Shikaoi-town established a biogas plant and composting facility next to the existing sludge treatment facility in 2007, for the purpose of proper treatment of livestock excrement and utilization of sewage sludge and food waste. The whole facility is called “Hokkaido Shikaoi Environmental Preservation Center.” The power generated from biogas is primarily used in the facility and the rest of the power is sold to Hokkaido Electric Power Corporation, taking advantage of the Feed In Tariff (FIT) scheme. Digested liquid derived from the biogas plant is used as fertilizer in farmland and thus promotes a local-level recycling-based society. Greenhouse cultivation of aquacultural product and aquaculture are also conducted by using the heat generated by the biogas plant.

Foreseeing the future hydrogen society, demonstration projects of manufacturing hydrogen from biogas has also started, supported by the Ministry of the Environment.

Urimaku Biogas Plant, another biogas plant in Shikaoi-cho, also started operation in 2016.

### Hokkaido Shikaoi Environmental Preservation Center (Nakashikaoi biogas plant)
- **Start of operation:** 2007
- **Processing capacity:** livestock excrement 94.8t/day
- **Main facilities:**
  - Generator 100kW × 1, 1190kW × 1
  - Hot water boiler 100,000kcal × 3
  - Steam boiler 1,000kg/h × 1

### Five main merits of biogas plant

1. **Improvement of Environment**
   - Improve the environment around dairy farmers
   - Reduce odor and prevent against river and groundwater pollution

2. **Improvement of agricultural productivity**
   - Improve quality of agricultural products by using digested liquid (fertilizer)
   - Reduce cost and labor needed for treatment of livestock excrement
   - Increase capacity for livestock

3. **Prevention of global warming**
   - Contribute to CO2 reduction by biogas power generation

4. **Establishment of recycle-based society**
   - Promote local production and consumption of energy (power, heat) and digested liquid (fertilizer)
   - Improve the attractiveness of the area for sightseeing
   - Increase employment
   - Create new industry (cultivation of crop or fruit and fish culture by using heat from biogas plant)

5. **Activation of rural economy**

### Urimaku Biogas Plant
- **Start of operation:** 2016
- **Processing capacity:** livestock excrement 210t/day
- **Main facilities:**
  - Generator 250kW × 4

### Demonstration of hydrogen utilization
- **Manufacturing method:** Steam reforming after membrane separation
- **Hydrogen purity:** above 99.97%
- **Way to utilize hydrogen stationary fuel cell (utilize power and hot water), fuel cell vehicle, fuel cell forklift**

- **Carrying material Vehicle for splaying fertilizer**
- **Sturgeon Mango**
Mikage Biogas Electric Power Plant is a biogas power station mainly using manure from livestock (bodily waste from milk cows) as the material for power generation.

As a biogas power station, it is the first case that has received capital from Agriculture, Forestry and Fisheries Fund Corporation for Innovation, Value-chain and Expansion Japan (A-FIVE).

Construction of a plant away from the generation site of the material was necessary due to such hinderances as linking it to an electric power company’s grid, making the high cost of transporting the material a challenge to address. The economic efficiency of the plant has been secured by building it near farmland where digestive fluid is sprayed so as to lower the cost of transporting the fluid.

Construction cost was lowered by adopting a lagoon-type system to store digestive fluid instead of a commonly used concrete or steel storage tank.

Summary of facilities

- **Name**: Mikage Biogas Electric Power Plant
- **Operating body**: Mikage Bioenergy Co. Ltd.
- **Design and construction**: Tsuchiya Dairy Equipment Mfg. Co.
- **Total project cost**: approx. 1.6 billion yen
- **Main facilities**: 2 material tanks, 4 fermentation tanks, 2 administrative buildings, etc.
- **Power generation**: 2 lines for 750kW (equivalent to powering 1,000 average households)
- **Use of electricity**: Private use and feed-in-tariff sale
- **Processing volume**: 240 tons/day (equivalent to manure from 2,800 grown-up cows)
  (acceptance from primary and neighborhood cattle farmers)
- **By-product**: Digestive fluid 228 tons/day
  (All amounts of solid and fluid sold for bedding and neighborhood farmers, etc., respectively.)
- **Start of operation**: May 2017

