Report on the Basic Survey about Climate Change Countermeasures (in the Renewable Energy Field) in Hokkaido

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Japan International Cooperation Agency

Hokkaido Environment Foundation

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1. Purposes and Background of This Survey

1-1. Background of This Survey

The Japanese government formulated the Global Warming Countermeasure Plan in 2015 (Heisei 27), and announced greater assistance for developing countries in their climate change countermeasures. This was done to help achieve the 2˚C reduction goal under the Paris Agreement, which both developed and developing countries have committed to in an effort to reduce greenhouse gas emissions. To carry out training programs in this field, JICA employed the principle of selection and concentration on the basis of regional comparative advantages.

In Hokkaido, many renewable energy projects are using locally abundant natural resources to promote the local consumption of locally produced, renewable energy. Due to its cold climate, the prefecture consumes more energy than other regions. These projects aim to relieve the financial costs of energy consumption on local people and businesses. They also help overcome Hokkaido's local challenges and are considered by the Hokkaido Plan to Promote Global Warming Countermeasures (formulated in 2010 (Heisei 22)) as one of the prefecture's global warming countermeasures.

Many communities in the prefecture are actively using local resources to overcome local challenges in economy, employment, disaster management, and environmental protection in a bid to build a sustainable society. In addition to large-scale, advanced initiatives to utilize renewable energy, there are also community-oriented initiatives of various scales and by various organizations. This includes three Eco Model Cities, which are pioneering efforts with ambitious goals to drastically reduce greenhouse gas emissions and create a low-carbon society.

Although many developing countries do not give priority to environmental problems and climate change in addition to the other various challenges they are facing, they have considerable potential to make effective use of renewable energy as part of their efforts to build a sustainable society and achieve SDGs. It will also aid their efforts to tackle challenges related to economy, employment, disaster management, and citizen involvement.

This purpose of this survey is to find and report activities and projects using renewable energy as climate change countermeasures that can help developing countries solve their problems. For this purpose, we targeted communities in Hokkaido that are making efforts to realize a sustainable society and report the activities and projects that can apply to JICA Hokkaido's activities and international cooperation projects.

1-2. Purposes of This Survey

We carried out the following tasks and report the results of the tasks so they can be applied to JICA Hokkaido's activities (mainly training programs):

(1) Gathering information on Hokkaido's climate change countermeasures, particularly renewable energy efforts and projects, and organizing the information in a systematic way

(2) Analyzing the relevance of efforts and projects in Hokkaido to various fields and their secondary effects, and making proposals about how such efforts and projects should be applied to JICA Hokkaido's training programs with to the goal of applying such efforts and projects to developing countries

1-3. Policy of This Survey

We analyzed in detail the current situations and problems of Hokkaido's efforts to tackle climate change, particularly efforts to promote renewable energy (such as solar, wind, small-scale hydroelectric, geothermal, and biomass), including project/facility operators, the involvement of local governments, budgets, and usage of the local environment. We focused on 14 projects, giving priority to those taking advantage of the local environment and ideas unique to Hokkaido.

Given that the projects will be studied in JICA Hokkaido's training programs in other fields (such as education, disaster management, local administration, regional development, agricultural and rural development) and used as helpful examples for international cooperation, we analyzed and examined how the gathered information and projects can be applied to such fields and what secondary effects might be brought about by climate change countermeasures and use of renewable energy. We also made proposals about how the projects should be used in JICA Hokkaido's training programs.

To study the surveyed projects, we efficiently gathered information by using publicly available literature, academic papers, analysis data, news articles, the Internet, and other means in a preliminary survey. Based on this information, we then interviewed many persons related to these projects and reflected the interview results in the analysis of gathered information.

O Scope of renewable energy

The target renewable energy of this survey is classified as below based on the scope of renewable energy shown in the figure on the right:

- Utilization of solar heat and solar power generation
- Wind power generation
- Utilization of waste heat and waste power generation
- Utilization of biomass heat and biomass power generation
- Utilization of snow and ice cold and utilization of temperature difference heat
- Hydroelectric power generation
- Geothermal power generation and utilization of geothermal heat

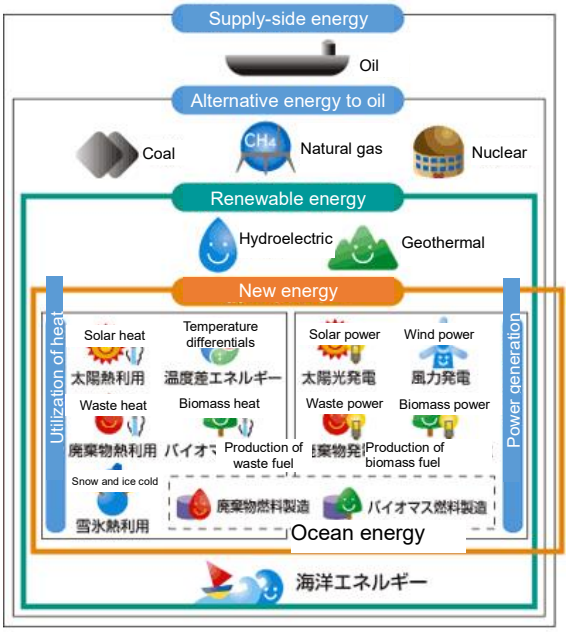

Figure 1 Scope of Renewable Energy

(Source: New Energy Guidebook 2008, NEDO)

The energy can be used as heat sources or for power generation. In selecting the target projects, we considered the following for the areas of heat utilization and power generation.

