Part 2: Procedure for Developing the Biomass Town Plan

2.3 Developing the Basic Policy

2.3.1 Setting the goals of the Biomass Town Plan (1/3)

(1) Definitions of terms used in the Biomass Town Plan (System, processes, and elemental technologies)

- **System**
  - The Biomass Town Plan is a coherent system plan. The system produces several biomass-derived products from several biomass sources, using several biomass conversion technologies.
  - The system has some processes, and reduces the environmental load and petroleum resource consumptions by supplying or receiving/using intermediate products or energy between processes.

- **Processes**
  - The Biomass Town Plan has some processes from biomass source to the final product. The biomass conversion facility is a centre of the Plan.
  - The basic policy is defined by four elements: who is business operator, what kind of biomass, how to collect, transport, convert and sale, and who is user. The basic policy is the process having the mentioned four elements, and a biomass utilization project is the concrete realization of the basic policy.

- **Elemental technologies**
  - Elemental technologies are the technologies used in collection, transportation, conversion, and sales.
2.3 Developing the Basic Policy

2.3.1 Setting the goals of the Biomass Town Plan (2/3)

(Reference)
Image of system in the Biomass Town Plan

System

Process A
Basic policy A
Utilization project A

Biomass A
Conversion facility A (Elemental technologies)
Product A

Who? (Business operator)
To whom? (User)

Intermediate products
Energy

Process B
Basic policy B
Utilization project B

Biomass B
Conversion facility B (Elemental technologies)
Product B

Who? (Business operator)
To whom? (User)
(2) Setting goals

- Sharing whole vision of the regional society
  - As well as the Biomass Town Plan describes biomass utilization system from biomass procurement, conversion, and to sales, whole vision and goals need to be shared among the stakeholders including how the local industry and the regional society ought to be.

- The relationship between goals and basic policy
  - The described goals defines the important direction of the basic policies for biomass utilization.

- The basics of setting goals
  - Confirming the strategies of central/local governments and the current situations and issues in the pilot municipality is an essential initial step to set the goals.

Goals to be shared by the stakeholders:

- Develop regional recycling of livestock and food waste to produce organic crops.
- Preserve the local environment.
- Revitalize the rural communities.
- Create new employment and industries.
- A new role for rural community as an energy source supplier.

Basic policy for utilization:

- Produce compost from livestock and food waste and return them to farming fields.
- Generate electricity by biogasification of livestock and food waste.
- Produce bio-fuel through pelletizing crop residues.

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2.3 Developing the Basic Policy

2.3.2 Investigating potential operators of the biomass utilization projects

- Two schemes of biomass utilization
  - Biomass utilization projects are categorized into two as follows;
    - An industrial production scheme which emphasizes active collection of biomass and the production and sales of biomass-derived products.
    - An agricultural support scheme focused on supporting the local agriculture.

- Industrial production scheme
  - Private business play a central role with the aim of establishing a relatively large-scale biomass refinery plant supported by the municipality, local communities, and farmers.

- Agricultural support scheme
  - Existing organizations such as municipalities, rural communities, and agricultural associations play new additional roles in biomass utilization, aiming to realize recycling-based agriculture.

- A municipality acts as an business operator
  - The municipality may become an business operator of a biomass utilization project, when existing waste disposal and sewage treatment facilities owned and run by the municipality are involved in biomass utilization.

Part 2: Procedure for Developing the Biomass Town Plan

2.3 Developing the Basic Policy

2.3.3 Surveying the major biomass sources and their available amount (1/2)

(1) Types of biomass

This guidebook classifies biomass as below.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock waste</td>
<td>cattle, pig, and poultry excrement</td>
</tr>
<tr>
<td>Sewage sludge</td>
<td>sewage sludge, septic tank sludge from human excrement</td>
</tr>
<tr>
<td>Wood waste from construction</td>
<td>construction and demolition debris, lumber residue</td>
</tr>
<tr>
<td>Woody biomass</td>
<td>forest thinning, reforestation</td>
</tr>
<tr>
<td>Food processing waste</td>
<td>syrup, corn cobs, bagasse</td>
</tr>
<tr>
<td>Urban garbage</td>
<td>food waste from food-selling businesses (markets, retail stores), cooking oil waste, food waste, used paper, paper-based garbage</td>
</tr>
<tr>
<td>Non-edible parts of crops</td>
<td>rice cultivation residues (rice straw, husks), wheat straw, bagasse, palm shells, corn cobs</td>
</tr>
<tr>
<td>Crops producing sugar/starch</td>
<td>sugar cane, cassava, corn</td>
</tr>
<tr>
<td>Oil-producing biomass</td>
<td>soy beans, field mustard seed, oil palm</td>
</tr>
<tr>
<td>Vegetation biomass</td>
<td>feed crops</td>
</tr>
</tbody>
</table>

Part 2: Procedure for Developing the Biomass Town Plan
2.3 Developing the Basic Policy
2.3.3 Surveying the major biomass sources and their available amount (2/2)

(2) Evaluating amount of available biomass

● Definition of available biomass
  – Available biomass is calculated using the following formula:

\[
\text{available biomass} = \text{biomass potential} - \text{amount of current used biomass}
\]

● Estimating biomass potential, amount of current used biomass
  – Biomass potential
    • It is basic to understand real situations for each biomass type, by collecting information from waste generators such as farmers and food processing factories and waste disposal operators.
    • Estimation based on statistical data is acceptable, but the data source and its survey period need identification.