Features of programs and facilities

- **Fundraising**
  Syndicated loan by Japan Finance Corporation, regional banks and other lenders, capital from the Dogin Agribusiness Fund (Fund for Development of Agriculture, Forestry and Fisheries into Growth Industry) and fund on hand
- **Location of plant and transportation of material and digestive fluid**
  Construction of a plant away from the generation site of the material was necessary due to such hinderances as linking it to an electric power company’s grid, making the high cost of transporting the material a challenge to address. The economic efficiency of the plant has been secured by building it near farmland where digestive fluid is sprayed so as to lower the cost of transporting the fluid.
- **Means of storing digestive fluid**
  Adoption of a lagoon-type storage system to cut the cost of construction
"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.

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**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
- **Use of byproduct (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 programs 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.
### Summary of facilities

- **Biogas Tahara Electric Power Plant**
- **Start of operation:** July 2017
- **Processing volume:** 17 tons/day (manure from livestock (equivalent to 3,000 pigs)
- **Equipment using biogas:** 30kW dynamo x 2 units
- **Use of electricity:** Feed-in-tariff sale
- **Use of heat:** Planned to apply to vinyl greenhouses in addition to heating of fermentation tanks
- **Use of byproduct:** Solid provided to farmers (used as manure) Fluid is for water treatment
- **Project operator:** Gunrui Chikusan
- **Design and construction:** Genech (under the wing of Icnam Holdings)
- **Technical guidance:** Toyohashi University of Technology
- **Dynamo/connection equipment:** E-Power and Aichi Electric Co.

### Features of facilities

- **Cost reduction:** Achieved by adopting an inexpensive overseas dynamo and ancillary equipment (gas bag and other low-technology devices) (made in China). Others have adopted existing domestic technologies, making nation-wide operations relatively easy.
- **Design and construction:**
  - A polygonal design, combining straight lines, rather than a conventional circular design, was adopted for the fermentation tank to shorten the period and cost of construction at the same time by rationalizing the work.
  - As a result, 50kW-level facilities could be introduced at around 100 million yen (excluding the fermentation tank).
**Main Case (5) (Shimokawa Town, Hokkaido)**

- Woody material used for making wood chips is carried in a wood processing facility run by local companies and residents. “Energy Supply Cooperative” which consists of local fuel supply companies is designated as an entrusted manager by the town and takes on production and supply of wood chips.
- Wood boilers are equipped in 11 places, such as the town office, hot spring, seedling facility, public housing, hospital and school.
- Ichinohashi area of the town promotes self-supply of energy mainly with wooden biomass and creates opportunities for communication among residents by encouraging them to live in collective public housing. Furthermore, various actions, including daily support to the elderly and creation of community business, are taken to solve complex issues of the area.

### Facilities for people with disabilities
- Battery charger for electric vehicles
- Dwelling-together houses (22 units)

### Heating and hot water supply
- Solar panels (15kW)
- Cubicle
- Chip boiler 500kWx2
- Wood chip silo, etc.

### Facilities to supply energy

<table>
<thead>
<tr>
<th><strong>Ichinohashi Biomass Village</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mushroom bed culturing</strong></td>
</tr>
<tr>
<td>- <strong>Results in 2015</strong></td>
</tr>
<tr>
<td>- Total yield of mushroom 53.9 tons</td>
</tr>
<tr>
<td>- Total sales amount 51 million yen</td>
</tr>
<tr>
<td>- <strong>Management scheme</strong></td>
</tr>
<tr>
<td>- 2 Town officers (researchers)</td>
</tr>
<tr>
<td>- 2 Temporary town officers</td>
</tr>
<tr>
<td>- 21 part-time town officers</td>
</tr>
<tr>
<td>- 2 Members of “local-community vitalization team”</td>
</tr>
</tbody>
</table>

### Point Approach from renewable energy
- Exchange plaza and community cafeteria
- Community center
(Reference 1) Main Case (6) (Maniwa City, Okayama Prefecture)

- Thinnings, forests offcuts, timber offcuts and barks are collected effectively with additional value.
- These woody materials are turned into wood chips, which are used as fuel in the Maniwa biomass power plant.
- The stakeholders have implemented a system for managing information from resource supply to distribution, which contributes to profit redistribution to forest holders.

