murakami City, adds sub-materials (mainly organic sludge) to them and carries out methane fermentation at Senami Biomass Energy Plant.
- Kaisei Noken, a Kaisei affiliate, uses digestive fluid from methane formation for production of rice, passion fruits, vegetables and other agricultural products.
- Produced agricultural products are purchased and cooked by spa inns and hotels, food supermarkets and other sources of food residuals.
- The abovementioned program utilizes the recycling program plan system under the food recycling law.

[Flow of plant and program]



Methane fermentation is technology to dispose of organic substances, such as food residuals (leftovers, kitchen waste, sold food losses, etc.) and others through decomposition by microorganisms. It is less environmentally burdensome than widely practiced incineration and is effective for reducing greenhouse gas emissions. Digestive fluid left behind after decomposition helps grow agricultural products as organic fertilizer. Methane fermentation assumes the role of a resource recycling mechanism to produce foodstuffs from food.

Full view of biomass plant

Dispersal by spray vehicle

Passion fruit

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Case 2-(3) Toyama Green Food Recycle Inc.

- Methane gas produced through the methane fermentation of food waste is sold to business enterprises in the local community for use as heat. The company is registered as a recycling business operator under the food recycling law.
- Toyama City has been stepping up efforts to reduce the amount of garbage by separating and recycling food waste from "burnable garbage" since FY2006 to establish a recycling-oriented society through "de-incineration" and "de-landfilling." The recycling of food waste is currently underway in 13 districts.

Summary of facilities

- Start of operation: 2003
- Total project cost: Approx. 1.8 billion yen
- Volume of processing: Approx. 40 tons/day
  Industrial waste, general business-related waste and general household-related waste (13 districts in Toyama City)
- Equipment using biogas: Power generator 30kW x 3 units
- Use of electricity: Private use
- Use of biogas: Sale (for use as heat)
- Digestive fluid: Solid: outsourced processing
  Liquid: Drainage treatment
- Sources of food waste: Food makers, hotels, inns, food supermarkets, convenience stores and household garbage

Features of program and facilities

- Separation of food waste
  Adoption of garbage separation equipment makes it possible to remove foreign items and cope with the inclusion of them to some extent. Wrapped food residuals are acceptable. Food residuals, excluding eggshells, bones, crab shells and edible oil waste, are acceptable.
- Registered as recycling business operator under the food recycling law

Full view of facilities

Garbage separation machine

Methane fermentation tank and gas holder

Power generator

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Case 2-(4) Jonanjima Food Recycle Plant of Bio Energy Corporation