  – Amount of current used biomass
    • It is basic to understand the data based on current real biomass utilization by its type, through interviews of the waste generators, waste disposal operators, and users of biomass-derived products as possible.

  – Points to estimate available biomass
    • There is no method to precisely estimate amount of available biomass.
    • Inadequate estimation of amount of the available biomass may lead to the termination of operating conversion facility after starting the biomass utilization projects, because it is difficult to collect biomass already used.
    • Therefore, it is essential to have accurate understand of the biomass generation and distribution processes in cooperation with biomass generators, users and waste disposal operators.
    • Determining “how much can be used” or “how much is accessible,” rather than “how much exists” is more important for the estimation.


Reference: Agricultural residue biomass potential estimation method using statistical information
  – The amount of agricultural and forestry waste can be estimated using the production amounts and the waste ratio (Waste ratio calculated using FAO statistics)
  – The amount of livestock waste generated can be estimated based on the excrement generated per head. (Amount excreted per head calculated using FAO statistics)
  – Household food waste can be estimated using the amount of food waste generated by one person. (The amount of food waste generated by one person calculated by sample survey of combustible waste)

Types of conversion technologies

- Biomass conversion technologies can be classified into material use and energy use.
  - Among the material conversion technologies, compost, livestock feed and fish farming feed production technologies are already commercialized. The woody biomass are widely used to make wooden board or wood-plastic composites after pulverizing.

- The energy conversion technologies can be further classified into thermochemical conversion and biochemical conversion technologies. In general, thermochemical conversion is effective for biomass with low moisture content, and biochemical conversion is effective for biomass with high moisture content since more energy is consumed to evaporate the high-content moisture.

Evaluating thermochemical conversion technologies

- Among the thermochemical conversion technologies, there are many examples such as biomass boilers, biomass pellet fuels, and solid fuels. Esterification of cooking oil waste to produce biodiesel fuel is also in practical use. Gasification is in validation phase.

Evaluating biochemical conversion technologies

- Among the biochemical conversion technologies, methane fermentation of livestock waste and ethanol fermentation of crops producing sugar and starch are in practical use.
### 2.3 Developing the Basic Policy

#### 2.3.4 Investigating applicable conversion technologies (2/2)

**Reference** Overview of commercialized conversion technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Overview</th>
<th>Applicable biomass</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composting</td>
<td>Decomposition of biomass using aerobic micro-organisms to produce fertilizer which is useful for crop growth.</td>
<td>Livestock waste, food waste</td>
<td>Fertilizer, soil conditioner</td>
</tr>
<tr>
<td>Methane fermentation</td>
<td>Decomposition of biomass using anaerobic micro-organisms to produce methane gas.</td>
<td>Livestock waste, food waste</td>
<td>Electricity, heat (gas engine electricity generation)</td>
</tr>
<tr>
<td>Carbonization</td>
<td>Heating biomass in a low oxygen content to produce charcoal through thermal decomposition.</td>
<td>Wood, livestock waste, food waste</td>
<td>Fertilizer, soil conditioner, fuel</td>
</tr>
<tr>
<td>Animal feed production</td>
<td>Production of animal feed by drying or liquefying biomass.</td>
<td>Food waste</td>
<td>Animal feed</td>
</tr>
<tr>
<td>Biodiesel fuel production</td>
<td>Esterification of cooking oil waste to produce light oil substitute.</td>
<td>Cooking oil waste, energy crop</td>
<td>Diesel engine fuel</td>
</tr>
<tr>
<td>Ethanol fermentation</td>
<td>Fermentation of sugars and starches, and distillation and dehydration of unrefined ethanol.</td>
<td>Sugars, starches</td>
<td>Bioethanol (gasoline substitute)</td>
</tr>
<tr>
<td>Direct combustion</td>
<td>Direct combustion of biomass to generate heat or electricity using a steam turbine.</td>
<td>Woody biomass, agricultural waste, poultry manure</td>
<td>Electricity, heat (steam turbine electricity generation)</td>
</tr>
<tr>
<td>Solid fuel production</td>
<td>Conversion technology to produce solid fuels such as pellets and refuse-derived fuel (RDF).</td>
<td>Wood waste, food waste</td>
<td>Solid fuels</td>
</tr>
</tbody>
</table>
Part 2: Procedure for Developing the Biomass Town Plan

2.3 Developing the Basic Policy

2.3.5 Surveying the existing local examples of biomass utilization (1/2)

- **Objectives of surveying existing examples (case research)**
  - Existing examples of biomass utilization are surveyed to consider suitable system of biomass from collection, transportation, conversion, and distribution/sales, based on the current situations and issues in the target area.