O Heat utilization

Since heat sources, the most basic use of energy, are also needed in developing countries, we gave priority to projects in this area. However, we did not focus on the technological aspects of utilizing snow and ice cold, an approach that takes advantage of Hokkaido's local environment, because many developing countries are located in the tropics.

O Power generation

The feed-in tariff program for renewable energy[1] (the "FIT program") plays a significant role in the introduction of renewable energy into power generation. We included projects selling generated power under the FIT program as candidates for the target projects, but were very careful in selecting such projects as some of them do not consider the creation of a sustainable society or communities.

1 A program that requires power companies to buy electricity generated from renewable energy at fixed prices for a certain period of time

2. Renewable Energy Ventures: Globally and in Japan

2-1 Situation of Actions to Address Climate Change: Globally and in Japan

Climate change is beginning to exert various effects around the world, including in Japan. For example, on a global scale, glaciers continue to shrink; particularly in Greenland, where 10% of the world's glaciers are located, they are melting at an accelerating pace. The contraction of sea ice in the Arctic Ocean is also prominent, and unless emission of greenhouse gases (hereinafter, "CO_2"), which induce climate change and are represented by the likes of carbon dioxide, is reduced, there is a high likelihood that, by the end of the 21st century, sea ice will mostly disappear during the summer season. In Japan, the rising trend of daytime high temperatures exceeding 35°C ("extremely hot days") is apparent, and the rate of occurrence of extreme weather conditions, such as "guerilla rainstorms," is also on the rise. In 2016 (Heisei 28), for the first time in recorded history, three typhoons made landfall on Hokkaido during the summer season, causing heavy damage throughout the region.

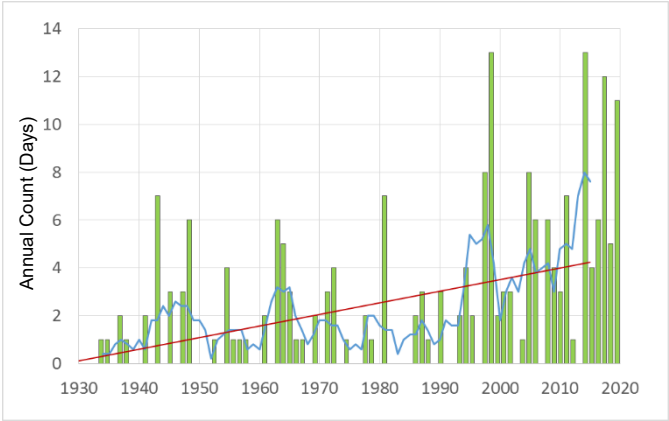

Figure 2 Change in the Annual No. of "Extremely Hot" Days Observed in Tokyo

(Prepared by the Hokkaido Environment Foundation based on the Climate Change Monitoring Report 2016 published by JMA)

The Intergovernmental Panel on Climate Change (IPCC)[1] has compiled the scientific research on climate change. According to the Fifth Assessment Report, which was released from 2013 (Heisei 25) to 2014 (Heisei 26), the likelihood that the release of human-derived CO_2 is the overwhelming factor behind the changes in climate observed since the mid-20th century is extremely high. Moreover, regarding the global average surface temperatures observed up to the end of the 21st century, taking the average temperatures between 1986 (Showa 61) and 2005 (Heisei 17) as the base, the report indicates that there is a possibility that temperatures could increase by as much as 4.8°C. On the other hand, should the most drastic CO_2 reduction scenario[2] be realized, the report indicates a high likelihood that the temperature increase will fall within the range of 0.3°C to 1.7°C; thus, efforts by each country to reduce CO_2 are resolutely sought in order to mitigate climate change.

Based on this scientific knowledge, the Paris Agreement, which sets the goal of restraining the rise in global average temperatures to well below 2°C above pre-industrial levels in addition to balancing the artificial discharge and recovery of CO_2 during the latter half of this century, was adopted at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), which was held in Paris, France between November 30th and December 13th, 2015 (Heisei 27). The Paris Agreement may be regarded as the starting point for the entire world's future efforts to address climate change.