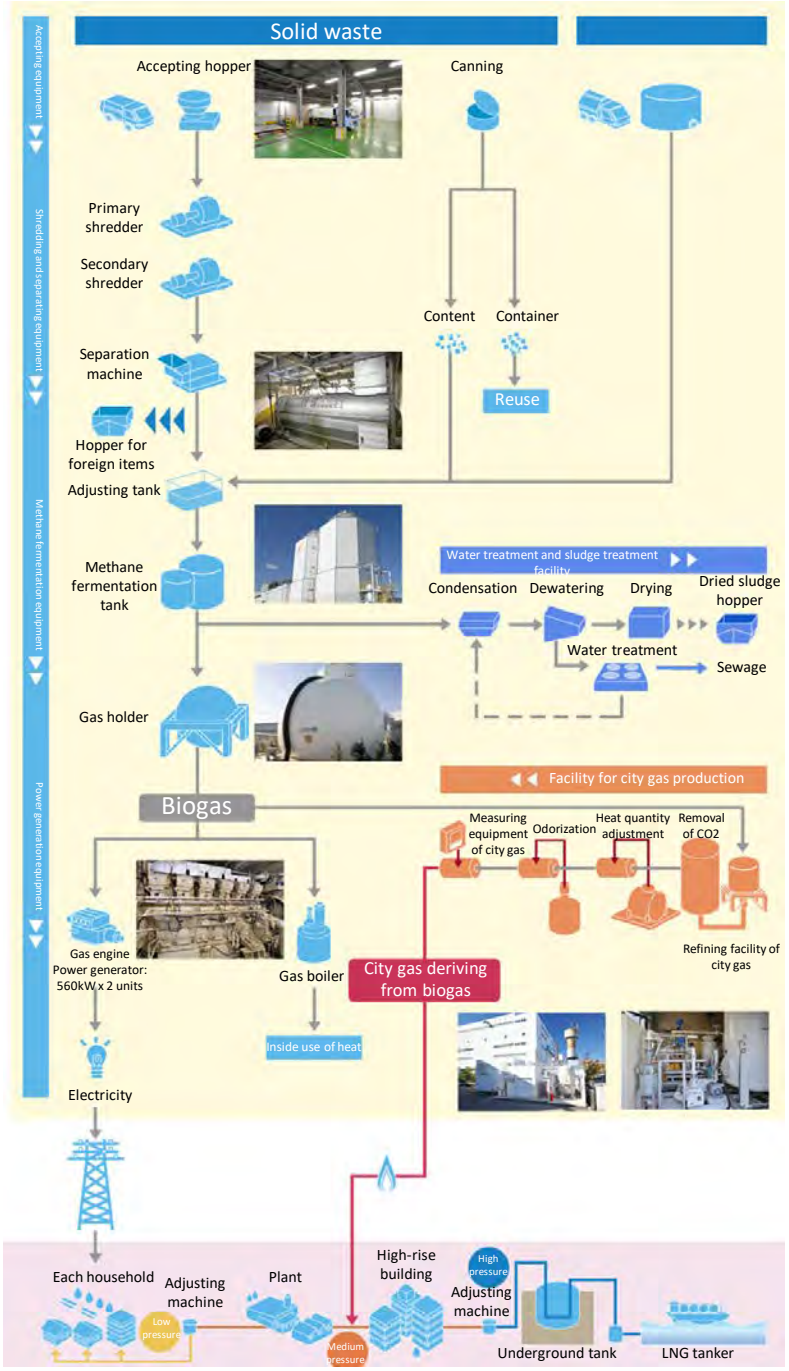
○ Jonanjima Food Recycle Plant of Bio Energy Corporation engages in Japan's first program that not only produces electricity (for sale to PPS operators) and uses heat by means of biogas but also refines biogas for supply to city gas as fuel.
○ Acquisition of license as registered recycling business operator under the food recycling law.

Summary of facilities

■ Summary of facilities Start of operation: April 2006
■ Total project cost: Approx. 3.8 billion yen
■ Volume of processing: Solid waste: 125 tons/day
Liquid waste: 5 tons/day
Industrial waste and general waste
■ Equipment using biogas: Power generator 560kW x 2 units
■ Use of electricity: Private use and FIT sale (to PPS)
■ Use of biogas: Sale (to Tokyo Gas Co.)
For use as heat in processing facility, etc.
■ Sources of food waste: Food makers, supermarkets, restaurants, etc.

Features of program and facilities

■ Separation of food waste
Adoption of garbage separation equipment makes it possible to remove foreign items and accept wrapped food waste insufficiently separated.
■ Biomass power generation
Generation of 26,880kWh (equivalent to 2,600 households) per day and sale to power generation company under the FIT system.
■ Supply of city gas
Refining of biogas into city gas and sale to Tokyo Gas Co. Supply of 2,400 m2 (equivalent to 2,000 households) per day
■ Yearly CO2 emission cut by 7,080 tons (equivalent to 921 ha of forests equal to 197 Tokyo Dome baseball fields)
■ Operation 24 hours per day for 365 days per year
■ Registered as recycling business operator under the food recycling law



Operation flowchart

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★Regional consolidation of biomasses and use of energy at sewage disposal plants

○At sewage disposal plants, facilities to use sewage sludge as energy are in operation (in 101 places across Japan as of April 2018). The use of surplus capacity, resulting from the dwindling of population, to accept regional biomasses, such as food waste, will realize effective region-wide use of energy. There are programs of such a kind in 9 places across Japan and the state will continue efforts to further expand them.