- **Scope of the survey**
  - Determining following important factors; who (business operators), what (what kind of biomass), how (collection, transportation, conversion, and sales), and to whom (users).
  - Examining economic feasibility and impacts on the local community and, considering and determining whether surveyed examples are applicable to the target area.
  - Conducting research of next-generation technologies in universities and other research institutions which differ from the Biomass Town Plan.

- **Area of the survey**
  - The survey are conducted in the pilot municipality initially, and as necessary, the area is expanded in cooperation with the central government and other organizations.

- **Specific survey items**
  - Specific survey items are shown on the following page.
Part 2: Procedure for Developing the Biomass Town Plan
2.3 Developing the Basic Policy
2.3.5 Surveying the existing local examples of biomass utilization (2/2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Survey Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business operators</td>
<td>Local communities, farmers associations, municipality, private enterprises</td>
</tr>
<tr>
<td>Biomass type</td>
<td>Types of biomass, amount utilized, source and cost of procurement</td>
</tr>
<tr>
<td>Collection and transportation</td>
<td>Methods and costs of collection and transportation, presence or absence of entrusted projects</td>
</tr>
<tr>
<td>Conversion</td>
<td>Facility overview (conversion technology, biomass treating and production capacities), conditions of facility location, operational procedures, records of operation and maintenance, production cost</td>
</tr>
<tr>
<td>Product sales</td>
<td>Product quality, distribution and sales methods, distribution cost</td>
</tr>
<tr>
<td>Users</td>
<td>Users, product needs, selling prices</td>
</tr>
<tr>
<td>Location</td>
<td>Coordination with municipality and residents to fix site for construction of the facilities.</td>
</tr>
<tr>
<td>Operating organization</td>
<td>Managing organizations (manufacturing division, sales division, general affairs division, etc.), number of people involved</td>
</tr>
<tr>
<td>Profitability</td>
<td>Revenues and expenditures (labor cost, production cost, etc.)</td>
</tr>
<tr>
<td>Relationship with a local community</td>
<td>Relationship with local community, farmers associations and others, engaged in biomass procurement and product usage</td>
</tr>
<tr>
<td>Impact on local society</td>
<td>Environmental improvement, local economic revitalization</td>
</tr>
</tbody>
</table>
2.3.6 Surveying needs of biomass-derived products and energy (1/2)

- The necessity of understanding needs
  - The Biomass Town Plan cannot be sustainable in case that the balance between supply of biomass and needs of products is not considered appropriately, even if biomass potential is well estimated. It is necessary to understand the needs trends and consider supply and needs balance and opportunities for energy substitution. Producing products according to the needs, rather than considering the utilization after they are produced, is essential.

- How to determine needs
  - Needs can be determined using the following methods.

### Material Use

<table>
<thead>
<tr>
<th>Product</th>
<th>How to determine needs</th>
<th>User examples</th>
</tr>
</thead>
</table>
| Compost          | ● Potential regional utilization amount of compost can be estimated by the amount of fertilizer used per area unit of arable and crop acreage.  
                    ● Since amount of compost used is heavily dependent on farmers intention, to interview farmers and agricultural associations about the amount, quality, and price of compost they prefer is key point in order to estimate actual amount of compost consumption. | Farmers                     |
| Animal feed      | ● Potential regional utilization amount of livestock feed can be estimated by amount of allotting feed per animal and number of keeping animals.  
                    ● The actual utilization amount is estimated by hearing livestock farmers about feed quality, amount, and price. | Livestock farmers           |

### Energy use (on-site)

<table>
<thead>
<tr>
<th>Method of utilization</th>
<th>How to determine needs</th>
<th>User examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity and heat</td>
<td>● Facilities which require heat all year round, including lumber drying facilities</td>
<td>Factories (lumber drying facilities), hotels, greenhouse, methane fermentation facilities</td>
</tr>
<tr>
<td>using co-generation</td>
<td>● Other factories which require both heat and electricity such as hotels</td>
<td></td>
</tr>
<tr>
<td>systems</td>
<td>● Other facilities which require hot water and heating.</td>
<td></td>
</tr>
<tr>
<td>Heat utilization</td>
<td>● Facilities which require heat all year round.</td>
<td>Factories (which have constant demand for heat)</td>
</tr>
<tr>
<td>using boiler</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 2.3.6 Surveying needs of biomass-derived products and energy