One significant feature of the Paris Agreement is that it demands that all countries submit and update a Nationally Determined Contribution (hereinafter, "NDC") towards climate change, such as CO_2 reduction goals, that is consistent with the country's conditions. As of the end of March 2016 (Heisei 28), 189 countries and regions, including Japan, have submitted an NDC (or equivalent, INDC[3]: Intended Nationally Determined Contribution),

and a majority of countries and regions have set quantifiable goals. In addition, a number of NDCs make reference to the preparation of national laws or policies pertaining to specific measures and regulations; among these, many specify the utilization and application of "renewable energy."

We will summarize the goals and trends of climate change measures by major foreign countries.

(1) United States

The US has set a goal of reducing CO_2 emissions by 26% to 28% versus to 2005 (Heisei 17) levels by 2025. Specific measures include the enforcement of emissions reduction measures in the construction industry, including energy conservation standards for equipment and housing, and approval for usage of alternative substances to replace hydrofluorocarbons (HFC), which have a high Global Warming Potential (GWP) value. Currently, the US is moving to restrict CO_2 emissions at new and existing thermal power plants as well as introducing fuel economy standards for heavy vehicles from 2018 (Heisei 30). (However, in June 2017 (Heisei 29), President Trump declared the US would withdraw from the Paris Agreement.)

(2) EU

The EU has set a goal of reducing CO_2 emissions by 40% versus 1990 (Heisei 2) levels by 2030. The EU has also set goals to reduce CO_2 emissions from sectors subject to EU-ETS[4] by 43% and non-subject sectors by 30% versus 2005 (Heisei 17) levels by 2030. Other goals include increasing the share of renewable energy (electricity and heat) in total final energy consumption to at least 27% by 2030.

(3) China

China has set a goal of reducing CO_2 emissions by 60% to 65% per GDP versus 2005 (Heisei 17) levels by 2030. China's CO_2 emissions will peak around 2030, and the country will make its best efforts to reach the peak as soon as possible. The country is executing a national strategy to counter climate change and building a low-carbon energy system.

(4) India

India has set a goal of reducing CO_2 emissions by 33% to 35% per GDP versus 2005 (Heisei 17) levels by 2030. Notably, India is touting several areas of particular emphasis, such as the introduction of new, more efficient and clean technology to thermal power plants; promotion of power generation via renewable energy; an increase in the ratio of alternative fuels in its fuel composition; and reduction in CO_2 emissions from the transport sector.

Table 1 CO_2 Emissions Reduction Goals in NDC/INDC Submitted by Major Countries

US	−26% to −28% by 2025 (vs. 2005), maximum effort towards −28%
EU	−40% by 2030 (vs. 1990)
Russia	−25% to −30% by 2030 (vs. 1990)
Canada	−30% by 2030 (vs. 2005)
Australia	−26% to −28% by 2030 (vs. 2005)
Switzerland	−50% by 2030 (vs. 1990)
Norway	−40% by 2030 (vs. 1990)
China	Reach the peak of CO_2 emissions by around 2030 60% to 65% reduction of CO_2 emissions per GDP by 2030 (vs. 2005)
India	33% to 35% reduction of CO_2 emissions per GDP by 2030 (vs. 2005)
Mexico	−22% by 2030 (vs. BAU[5]), conditional −36% by 2030 (vs. BAU)
South Africa	−398 Mt to −614 Mt by 2025 and 2030 (vs. BAU)
Brazil	−37% by 2025 (vs. 2005), −43% by 2030 (vs. 2005)

(Quoted from the Ministry of Foreign Affairs website)

Japan's NDC (INDC, upon submission) was recognized as the "Draft of Japan's Commitment" at the Global Warming Prevention Headquarters in July 2015 (Heisei 27). Its outline is as follows.

> The "Draft of Japan's Commitment" intended to reduce greenhouse gas emissions after 2020 aims to achieve a level (1.042 billion tons – CO_2) that is −26.0% (−25.4% vs. FY2005 (Heisei 17) levels) compared to FY2013 (Heisei 25) levels by FY2030, through emissions reduction and absorption amount procurement in Japan, as a realizable reduction goal through substantiated measures, policies, and technological stockpiling with sufficient consideration to technical constraints and costs, in order to ensure consistency with the energy mix.

With this "Draft of Japan's Commitment" in mind, in May 2016 (Heisei 28), the Cabinet determined the Global Warming Countermeasure Plan based on the Act on Promotion of Global Warming Countermeasures. Under this plan, the basic roles of the country, local public organizations, businesses, and citizens have been clearly defined, and the goal of curtailing CO_2 emissions originating from energy is defined as per Table 2.