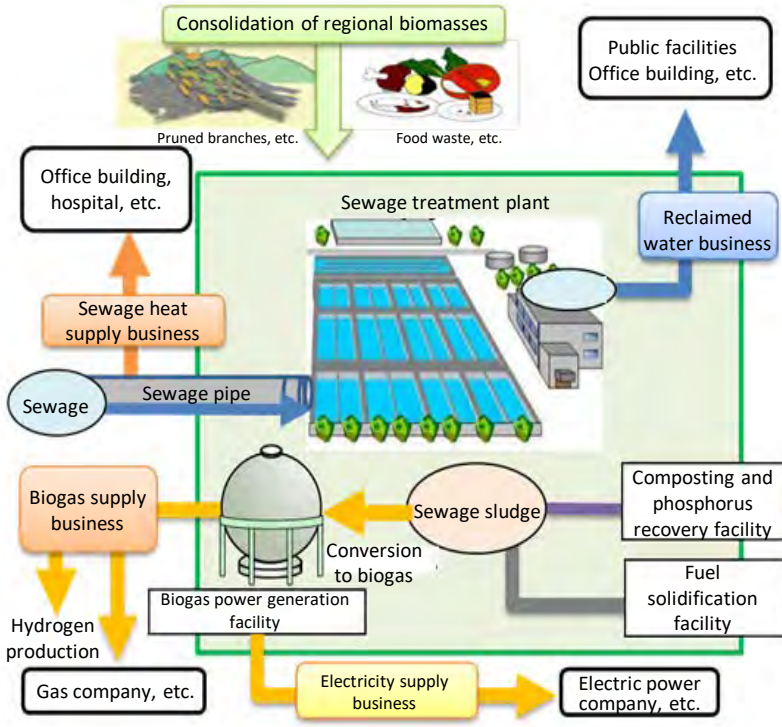
Merits of accepting regional biomasses at sewage disposal plant

- ○ Cut in the cost of processing waste at existing waste treatment facilities and cut in the cost of construction by consolidating human waste and other processing facilities due to be renewed.
- ○ Cut in electric power cost and the cost of treating sludge by effective use of energy to realize sustainable sewage management.
- ○ Generation of gas by sewage sludge is limited but increases by accepting other biomasses (In particular, food waster is effective for use as energy as it generates a large amount of gas)
- ○ Effective use of surplus capacity (sewage stock) due to the dwindling of population

Bistro Sewage and Junkan Sodachi (Cyclic Breeding)

- ○ Program to make effective use of sewage sludge (sludge, reclaimed water, heat, carbon dioxide, etc.) as fertilizer, etc. is called “Bistro Sewage” and promoted by the Ministry of Land, Infrastructure, Transport and Tourism.
- ○ Foodstuffs produced through effective use of sewage sludge are nicknamed “Junkan Sodachi (Cyclic Breeding)” and efforts are underway to facilitate the understanding of their safety and security as well as the program.

Consolidation of regional biomasses and use of energy at sewage treatment plant



9 districts across Japan

Local government	Other regional biomasses
Kitahiroshima City, Hokkaido	Human waste, septic tank sludge, settlement drainage sludge and raw garbage (household- and business-related)
Eniwa City, Hokkaido	Human waste, septic tank sludge and raw garbage (household- and business-related)
Kanuma City, Tochigi Prefecture	Human waste, septic tank sludge and raw garbage
Niigata City, Niigata Prefecture	Cut grass, etc.
Kurobe City, Toyama Prefecture	Septic tank sludge, settlement drainage sludge, raw garbage and food waste
Suzu City, Ishikawa Prefecture	Human waste, septic tank sludge, settlement drainage sludge and raw garbage (business-related)
Nakanoto Town, Ishikawa Prefecture	Human waste, septic tank sludge, settlement drainage sludge, raw garbage (business-related) and food waste
Toyohashi City, Aichi Prefecture	Human waste, septic tank sludge and raw garbage
Kobe City, Hyogo Prefecture	Wood debris and business-related food waste

☆Manual for utilizing reginal biomass at sewage treatment plant (Ministry of Land, Infrastructure, Transport and Tourism, 2017)
http://www.mlit.go.jp/mizukokudo/sewerage/crd_sewerage_tk_000124.html