1. **Biomass power plant**
   - **Forestry**
   - **Collecting base**
     - Collect and store woody resource
     - Turn them into wood chips and supply to power plant
   - **Maniwa biomass power corporation** (consisting of stakeholders in the area)
     - Generation capacity: 10,000KW (corresponding to demand of 22,000 households)
     - The power is sold using FIT
     - Introduction cost: 4.1 billion yen including subsidy (1.4 billion yen)
     - Use of woody biomass
       - Unused wood: 90,000t per year
       - General wood: 58,000t per year
     - Power generation: 79 million kWh per year
     - Employment: 15 direct employees
   - Structure:
     - Forest holder
     - Profit redistribution (500 yen per ton)
     - Forest cooperative, material company, Timber company, etc.
     - Biomass collecting base (several companies)
       - collect, store, process, supply
     - Wood resource stable supply council
       - Several stakeholder have worked together to establish the council, which redistributes profit from fuel sales to forest holder.

2. **Wooden biomass refinery**
   - Support from Industry Technology Institute
   - Maniwa city biomass refinery promotion council
   - Creation of new biomass industry by utilizing forest resources
   - Development of material (Ex. cellulose nano-fiber) and product

3. **Recycle organic waste (biogas production from garbage)**
   - Household garbage
   - Sewage sludge, business garbage (collected by authorized collector)
   - Food-related waste
   - Biogas plant
     - Capacity: 5t per year
     - Produce digested liquid and methane gas
     - Use at farmland
     - Gas use
   - Use at farmland
   - Use in industry

4. **Expansion of tourism**
   - Biomass tour (since 2006)
   - Expanded course menu in 2014
     - Total tour visitors in 2014: 2,912 people
   - Souvenirs including made-in-Maniwa ingredients
     - pellet cookie, CLT chocolate
“Hida-Takayama Shibuki no Yu Small Wooden Biomass Electric Power Generation Plant” is a small-scale combined heat and power (CHP) station using wooden pellets, made from locally available unutilized timber, as the source of power generation.

Construction of the station passed benefits on to the locality as it used local enterprises to the best possible extent.

Electricity is sold to Chubu Electric Power Co. under the feed-in-tariff system, while heat is sold to a municipal hot spring facility adjacent to the power station.

While attention should be paid to the property of wooden biomass (moisture content of less than 10%, etc.) to gasify the fuel, close cooperation with the producer of the fuel has made it possible to operate the plant continuously and stably through proper monitoring of its operation by means of such devices as a sensor while maintaining the quality of the fuel.

Fuel production facilities

Forest in Hida-Takayama

Unutilized timber

Grinding and sawdust production facility

Ground to 3 to 5 mm

Sawdust

Drying facility

Dried down to moisture content of less than 15%

Pelletization facility

Pellets

Pellets→

Generated gas

Power generation building and fuel silos

Automatic supply from silo to gasification tank

Gasification and CHP facilities

Hida-Takayama Shibuki no Yu Small Wooden Biomass Electric Power Generation Plant

- Operating body: Hida-Takayama Green Heat Godo Co.
- Start of operation: May 2017
- Total project cost: 265 million yen (including equipment, building and other expenses)
- Fuel: Wooden pellet (35,000 yen/ton)
- Approx. 900 tons per year
- Subsidy
  - Project eligible for Seiryu no Kuni Gifu Forest and Environment Fund (project to promote the introduction of facilities using wooden biomass)
  - Support Program to Entice Enterprises to Takayama City

- Scale of output
  - Heat output gasification unit 70kW
  - CHP system 190kW
  - Electricity output 165kW
- Use of electricity
  - Feed-in-tariff sale (40 yen/kWh) *partial private use 1,192MWh/year
  - Use of heat
    - Sale to municipal hot bath facility (2.7 yen/MJ nearly equals 9.7 yen/kWh) 1,146MWh/year

Gasification unit: V3.90 made by Burckhardt of Germany

CHP unit: ECO-165HG made by Burckhardt of Germany

* Real-time monitoring of temperature and composition of produced gas in gasification tank by means of sensor, etc.