Table 2 Guideline on CO_2 Emissions Originating from Energy by Sector (Unit: million tons – CO_2)

	FY2005 Actual	FY2013 Actual	Guideline for Emissions in FY2030
Industrial Sector	457	429	401
Other Business Sectors	239	279	168
Housing Sector	180	201	122
Transportation Sector	240	225	163
Energy Conversion Sector	104	101	73

(Taken from "Global Warming Countermeasure Plan")

Of these, regarding endeavors in the energy conversion sector, renewable energy is highly rated for its extremely small CO_2 emissions output; in addition, it is considered to be a low-carbon, domestically derived energy source that may contribute to the country's energy security as a home-grown source of energy. In particular, the reduction goal in the energy conversion sector includes the CO_2 output that is distributed to other sectors, such as the industrial and housing sectors, so reducing CO_2 emissions in this sector is extremely important.

Given these facts, the goal of broadening the introduction of solar power generation has been set at approximately 7 times current levels, while the goals for wind and geothermal power generation have been set at approximately 4 times from FY2013 (Heisei 25) to FY2030. Also, by FY2030, about 22% to 24% of total power generation is expected to be derived from renewable energy.

Table 3 Share by Power Source, 2030

Electricity Source		Ratio, etc.
Total Generated Electricity		1.065 trillion kWh
Renewable Energy		Approx. 22 to 24%
	(Solar)	Approx. 7%
	(Wind)	Approx. 1.7%
	(Geothermal)	Approx. 1.0 to 1.1%
	(Hydro)	Approx. 8.8 to 9.2%
	(Biomass)	Approx. 3.7 to 4.6%
Nuclear		Approx. 20 to 22%
Coal		Approx. 26%
LNG		Approx. 27%
Oil		Approx. 3%

(From the "Draft of Japan's Commitment")

2-2 Global Trends in Renewable Energy

In countries around the world, use of renewable energy is regarded to be an important countermeasure against climate change, and its adoption has more than doubled in the past 10 years. In terms of countries, Germany and China are leading the way in use of renewable energy; the shares of renewable energy in China and Germany are expected to reach 29.7% and 50%, respectively, by 2030.

In terms of type of renewable energy, wind and solar power are prominently expanding their rates of utilization. The cumulative amount of solar-generated electricity will be close to 300 million kW by the end of 2016 (Heisei 28), and compared to 2006 (Heisei 18) levels, this is an approximately 50-fold increase. Wind-generated electricity has also reached 467 million kW, which is 7 times the level achieved in 2006 (Heisei 18). China prominently leads the rapid growth in solar-generated electricity, but it is also joined by Japan, Germany, and the US, which show strong growth. The EU previously led in wind-generated electricity, but in recent years, usage in China is expanding, and as of the end of 2016 (Heisei 28), the cumulative usage amount in China exceeds that of all 28 EU member countries combined.

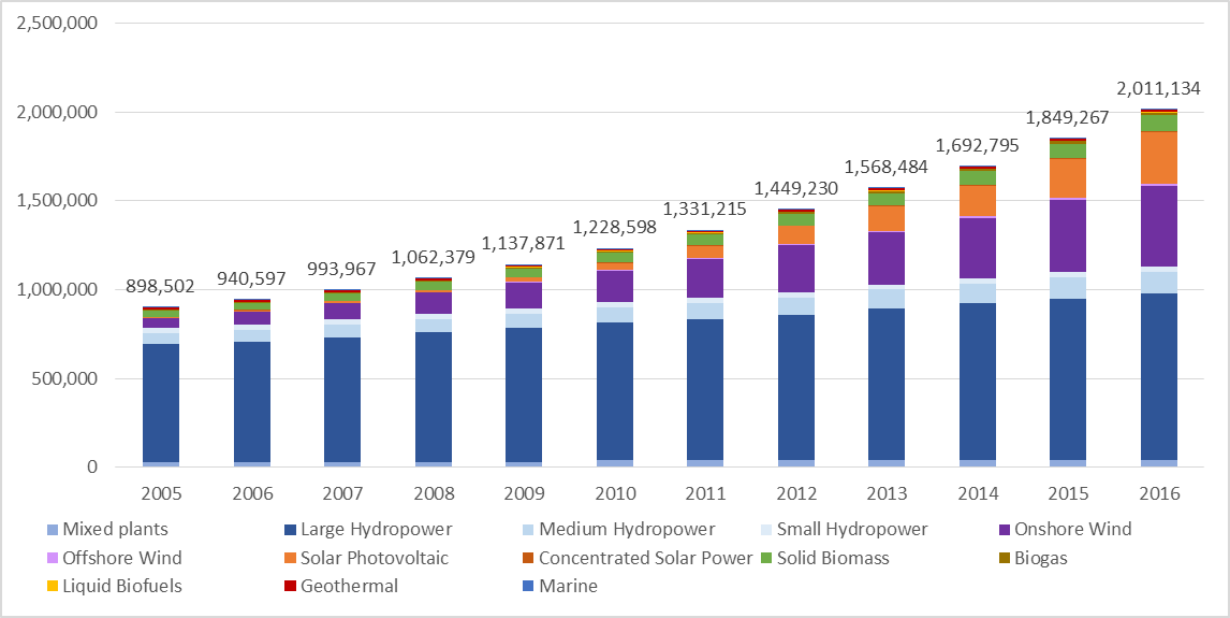

Figure 3　Change in the Cumulative Usage of Renewable Energy (Unit: MW)