☆Bistro Sewage
http://www.mlit.go.jp/mizukokudo/sewerage/mizukokudo_sewerage_tk_000565.html

Implementation of nationwide publicity of “Junkan Sodachi”

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Case 3-(1) Suzu City Sanitation Center (Suzu City, Ishikawa Prefecture)

- The center engages in the intensive and combined treatment of sewage sludge, business-related food waste, farming settlement drainage sludge, septic tank sludge and human waste. Methane gas generated in the process is used to heat the methane fermentation tank and dry sludge in the center.
- Use of methane gas in the center has sharply cut the cost of fuel needed for the combustion treatment of sewage sludge. As a result, CO_2 emissions have been reduced by 2,370 tons/year compared with the conventional method, and the cost by 57 million yen/year.
- Business-related food waste is accepted from a variety of sources such as public facilities, including elementary and junior high schools, convenience stores and privately owned restaurants.

Background of operation

- Rise in processing cost caused by increase in the volume of sewage sludge treatment.
- Need for the establishment of human waste treatment system by the city alone
- Policy-related backgrounds such as “Kyoto Protocol,” “Comprehensive Strategy for Biomass Japan” and “Sewage Vision 2100”

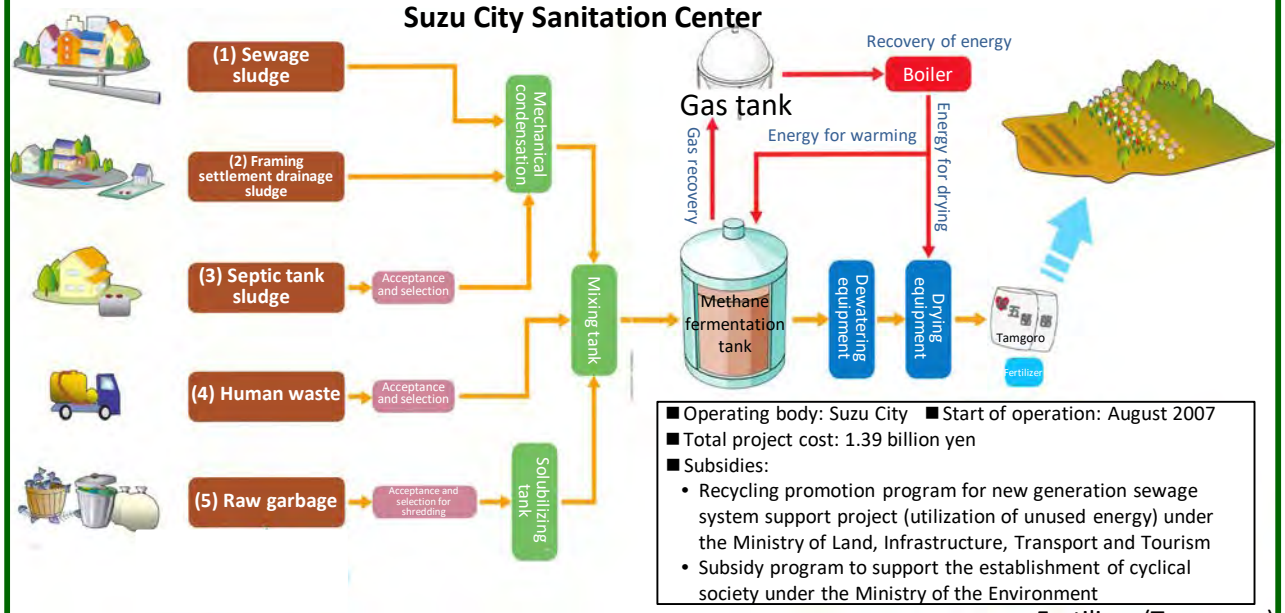
Introduction of compound biomass fermentation facility to comprehensively settle the abovementioned problems.

Acceptance of food waste

- On transport of food waste to the sanitation center
  Notice to many organizations, etc. in the city, winning support from 68 organizations (in 2017). Stable acceptance of 0.7 tons/day as planned.
- Food waste supplying organizations, etc.
  - Convenience stores and supermarkets
  - Food factories
  - Elementary and junior high schools
  - Privately owned restaurants Etc.