#### Energy use (off-site)

<table>
<thead>
<tr>
<th>Product</th>
<th>How to determine needs</th>
<th>User example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellets</td>
<td>● The needs can be estimated based on the current status of installed pellet stoves and boilers, and on the future installing estimation done by government.</td>
<td>Public facilities, residents, offices, greenhouse, factories</td>
</tr>
<tr>
<td>Charcoal</td>
<td>● Charcoal is used as fuel substitute for coal. The needs are expected at coal-fired power plants, paper mills, etc. &lt;br&gt;● The quality of charcoal as coal substitute is important for the potential users. Therefore, supplier and users should consult to set the quality in advance.</td>
<td>Factories using coal boilers, greenhouse facilities</td>
</tr>
<tr>
<td>Solid fuels</td>
<td>● Solid fuel is used as fuel substitute for coal. The needs are expected of coal-fired power plants, paper mills, etc. &lt;br&gt;● The supplier and the users should consult important matters in advance.</td>
<td>Factories using coal boilers, greenhouse facilities</td>
</tr>
<tr>
<td>Biodiesel fuel (BDF)</td>
<td>● BDF is used as fuel substitute for light oil.  &lt;br&gt;● The needs are expected at public transportation vehicles. Therefore, it is necessary to recognize users and amount of BDF usage with a municipal.</td>
<td>Diesel vehicles</td>
</tr>
<tr>
<td>Bioethanol</td>
<td>● Bioethanol is mixed with gasoline as automobile fuel. &lt;br&gt;● The coordination with present petroleum distributors is necessary to sell bioethanol.</td>
<td>Gas stations, public vehicles</td>
</tr>
</tbody>
</table>

2.3.7 Developing the basic policy (1/4)

(1) Development procedures of the basic policy

- **Developing the basic policy**
  - Developing the basic policy is to define essential items of biomass utilization projects. In particular, necessary works are to determine the type and amount of used biomass, conversion technologies and persons/parties from collecting to selling based on the forecasted needs of biomass-derived products and energy.

- **Selecting conversion technologies**
  - The basic policy is planned mainly based on technologies in practical use. However innovative technologies, such as bioethanol production from cellulosic biomass and fuel production from algae, can be considered in the medium-and long-term vision.

- **Points to consider in developing the basic policy**
  - Biomass utilization projects usually cover area within 20 - 30 km radius from the viewpoints of transportation and living area.
  - Whether large-scale centralized facilities or small-scale decentralized facilities is more advantageous should be considered.
  - Whether manufacturing products from biomass at single site or manufacturing intermediate products at multiple locations to produce final products at single site is more advantageous should be considered.
  - When it is difficult for single facility to use biomass effectively, it is possible to manufacture products with higher value or with greater efficiency by exchange of intermediate products or energy among some facilities. However, risks of complicated system also need to be considered.
  - The basic policy should be finalized by comparing and evaluating several drafted options.
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2.3 Developing the Basic Policy

2.3.7 Developing the basic policy (2/4)

(2) How to use survey results for development the basic policy

- Understanding the situations and issues in the target area is important preparatory work to consider input (main biomass sources) and output (feed, fertilizer and energy), in developing the basic policy.

- Input is determined based on the societal and economic characteristics and regional issues, such as reducing waste and preventing water pollution.

- Output is determined based on the societal and economic characteristics and regional issues, such as revitalizing rural community.

- The example survey described in 2.3.5 provides basic information on the biomass flow from input to output.

The goals of the Biomass Town Plan
(Revitalizing rural community, creating recycling-based society, creating new industries, etc.)

Regional situations and issues
Amount of available biomass
Estimated needs for biomass

Who?
(business operator)

What?
(biomass type)

How and what kind of products
(collection/transportation, conversion, sales)

To whom?
(users)

Existing examples of biomass utilization, applicable level of available technologies
Part 2: Procedure for Developing the Biomass Town Plan
2.3 Developing the Basic Policy
2.3.7 Developing the basic policy (3/4)

(3) Example of how to develop basic policy

1. Current situations in the target area
   Livestock farming is a major industry in a rural community with a population of 15,000. Livestock waste is composted at individual farms, but imperfect treatment is leading to pollution of the ground water. In addition, nitrogen compounds are flowing into the river due to a plenty of chemical fertilizer application.

2. Issues in the target area
   Establishing a centralized composting facility to treat livestock waste appropriately. Reduction of chemical fertilizer application by promoting the compost produced from the livestock waste.

The basic policy draft
1. Who? (Business operator)
   A municipality

2. What? (Biomass)
   Livestock waste, rice husks

3. How? (Collection/transportation, conversion, sales)
   A municipality establishes a centralized composting facility to treat livestock waste.
   A municipality collects and transports livestock waste with commission charges.
   A municipality itself operates the facility and sells compost produced.

4. To whom? (Users)
   Farmers.
   A municipality allows agricultural products using the compost to be sold at the public market, as municipality recommended organic produce.
2.3.7 Developing the basic policy (4/4)

(4) Evaluation of drafted options

Several drafted options are developed and evaluated to finalize the basic policy.

- Multiple drafted options (for methane fermentation from livestock waste)

  **Option 1 (Liquid fertilizer production)**
  - Livestock waste → Wet methane fermentation → Methane → Power generator → Electricity usage → Heat usage

  - Fermentation residue → preparation as liquid fertilizer

  **Option 2 (Composting)**
  - Livestock waste → Wet methane fermentation → Methane → Power generator → Electricity usage → Heat usage

  - Fermentation residue → Solid-liquid separation → Composting → Farming usage

  - Liquid waste treatment → Discharge

  **Option 3 (Dry methane fermentation)**
  - Livestock waste → Dry methane fermentation → Methane → Power generator → Electricity usage → Heat usage

  - Fermentation residue → Composting → Farming usage

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2.3 Developing the Basic Policy

2.3.8 Formulating the basic policy

- A coherent basic policy is formulated based on several basic policies.
- Exchange of intermediate products and/or energy between the processes should be considered to improve the efficiency of the total system.