(Prepared by the Hokkaido Environment Foundation based on IRENA Resource)

The backdrop to this rapid increase in renewable energy adoption is the decrease in the cost of electricity generation. The average cost to generate electricity worldwide at large-scale solar power plants has fallen about 58% between 2010 (Heisei 22) and 2015 (Heisei 27), reaching US$ 0.13/kWh, while the average cost of wind-generated electricity (above ground) is also falling, and these costs are expected to drop still further. Renewable energy investment is also on the rise, and in recent years, the upward trend has been pronounced, especially in China but also in India and the Asia-Oceania region. Japan too is moving forward in this field with international cooperation. For example, during the five years between 2009 (Heisei 21) and 2013 (Heisei 25), Japan invested a cumulative total of more than US$ 10 billion through ODA to support developing nations in the energy field,

and approximately US$ 2.7 billion, which is more than a quarter of this entire budget, was appropriated to support the adoption of renewable energy.

As a result, investment in solar- and wind-generated power is rapidly increasing worldwide, and by the end of 2016 (Heisei 28), the installed capacity of wind and solar power combined reached close to 800 million kW. This is equivalent in scale to 2 times the total installed capacity of all nuclear power plants on earth.

2-3 Trends in Japan Related to Renewable Energy

Development of the renewable energy field in Japan started as a reaction to the oil crisis during the 1970's, giving it a rather long history. In particular, aggressive efforts have been made in the technical development and dissemination of solar energy, and from the latter years of the 1990's to the early years of the 2000's, Japan led the world in terms of solar energy usage amount and solar panel production volume. On the other hand, from the perspective of climate change countermeasures and energy security, nuclear energy was thought to be important, and as the share of renewable energy expanded in Europe, Japan's share of electricity generated from renewable energy crept along at about 10%.

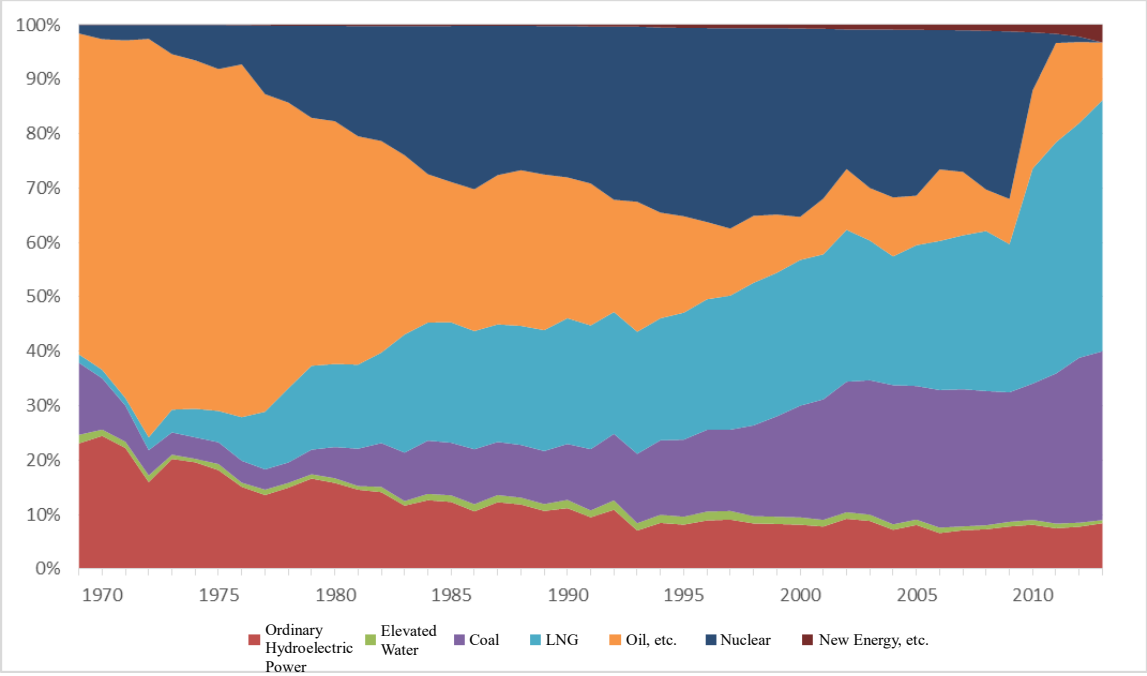

Figure 4 Historical Volume of Electricity Generated by Energy Type

(Prepared by the Hokkaido Environment Foundation based on "Energy White Paper 2017")