Municipal hot bath facility

Utsue 48 Waterfalls Hot Spring

Shibuki no Yu Yu Yukan hotel

Cut in use of kerosene

Approx. 120,000 liters/year

* Heat used in excess of planned amount is provided free of charge

Some 2,500 tons of pellets are produced annually for supply not only to the power station (approx. 900 tons per year) but also to pellet boilers (6 units) installed in facilities in the city, such as a large hotel and a public bath, pellet stoves (approx. 300 units) in elementary and junior high schools, general households, etc. and sale to do-it-yourself stores and others.
Suzu City Sanitation Center's biomass methane fermentation facility 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, CO2 emissions have been reduced by 2,370 tons/year compared with the conventional method, and the cost by 57 million yen/year.

Business-related raw 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.

Summary of facilities and subsidy programs

- Acceptance of food waste
  - 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).

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

- 68 organizations (in 2017)
  - Stable acceptance of 0.7 tons/day as planned.
  - Notice to many organizations, etc. in the city, winning support from 68 organizations.
  - No fees are collected for treatment of food waste
  - 40 times the emissions from sewage sludge (test data)

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

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)
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).

Kashima Chubu Clean Center's biomass methane fermentation facility 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.

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

Summary of facilities and subsidy programs

Methane Utilization of Ishikawa Model

- 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

Flow of treatment

Acceptance of deep-fried bean curd
Bio-degradable bag

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

Flow of treatment

- Acceptance of deep-fried bean curd
- Bio-degradable bag
- Consolidation by dewatering of sludge
- Promotion of sludge fermentation by changing the property of sludge
- Downsizing of fermentation tank by high-concentration digestion
- Power generation (private enterprise)
- Electricity
- Fertilizer

- 4.09 tons/day (planned treatment)
- Sewage sludge
- Other sewage treatment plant
- Sewage sludge
- Farming settlement drainage sludge
- Human waste and septic tank sludge
- Business-related raw garbage
- Food waste

- 0.11 t/day
- 4.32 t/day
- High-concentration methane fermentation + Dewatering + Drying

- 0.10 t/day
- 0.20 t/day

- 4.32 t/day
- 0.10 t/day
- 0.20 t/day

- 0.11 t/day
"Erianthus" is a plant of the grass family growing wild in tropical and subtropical regions. Long-term year-round cultivation of the perennial plant is possible. "JES1" is a plant raised by national research organizations for use as a local self-sufficient fuel and does not become a weed if raised north of Kyushu. A private enterprise cultivates and harvests Erianthus (JES1) on farmland revived from deterioration and processes the plant into pellets. The city buys the pellets and uses them in a pellet boiler installed in a municipal hot water facility as the source of warming water for showers, etc. under the joint industry-government-academia program. A plan is under consideration to expand the cultivation area of Erianthus so as to use the plant as the only source of heat in the municipal hot water facility.

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**Cultivation and harvesting**

Field for cultivation of Erianthus (Ear heaping field)

[Image of Erianthus field]

- "Erianthus" is a plant of the grass family growing wild in tropical and subtropical regions. Long-term year-round cultivation of the perennial plant is possible.
- "JES1" is the first breed cultivated in Japan by the National Culture and Food Research Organization*1 and the Japan International Research Center for Agricultural Sciences*2.
- There is no concern about the plant becoming a weed if cultivated north of Kyushu, as it produces no seeds.

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**Production**

Pellet production facility

[Image of pellet production facility]

- Pelletization of Erianthus is more difficult than that of wooden biomass. To make up for such property of the plant, original and ingenious efforts have made pellets from Erianthus comparable in quality with biomass pellets.

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**Use**

Hot bath facility

[Image of hot bath facility]

- Pellets are dumped into the pellet boiler through the silo and burned.
- Combustion heat is supplied to the hot bath facility through the heat exchanger.

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**Summary of program**

1. The National Culture and Food Research Organization and the Japan International Research Center for Agricultural Sciences allow Takano Farm to use seeds of JES1. JIRCAS provides seeds gathered at tropical and island research bases in Ishigaki City, Okinawa Prefecture.
2. Takano Farm revives farmland from deterioration and cultivates Erianthus (8 hectares as of July 2017).
3. Takano processes Erianthus into pellets and sells them.
4. The city office buys pellet fuel for a bio-pellet boiler it has installed in Municipal Motoyu Onsen hot bath facility for use as heat source for showers, etc.