*RPF=Refuse Paper and Plastic Fuel
Part 2: Procedure for Developing the Biomass Town Plan

2.4 Planning biomass utilization projects

2.4.1 Surveying the detailed implementation conditions

- The basic information needs to be surveyed to determine the appropriate process. Survey items are as follows.

<table>
<thead>
<tr>
<th>Item</th>
<th>Overview of survey</th>
</tr>
</thead>
</table>
| Amount and properties of the target biomass | - The amount, properties, location where the target biomass is generated, and its distribution need to be surveyed.  
- The survey is conducted by interviewing farmers and businesses which generate the target biomass. Monthly amount of generated biomass and seasonal variations of biomass properties also are surveyed.  
- The price of biomass, whether the generators pay, get paid, or provide the biomass free of charge, should be surveyed additionally.  
- Prospect of the biomass supply also is estimated. |
| Site for the conversion facility  | - The requirements for approves and licenses need to be fully investigated since the facility installation greatly depends on the regulations of construction and installation.  
- Effects on the local environment and how to obtain neighboring residents consensus are considered in the facility site. |
| Methods and costs of collection/transportation of biomass | - Methods for collection and transportation are considered based on amount and distribution of the targeted biomass.  
- The costs for collection and transportation are calculated based on the distance and transporting time between generation site and delivery site, and loading and unloading times. |
| Understanding needs              | - The amount and period of needs are estimated based on interviews of potential users expected in the basic policy.  
- For composts, the amount of needs, required quality, the period of needs, and collecting method are surveyed.  
- For energy, whether the electricity is self-consumed or sold, or whether generated heat should be provided as steam or hot water, are surveyed. Daily, weekly, monthly, and seasonal variations of the needs also are surveyed.  
- Prospect for the product/energy needs also is determined. |

Reference: Japan Organics Recycling Association “Biomass Town Advisor-Training Text” (2009), p253
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2.4 Planning biomass utilization projects

2.4.2 Selecting the optimal process for each policy

- The optimal conversion process is considered based on implementation conditions.
- Followings need to be considered to select the optimal conversion process.
  - Mostly cost are directly proportional to efficiency.
  - Since highly-efficient conversion process often uses undeveloped technologies, the level of the technologies (research, validation phase or practical use) are carefully evaluated.
  - Lack of domestic maintenance services may lead to terminate conversion operation, even if the technology is widely used in other countries.

<table>
<thead>
<tr>
<th>Raw materials (biomass)</th>
<th>Energy usage</th>
<th>Cost/efficiency</th>
<th>Facility installation site</th>
</tr>
</thead>
</table>
| Properties              | Electricity: self consumption/sales | Initial cost
| Amount and variation    | Heat: Steam/hot water | Operating costs
| Price/cost              | Needs variations | System efficiency
|                         |                  | Technological level
|                         |                  | Site: Residential or industrial area
|                         |                  | Securing labor |

Selecting the optimal conversion process

(Examples of conditions in selecting: case of power generation using poultry manure and waste lumber)

- Direct combustion or pyrolysis gasification furnace systems?
- Plant scale based on heat needs or electricity needs?
- Only electricity needs is determined due to unstable heat needs?
- Only poultry manure is used in order to use ashes as fertilizer?
- Generate electricity only for self-consumption in consideration of selling price of electricity?

Reference: Japan Organics Recycling Association “Biomass Town Advisor-Training Text” (2009), p252
Part 2: Procedure for Developing the Biomass Town Plan
2.4 Planning biomass utilization projects

2.4.3 Planning the basic design for each conversion facility

- The basic specifications of the facility such as its capacity are determined after the optimal conversion process selection.
- After the initial cost and operational costs can be calculated based on the basic specifications, detailed design and specification document can be developed.

Example of specifications: case of a methane fermentation facility

<table>
<thead>
<tr>
<th>Raw materials</th>
<th>Pretreatment equipment</th>
<th>Methane fermenter</th>
<th>Gas holder</th>
<th>Power Generation</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Treatment method</td>
<td>Specifications</td>
<td>Capacity</td>
<td>Power generator</td>
<td>Self consumption</td>
</tr>
<tr>
<td>Properties</td>
<td></td>
<td>Tank type</td>
<td>Amount of gas generated</td>
<td>Type of generation</td>
<td>Surplus electricity</td>
</tr>
<tr>
<td>• Test specification</td>
<td></td>
<td>Agitation type</td>
<td>Amount of methane</td>
<td>• Total output</td>
<td></td>
</tr>
<tr>
<td>• Amount of solids</td>
<td></td>
<td>Capacity</td>
<td>Concentration</td>
<td>• Number of electric systems</td>
<td></td>
</tr>
<tr>
<td>• Organic elements content</td>
<td></td>
<td>Heat requirements</td>
<td>Heat generated</td>
<td>Power generated</td>
<td></td>
</tr>
<tr>
<td>• Amount of organic elements</td>
<td></td>
<td>Organic matter decomposition</td>
<td>Efficiency</td>
<td>Efficiency</td>
<td></td>
</tr>
<tr>
<td>• Bulk density</td>
<td></td>
<td>amount and rate</td>
<td>Heat generated</td>
<td>Heat generated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digestive juice</td>
<td>Amount of heat recovered from power generation</td>
<td>Amount of heat</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Amount generated</td>
<td>• Recovery efficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Moisture content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Amount of solids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Amount of organic elements</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diagram: Flowchart of the biomass utilization process with specifications for each stage.
Part 2: Procedure for Developing the Biomass Town Plan
2.4 Planning biomass utilization projects