What changed this landscape drastically was the Great East Japan Earthquake, which struck on March 11, 2011 (Heisei 23). As nuclear power plants were stopped, ceasing to provide electricity in the aftermath of TEPCO's Fukushima Daiichi Nuclear Power Plant accident, the electricity supply fell short, and energy became a serious concern for all citizens. This led to active deliberation on nuclear power generation and the positioning of renewable energy. Given such circumstances, the FIT program started in July 2012 (Heisei 24), and adoption of renewable energy expanded rapidly focused around solar power generation. Based on the fact that the "Long-

term Energy Supply/Demand Outlook" (Energy Mix), which was decided in July 2015 (Heisei 27), stipulates a goal of making renewable energy's share among all electricity generated to be 22% to 24% by 2030, the adoption and proliferation of renewable energy is expected to increase still further as one of Japan's key energy sources and as a pillar supporting climate change countermeasures.

Here, we will summarize the current state of electricity generated from renewable energy in Japan.

(1) Solar Power

The cumulative installed capacity of solar power has reached approximately 40 million kW as of the end of 2016 (Heisei 28). The cumulative introduced amount of energy exceeds that of Germany and is second globally after China; the FIT program has played an important role in this expansion. Before the FIT program, solar power generation was mainly adopted by residences, but at present, non-residential solar power generation makes up the majority of new introductions. However, large-scale solar power facilities (e.g., mega-solar power plants) are causing problems in some regions due to the large-scale development and construction work involved.

(2) Wind Power

Similar to solar power, the installed capacity is increasing steadily, but the cumulative introduced amount of energy hovers at just over 3 million kW. This is less than one-fiftieth of China's energy amount (169 GW), the world leader in terms of cumulative introduced amount of energy as of the end of 2016 (Heisei 28). Nevertheless, Japan has projects totaling 15 million kW undergoing environmental impact assessment as of the end of November 2017 (Heisei 29), which suggests strong growth going forward. In recent years, there have been conflicts in some areas where small-scale wind power generation facilities, which have been assigned high compensation for electricity under the FIT program, are being built close to residential areas.

(3) Biomass Power

Until recently, waste power generation was the mainstream, but power generation plants that utilize unused biomass and ordinary lumber are increasing in number due to the FIT program's introduction. Biomass power generation is on the rise globally, and procurement of sustainable fuel is a challenge. Use of palm shells, which are imported as ordinary lumber, is expanding under the FIT program, but this has been criticized from the perspective of promoting self-sufficient energy.

(4) Geothermal Power Generation

Japan boasts the world's third largest geothermal resource reserves, but the country has

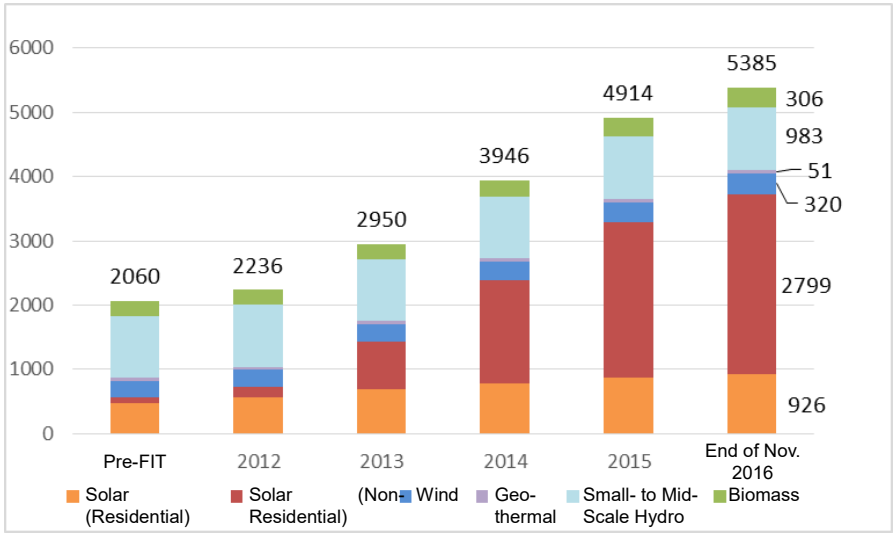

Figure 5 Trend in Introducing Renewable Energy Facilities (unit: 10,000 kW)

(Prepared by the Hokkaido Environment Fund based on the "2017 Energy White Papers")

been stymied by issues such as development within national parks and consensus building among hot spring (*onsen*) operators, so no new implementations have started since 2000. Since the advent of the FIT program, very small-scale power generation using geothermal heat (hot springs) is seeing progress. Geothermal power generation draws favorable ratings due to its low cost per amount of power generated and as a base load power station with stable power generating capability, suggesting a high likelihood of further development.