- No fees are collected for treatment of food waste positioned as useful material for generation of methane gas (Collection and transportation fees are separately collected).

Summary of facilities and subsidy programs



- Operating body: Suzu City
- Start of operation: August 2007
- Total project cost: 1.39 billion yen
- Subsidies:
  - Recycling promotion program for new generation sewage system support project (utilization of unused energy) under the Ministry of Land, Infrastructure, Transport and Tourism
  - Subsidy program to support the establishment of cyclical society under the Ministry of the Environment


Acceptance of food waste


Methane fermentation tank


Gas tank

Fertilizer (Tamegoro)

- Production of fertilizer by drying digestive sludge
- Production of locally useful fertilizer by combining 5 types of biomass (Product name “Tamegoro” reflects the locally useful nature)

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Case 3-(2) Kashima Chubu Clean Center (Nakanoto Town, Ishikawa Prefecture)

Food Industry Affairs Bureau, Ministry of Agriculture, Forestry and Fisheries

○ The center began its full operation in October 2017 as the first case of the “Methane Utilization Ishikawa Model” (the composite biomass methane fermentation system at a small-scale sewage sludge treatment plant) compiled through industry-government-academia cooperation. It engages in the intensive and combined treatment of sewage sludge, business-related food waste (from food plants and school lunch center), farming settlement drainage sludge, human waste and septic tank sludge.

○ Private enterprises buy methane gas, produced in the treatment process, to generate electricity in the center’s facility for sale under the FIT system. Surplus heat, produced during power generation by the gas, is used to warm the methane fermentation tank and dry sludge in the center.

Methane Utilization of Ishikawa Model

○ Secure a sufficient volume of sludge by bringing multiple regional biomasses to one place (consolidation)

○ Adoption of reformulation technology to promote the fermentation of sewage sludge has improved the generation rate of methane gas (rationalization).

○ Development of technology to stir high-concentration sludge and downsizing of methane fermentation tank (downsizing)

Acceptance of food waste

○ Organizations, etc. supplying food waste

- Food plants producing deep-fried bean curd and paste
- School lunch center, nursing-care facilities

Etc.

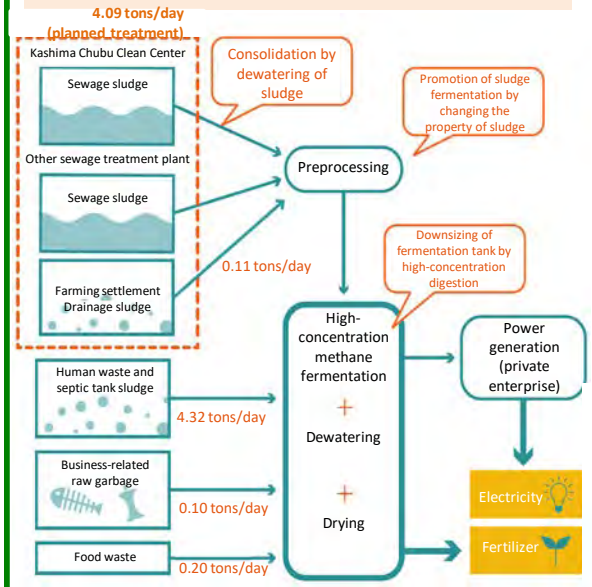
○ Food waste suppliers’ compliance with request for using bio-degradable bags as inclusion of nylon and other bags is expected

Acceptance of deep-fried bean curd

Bio-degradable bag

Summary of facilities and subsidy programs

Flow of treatment



■ Operating body: Nakanoto Town
■ Start of operation: October 2017
■ Total project cost: 1.48 billion yen
■ Operating system (Comprehensive subsidy for social infrastructure improvements)
- Recycling promotion program for new generation sewage system support project (utilization of unused energy)
- Project for development of filthy water processing facilities
- Project for promotion of effects

Kashima Chubu Clean Center

Gas power generation equipment and methane fermentation tank

Surplus heat from the gas power generation equipment is used to dry methane digestion sludge

Production of fertilizer by drying digested sludge

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