2.4.4 Evaluating income and expenditure

- **Basic approach**
  - Economic feasibility is assessed based on 15 to 20 years business plan using initial cost and operating cost from the basic design of each facility.

- **How to evaluate economic feasibility**
  - There are various methods to evaluate economic feasibility such as annual revenue and expenditure, payback period, and internal rate of return. Each method is described below. (The details can be found in the reference material part.)
  - **Annual revenue and expenditure**
    - Calculate; revenue (sell and self-consumption) – expenditure (including depreciation)
    - The gained figure is examined considering the expected durable years of the facility.
    - Having a surplus after three years operation is an important indication.
  - **Payback period**
    - Calculate; years to recover the initial cost.
    - Whether the payback period is shorter than the loan period and/or expected durable years of the facility is considered.
  - **Internal rate of return (IRR)**
    - IRR is a rate which makes the present value of the total investment and the present value of cash flow equal.
    - Whether IRR is at least higher than the cost of capital procurement is considered.

- **Selecting evaluation method**
  - The evaluation method should be selected based on the facility scale and risks associated with the project.
  - In case where public organizations such as municipality are the business operators, the economic feasibility for the entire system should be considered.

- **Expenses to consider for evaluating economic feasibility**

<table>
<thead>
<tr>
<th></th>
<th>Revenue</th>
<th>Operating cost</th>
<th>Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction cost</td>
<td>Sales of products (compost, etc.)</td>
<td>Raw material purchase costs</td>
<td>Pre-tax profit</td>
</tr>
<tr>
<td>Subsidy</td>
<td>Sales of energy (electricity, heat)</td>
<td>Maintenance costs</td>
<td>Corporate tax, etc.</td>
</tr>
<tr>
<td>Actual construction cost</td>
<td>Byproduct sales</td>
<td>Depreciation cost</td>
<td>After-tax profit</td>
</tr>
<tr>
<td></td>
<td>Waste treatment charge</td>
<td>Interest rate</td>
<td>Cash flow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Administration cost</td>
<td>Accumulated cash flow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utility costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Labor costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost of waste treatment, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taxes and dues</td>
<td></td>
</tr>
</tbody>
</table>

2.4.1 Surveying the detailed implementation conditions
2.4.2 Selecting the optimal process for each policy
2.4.3 Planning the basic design for each conversion facility
2.4.4 Evaluating income and expenditure
2.4.5 Considering to improve income and expenditure
2.4.6 Considering to handle risks
**Part 2: Procedure for Developing the Biomass Town Plan**

### 2.4 Planning biomass utilization projects

*(Reference)* Example of operational revenue and expenditure plan

#### Unit: In millions of yen

<table>
<thead>
<tr>
<th>Year of operation</th>
<th>Initial cost</th>
<th>1st year</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
<th>9th</th>
<th>10th</th>
<th>11th</th>
<th>12th</th>
<th>13th</th>
<th>14th</th>
<th>15th</th>
<th>16th</th>
<th>17th</th>
<th>18th</th>
<th>19th</th>
<th>20th</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Construction cost</td>
<td>-10</td>
<td></td>
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<tr>
<td>2. Subsidy (Subsidy rate is within 1/2)</td>
<td>0</td>
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<tr>
<td>3. Real construction cost</td>
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<tr>
<td>4. Revenue</td>
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<td></td>
</tr>
<tr>
<td>(1.) Electricity sales</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
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</tr>
<tr>
<td>(4.) Re-investment income</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
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</tr>
<tr>
<td>(5.) Taxes and public dues</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
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<td>0.2</td>
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<td>0.2</td>
<td></td>
</tr>
<tr>
<td>(6.) Depreciation</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
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<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>(9.) Yearly cash flow</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
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<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td></td>
</tr>
</tbody>
</table>

**IRR**

1.4% 2.0% 3.5% 4.3% 5.0% 5.5% 6.0% 6.4% 6.8%
Part 2: Procedure for Developing the Biomass Town Plan

2.4 Planning biomass utilization projects

2.4.5 Considering to improve income and expenditure

- Measures to improve the economic feasibility may need to be considered after the evaluation of the projects’ revenue and expenditure. Examples of improving methods are as follows.