(5) Hydroelectric Power

Small- to mid-scale hydroelectric power generation is part of the FIT program, and its introduction is advancing gradually. If we take large-scale hydroelectric power generation into consideration, hydroelectric power constitutes much of Japan's total renewable energy usage.

Generally speaking, renewable energy is used in small-scale deployments scattered across various areas that promote its utilization as a small-scale heat source. These areas utilize heat from various renewable energy resources in accordance with their characteristics, such as utilization of snow and ice cold in cold regions like northern Japan and supply of heat that utilizes wooden biomass in regions rich in forest resources.

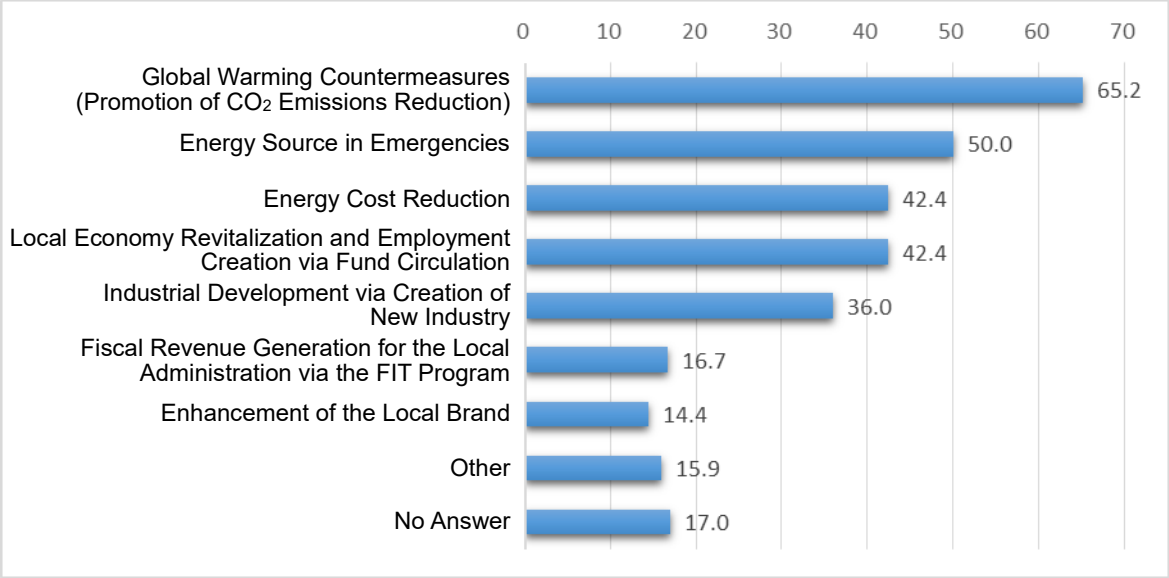

Figure 6 Regional Energy Concept and Project Objective (unit: %)

(Prepared by the Hokkaido Environment Foundation based on the "Report on the Current Situation of Local Governments' Undertakings to Promote Regional Energy Policy" (Ministry of the Environment))

As one pillar of our country's efforts to counter climate change, the government upholds promotion of renewable energy use, but this undertaking's objective is not limited to climate change countermeasures. In general, there is greater potential to adopt renewable energy in suburbs and rural areas compared to urban areas, and it can be found in various forms in accordance with each region's unique characteristics. Taking advantage of this quality, by planning to introduce renewable energy that can be rooted in each region, activities related to comprehensive development of a given region can be implemented, such as job creation, regional revitalization, and ensuring of energy supply in times of emergency. In consideration of these significant points, efforts to utilize renewable energy are being started not only as climate change countermeasures but also with sights set on solving regional

issues and generating regional benefits at the local administrative level as well as at the national level. Examining the results[6] of questionnaire research carried out on local governments across the country regarding regional energy policies, one finds that local governments' objectives in their efforts to execute or examine regional energy policies are, as evident in Figure 6, not only about reducing CO_2 emissions but also about developing a vision to solve regional issues and generating regional benefits.

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[1] An organization that was set up in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). It aims to conduct holistic evaluation of climate change caused by human activities, its impact, acclimatization, and mitigative strategies from scientific, technical, and socioeconomic perspectives.

[2] In the most severe CO_2 reduction scenario, it states that, "emissions shall be reduced by 40% to 70% by the year 2050 (versus 2010 levels)" and "emission levels shall be zero or less by 2100."

[3] Refers to the "intended contribution concerning climate change countermeasures determined by each country" regarding the post-2020 emissions reduction targets required of all countries that were determined at COP19's Warsaw convention in 2013 preceding the Paris Agreement. After each country signed the Paris Agreement, these are considered to be NDC unless separately adjusted.

