Demonstration Project on a Regional Independent System in a Dairy Farming Area using Livestock Manure-Derived Biogas Energy

Japan Agricultural Cooperatives Akan

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Business profile

- Japan Agricultural Cooperatives Akan (JA Akan)
  - 76 employees; 150 full members; and sales of ¥7.79 billion (FY2017)

<Operations>

- Agriculture management guidance, credit business, sales & marketing, purchasing and mutual aid programs
- Installation of shared agricultural facilities

Conversion of centralized composting facility into biogas plant

[Concept]

Energy conservation
Local energy production for local consumption
Geographical relationship between the centralized composting facility and dairy farms
Background to the introduction of the biogas plant

[Problems]

Dairy farm

- Increase in energy consumption
- Burden on dairy farm management

Centralized composting facility
(Kushiro City Compost Utilization Center)

- Increase in maintenance/management costs
- FIT program not applicable

Production site & environment

- Low-quality feed crop and milk
- Foul odor and groundwater contamination

[Issues]

① Energy conservation for dairy farms and the community
② Production of quality compost and liquid fertilizer, quality livestock feed and milk production
③ Reduction of foul odor and groundwater contamination
④ Reduction of financial burden on cooperative members with a reduction in animal waste treatment fees
⑤ Localized energy production and consumption, independent of the FIT program
Overview of the demonstration project for regional energy independent system for dairy farming

① Ideas in raw material procurement
- Collection and shipment system already in place
  → Stable supply of raw materials

② Ideas in energy conversion
- Low-cost power generator & use of unused animal waste
  → Stability in energy supply and demand

③ Ideas in energy use
- Inclined mixer & total gas supply via pipe
  → Energy conservation & total energy consumption

④ Ideas for the system as a whole
  • Curb an increase of dairy farm cost & disease prevention
  → Stable management
  • Use of existing facilities
    → Reduced construction cost
  • 24 dairy farms
    → Agreement reached on system implementation
Arrangement plan of the regional energy independent system (biogas plant) in the dairy farming area (as of May 2018)
Advantages of JA Akan and this region

① Mature collecting system is already formulated

To stably and surely obtain a raw material

Container vehicle

② A large-scale dairy farm is located next to the composting facility

To feed biogas by using a piping

Tank lorry

Within 200m

Enable to plumb

③ Be available for the existing facilities

To achieve reduction in construction cost

Existing facilities available for use

④ 24 dairy farmers manage the composting facility

A consensus has already been formed on introducing a new system

Existing composting facility

JA Akan has a better environment for introducing this biogas plant
①–1 Ideas in raw material procurement

Processing only of medium and high moisture-content waste that is difficult to compost

- **Medium and High-moisture animal waste** (Moisture content of approx. 85%)
  - Total: 60 (tons/day)

- **High-moisture animal waste** (Moisture content of approx. 88%)
  - [Target raw materials]

- **Urine & slurry**
  - 95 (tons/day)
  - [Liquid fertilizer used]

- **Low-moisture animal waste**
  - 46 (tons/day)

- **Waste feed, etc.**
  - Disposal of 12 (tons/day)

- **Plant dehydration sludge**

- **Sewage sludge**

- **Waste feed**

- **Low-moisture animal waste**
  - (Moisture content of approx. 80% or lower)

- **Low-moisture animal waste**

- **Urine and slurry**

- **Medium and High-moisture animal waste**

- **Medium moisture content animal waste** (Moisture content of approx. 85%)

- **Liquid fertilizer used**

[Compost maturation possible as is]
Introduction of hi-performance domestic solid/liquid separator

Liquid/solid separation possible from mixture of straw and animal waste that is normally difficult to process

Optimal combination of screen pore diameter

<table>
<thead>
<tr>
<th>Separation ratio (Weight ratio)</th>
<th>Solid</th>
<th>Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation ratio (Weight ratio)</td>
<td>35%</td>
<td>65%</td>
</tr>
<tr>
<td>Moisture content</td>
<td>70% (TS 30%)</td>
<td>88% (TS 12%)</td>
</tr>
<tr>
<td>Suitability of methane fermentation</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>Suitability of compost production</td>
<td>○</td>
<td>—</td>
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</table>
Methane fermentation of liquid enabled by optimal screen pore size combination

Laboratory-scale fermentation test

Steady biogas production & stability in energy supply and demand
②-2 Ideas in energy conversion

[Case of production with separated liquid only]

- High & medium moisture content animal waste (60 tons/day)
- Solid/liquid separator
- Separated liquid 43.7 (tons/day)
- Biogas output: 15,631 (MJ/day) (749 m³/day)
- Fermentation tank
- Gas power generator
- Gas boiler
- Recovered heat (※) Consumption by plant (Jan) 13,911 (MJ/day) < 25,467 (MJ/day)