<table>
<thead>
<tr>
<th>Item</th>
<th>Methane fermentation of livestock waste</th>
<th>Methane fermentation of food waste</th>
<th>BDF production from cooking oil waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material</td>
<td>➢ Use other biomass such as food waste to generate more energy and increase waste treatment charge income.</td>
<td>➢ Increase treatment amount by collecting the food waste in broader areas to achieve advantage of scale in initial and utility costs.</td>
<td>➢ Consider to charge waste generators for waste treatment when cooking oil waste from commercial establishments such as hotels and markets is collected.</td>
</tr>
<tr>
<td>Sales</td>
<td>➢ Sell digestive liquid. The quantity and quality of liquid fertilizer need to be stable. Providing applying service might lead to create new needs.</td>
<td>➢</td>
<td>➢ Consider to refine for selling byproduct glycerin, in case of comparatively large plants.</td>
</tr>
<tr>
<td>Operations</td>
<td>➢ Reconsider selection of equipments to reduce utility and maintenance costs. ➢ Reduce labor cost by installing the facility next to the existing plants.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Part 2: Procedure for Developing the Biomass Town Plan

2.4 Planning biomass utilization projects

2.4.6 Considering to handle risks

- Various risks, such as shortage of procure raw materials as planned or decline in price of byproducts, are included in biomass utilization projects.

- Risk handling is to determine necessary procedure base on risk analysis and implement the determined handling work.

- Risk handling is measures reducing the probability of risk occurrence, reducing the adverse effect of risk, dispersion of the risks among all stakeholders. Termination of the project might need to be considered if the risks cannot be avoided.

- Examples of risks and measures in biomass utilization projects are described below.

<table>
<thead>
<tr>
<th>Project</th>
<th>Risk</th>
<th>Details of risk</th>
<th>Risk handling example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane fermentation of livestock waste</td>
<td>Facility management</td>
<td>The properties (lower heating value) of livestock waste is different from the planned value.</td>
<td>Investigate the variations of the properties beforehand and reflect them on the facility design.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collection of livestock waste is less than the planned amount.</td>
<td>Check business plans of farmers to supply biomass beforehand and design the facility to accommodate any estimated medium- and long-term variations.</td>
</tr>
<tr>
<td></td>
<td>Electricity prices</td>
<td>Electricity selling price falls after operation starts.</td>
<td>Negotiate and sign contracts with farmers to allow for a nominal increase in waste treatment fees in the case which the price falls.</td>
</tr>
<tr>
<td></td>
<td>Byproduct usage</td>
<td>No progress in digestive juice utilization.</td>
<td>Offer services which benefits farmers such as fertilizer application and application plan making.</td>
</tr>
<tr>
<td>Methane fermentation of food waste</td>
<td>Facility management</td>
<td>Collection of food waste is less than planned amount.</td>
<td>Plan to expand the collection area in case where food waste cannot be collection as planned.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collection of food waste is less than planned amount.</td>
<td>Plan to expand the collection area in case where food waste cannot be collection as planned.</td>
</tr>
<tr>
<td></td>
<td>Collection</td>
<td>No progress in food waste separation at households.</td>
<td>Distribute specialized containers to make waste separation easier to households.</td>
</tr>
<tr>
<td></td>
<td>Fertilizer prices</td>
<td>Fertilizer prices fall after operation starts.</td>
<td>Sign a long-term contract with users to guarantee fertilizer prices.</td>
</tr>
<tr>
<td>BDF production from cooking oil waste</td>
<td>Fuel quality</td>
<td>Fuel quality is unstable even when the plant is operated as planned.</td>
<td>Integrate manufacture's performance guarantees in the plant design and construction contract.</td>
</tr>
<tr>
<td></td>
<td>Sales price</td>
<td>Sales price of BDF falls with a drop in light oil prices.</td>
<td>Sign a long-term contract with users to guarantee prices.</td>
</tr>
<tr>
<td></td>
<td>Collection</td>
<td>No progress in collection from households.</td>
<td>Community leaders who will promote collection in their own areas are educated.</td>
</tr>
<tr>
<td></td>
<td>Facility management</td>
<td>The properties of cooking oil waste different from the planned value.</td>
<td>Incorporate the estimated value variations in the facility design.</td>
</tr>
</tbody>
</table>

Part 2: Procedure for Developing the Biomass Town Plan

2.5 Formulating the Biomass Town Plan

2.5.1 Considering the advisability of the projects

- Final checks before project implementation
  - Perfection level and sustainability of each utilization project draft is evaluated to determine its implementing possibility and priorities.

- Evaluating perfection level
  - Evaluate perfection level of each project draft from the perspectives of operational feasibility and the business operator’s eligibility.

- Evaluating sustainability
  - Evaluate influence of the large-scale project on social issues such as competition with food production and environmental issues (biodiversity).

Points of evaluating perfection level

1. Operational feasibility
   - Technology: in practical use?
   - Facility design: scale and performance are adequate?
   - Site: site is secured?
   - Raw material procurement: long-term procurement is secured?
   - Product usage: users is secured?
   - Revenue and expenditure: plan is valid?
   - Financial plan: prospect?
   - Coordination: coordination with municipality and/or residents?
   - Licenses and approvals: necessary approvals are obtainable?

2. The business operator eligibility
   - Operators: operators are selected?
   - Organization: necessary organization is organized?
   - Economic basis: financial management is capable?

Points of evaluating sustainability

1. Life cycle assessment
   - The greenhouse gas emissions from production to consumption of biomass fuel are lower than the greenhouse gases emissions over the life cycle of the fossil fuels to be substituted?

2. Competition with food production
   - There is influence on food production for local residents?

3. Biodiversity
   - The plan complies with biodiversity regulations?

4. Economic potential of biomass energy
   - The prices are set comparatively lower than competing energy prices?

Part 2: Procedure for Developing the Biomass Town Plan

2.5 Formulating the Biomass Town Plan

2.5.2 Obtaining resident consensus

- The necessity of local residents’ participation
  - Active engagement of local residents are needed to utilize local biomass and exclusive use the energy produced as possible in the area. This is necessary, if the household waste is targeted in the projects.

- Fostering environmental awareness
  - Local residents and farmers need to be conscious of global environmental issues, and build the momentum for action, in order to positively use compost and energy produced locally.

- Basics of promotional activities
  - Promotional activities are to share information meeting the social needs of biomass utilization, as well as holding events.
  - Continuous efforts, such as a series of small-scale training session.

- The necessity of organizing network
  - Various organizations such as schools, businesses, local communities should play different roles and form network to promote biomass utilization concept in the entire community.

Examples of promotional activities
- Invite participation of local residents in the formulation of the Biomass Town Plan.
- Create publicity tools such as brochures, and hold regular training sessions to foster an awareness of the Biomass Town Concept and the environment.
- Implement promotional activities at various organizations such as schools, businesses, local communities, etc.
- Foster the environmental awareness through offering hands-on experiences, such as cooking classes using vegetables grown with biomass-derived compost.
- Cultivation of human resources as trainers for training seminars.
- Build an organization to coordinate the human resources with some activities of local communities and businesses.
- Implement promotional activities strategically, having high education effect such as holding training sessions for people those with a high concern for environmental issues.
- Implement more effective activities which consist of two-way communication, including questionnaires, interviews, workshops, etc.
- Evaluate and promote recognition, sponsorship, and support of the activities undertaken by schools, etc.
- Organize a council to create a network among schools, businesses, the local community, and NPOs.

Part 2: Procedure for Developing the Biomass Town Plan

2.5 Formulating the Biomass Town Plan

2.5.3 Developing the schedule from design to starting operation

- The implementation schedule including site acquisition and permit acquisition, promotional activities, facility designing and construction, test operations, and others should be considered for each biomass utilization project.

> Example of schedule for project implementation

<table>
<thead>
<tr>
<th>Operation</th>
<th>First year</th>
<th>Second year</th>
<th>Third year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding</td>
<td>Application for subsidy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site acquisition</td>
<td>Negotiation and contract</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permits and approvals</td>
<td>Coordination with power companies</td>
<td>City permits of planned construction</td>
<td>Permits of fire laws</td>
</tr>
<tr>
<td>Promotional activities</td>
<td>Explaining the project to local residents and offering training in the separation of household waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detailed design</td>
<td>Detailed design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facility construction</td>
<td></td>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>Test operations/adjustments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Part 2: Procedure for Developing the Biomass Town Plan
2.5 Formulating the Biomass Town Plan
2.5.4 Formulating a coherent plan

- A total schedule for the Biomass Town Plan should be shown after implementing projects are listed.
- The planning body should manage the total schedule during the implementation period.
- The Plan should periodically evaluated, and improved when necessary.

<table>
<thead>
<tr>
<th>Project</th>
<th>Business operator</th>
<th>First year</th>
<th>Second year</th>
<th>Third year</th>
<th>Fourth year</th>
<th>Fifth year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composting A</td>
<td>Municipality</td>
<td>Project planning, recruit participating farmers</td>
<td>Facility construction</td>
<td>Operation, monitoring</td>
<td>Submit information on monitoring results</td>
<td>Promoting activity to farmers who are not participating</td>
</tr>
<tr>
<td>Composting B</td>
<td>Private business</td>
<td>Attract enterprises in coordination with related parties</td>
<td>Design</td>
<td>Facility construction, Operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Making a application map for compost use</td>
<td>Municipality</td>
<td>Gather information</td>
<td>Make a map</td>
<td>Provide a map in a compost awareness campaign</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biogas production</td>
<td>Municipality</td>
<td>Demonstration of experimental operation</td>
<td>Recruit participating farmers</td>
<td>Pilot operation facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion campaign of compost utilization</td>
<td>NPO</td>
<td>Use of compost at schools and allotment garden</td>
<td>Event to sell vegetables grown with compost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BDF production</td>
<td>Private business</td>
<td>Consider collection systems</td>
<td>Atract enterprises</td>
<td>Facility construction</td>
<td>Operations, monitoring</td>
<td></td>
</tr>
</tbody>
</table>

2.5.1 Considering the advisability of the projects
2.5.2 Obtaining resident consensus
2.5.3 Developing the schedule from design to start operation
2.5.4 Formulating the Biomass Town Plan