[Case of production with separated liquid + unused animal waste]

- High & medium moisture content animal waste
- Solid/liquid separator
- Separated liquid 43.7 (tons/day)
- Biogas output: 39,781 (MJ/day) (1,905 m³/day)
- Fermentation tank
- Gas power generator
- Gas boiler
- Recovered heat (※) Consumption by plant (Jan) 33,937 (MJ/day) > 33,548 (MJ/day)
②－3 Ideas in energy conversion

**[Separated liquid only]**

- Biogas heat output: 15,631 (MJ/day)

**[Separated liquid + unused animal waste]**

- Surplus energy (biogas sales)
- Biogas heat output: 39,781 (MJ/day)

### Calorific value required (MJ/day)

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<tr>
<th>Month</th>
<th>Calorific Value</th>
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<tr>
<td>1</td>
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<tr>
<td>11</td>
<td>60,000</td>
</tr>
<tr>
<td>12</td>
<td>65,000</td>
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</table>

- **Raw material freeze-thaw**
- **Fermentation heating**
- **Sterilization**
- **Slope heating**
- **Compost facility electric power consumption**
- **Large-scale dairy farm electric power consumption**
③-1 Ideas in energy use

Energy consumption control with inclined mixer

In conventional mixing method
(Total output: 60kW)

Horizontal mixer (15kW × 2 units)
Horizontal mixer (15kW × 2 units)

15kW × 4 units
(When tank capacity is 1800m³)

When inclined mixer is used
(Total output: 15kW)

Actual installation
(Courtesy of manufacturer website)

15kW × 1 unit
(When tank capacity is 1800m³)
Recycled bedding made from digestion from the dairy cow waste biogas plant

**Dairy cow waste**
- 38 tons/day

**Example of biogas plant in Hokkaido**

**Use of Digestion**
- Chemical fertilizer use reduced by more than 30%, and quality feed crop is produced as well

- **Grassland**
- **Farmland**
- **Watery, low viscosity**
  - Viscosity: 250 mPa•s
- **Seed death rate**: 100%
- **Weed seed (death)**
- **Ammonia vaporization rate**: 9%
- **Nitrogen & organic chemicals penetrate**
- **Moisture penetration rate in soil**: 81%
- **Quality grazing land without weeds**
- **Highly developed aggregate structure & softness of soil**
- **High-quality feed crop**

**Clean-living cow**
- Recycled bedding
- 4.5 tons/day

**High looseness level & water absorbency**
- Safety identical to other bedding materials

**Power generation**
- Biogas

**Solid/liquid separator**
- Liquid
- Solids

**Farm field**
- Examples of biogas plant in Hokkaido
④-1 Ideas for the system as a whole

① Construction cost reduction with use of existing facilities & equipment
② The system expected to cut down CO2 by 3,800 tons/year
③ Agreement concluded between JA Akan and Composting facility management council (24 dairy farmers who are members), allowing continual system operation & management.
④ With dairy farmer share of processing fee on the rise (current at ¥24,500 per head/year), the system curbs further rise.
⑤ Digestion sterilization with surplus heat and complete compost maturation with fermentation heat prevents spread of Johne’s disease, a grave disease.
# Project schedule

<table>
<thead>
<tr>
<th>Action items</th>
<th>FY2018</th>
<th>FY2019</th>
<th>FY2020</th>
<th>FY2021</th>
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<td>Facility design</td>
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<td>Regional energy independent system design</td>
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<td><img src="image6.png" alt="Business continuity" /></td>
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Conceptual image of JA Akan Biogas Plant at completion

Large-scale dairy farm

Raw material acceptance room

Centralized composting facility

Fermentation tank

Digester storage tank

Digestate storage tank

Liquids storage tank for the composting facility

2 Power generator

Acceptance tank

Machine room

Separated solids-yard

Surplus gas flare apparatus

Existing stockyard

Machine room

Separator room for digestion

Separation room

Control room

Sterilization tank

Separated digestate tank

Machine room

Fermentation tank (future vision)

Machine room for gas purification

Desulfurization apparatus

Gas holder

Raw material (separated liquids)

Raw material (unused manure)

Digestate

Raw material gas

Desulfurized gas

Existing pipe

Unused manure
The regional energy independent system model created through demonstration under the project to be promoted to the 49 large-scale centralized composting facilities in Hokkaido that face the same problems and issues as JA Akan and to contribute to energy conservation in the entire dairy industry.