[4] Refers to the EU greenhouse gas emissions allowance trading system, which is a "cap & trade system." By limiting the total emissions volume, participants may buy and sell the required emissions allowances within the limited volume.

[5] Estimated emissions volume of the basis year based on current emissions rates.

[6] Conducted for municipalities across the country in September 2013 as part of the "FY2014 Consignment of Study and Investigation of Support for Creation of a Sustainable Society Based on Efficient Regional Energy." The recovery rate was 55% (985 municipalities out of 1,789 responded).

3. Hokkaido's Renewable Energy Undertakings

3-1 Hokkaido's Policy on Climate Change and Renewable Energy

In cold and snowy Hokkaido, the CO_2 emissions rate per person exceeds the national average due to the high usage rate of kerosene during the winter season and a reliance on automobiles due to the island's geography being spread out over a wide area. On the other hand, the region's main industries include tourism, agriculture, forestry, and fisheries, all of which are vulnerable to climate change, making climate change countermeasures a high priority in Hokkaido.

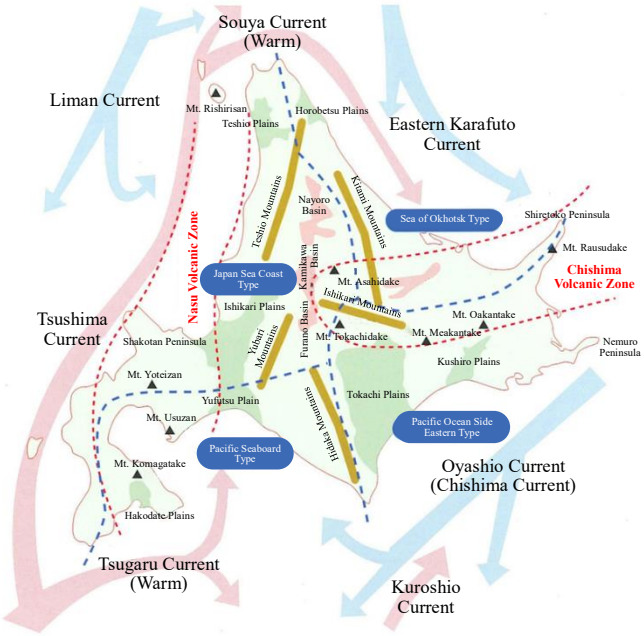


Figure 7 Hokkaido's Geographical Characteristics
(From "Overview of Plans to Protect the Biodiversity of Hokkaido/Hokkaido's Biodiversity")

Still, Hokkaido is located in waters where warm and cold currents meet, and seasonal winds and geography influence each other, bringing about diverse climatic features. As a result, Hokkaido is blessed with a rich natural environment that it takes prides in, boasting to the rest of the country. Examples include the splendid nature of the *Shiretoko* World Natural Heritage Site as well as a wide variety of local resources. In the Comprehensive Plan for Hokkaido, which was formulated in March 2016 (Heisei 28), such an "exceptional natural environment" and "various energy resources" are touted as Hokkaido's value and strengths, and the various policies of Hokkaido can be seen to capitalize upon these strengths.

The "Hokkaido Environmental Basic Regulation" (enforced in October 1996 (Heisei 8)) serves as the basis of activities under Hokkaido's overall environmental policy. In accordance with this regulation, the "Hokkaido Environmental Basic Plan (2nd Phase)" was formulated in March 2008 (Heisei 20), and this was revised in March 2016 (Heisei 28). The plan proclaims a long-term goal of "a sustainable Hokkaido, inspired by circulation and symbiosis, which places a low burden on the environment," and lists four fields of emphasis towards this goal's realization. One such field is "Regionally Initiated Conservation of the Earth's Environment," which is described in Table 4. This initiative aims to move forward with climate change countermeasures, which are positioned as a major sphere of Hokkaido's environmental policy.

Table 4　Hokkaido's Policy Framework and Related Plans to Promote Climate Change Countermeasures

Policy Framework		Individual Plans & Major Related Plans, etc.
(1) Regionally Initiated Conservation of the Earth's Environment		
A. Promotion of Global Warming Countermeasures		Plans to Promote Global Warming Countermeasures
(i) Conversion to low-carbon lifestyles and business styles		Action Plan to Promote Energy Conservation and New Energy
(ii) Introduction of environmentally friendly energy sources that capitalize on the region's characteristics		┗ Basic Direction to Expand New Energy Adoption
(iii) Actions on forests as an absorption source		Plans to Promote Action on Forests as an Absorption Source
(iv) Examination of measures to adapt to climate change		
B. Promotion of Other Measures to Conserve the Environment		Plans to Promote Action on Objects Washed Ashore

(Prepared by the Hokkaido Environment Foundation based on the "Hokkaido Environmental Basic Plan (2nd Phase) Revised Version")

3-1-1　Hokkaido's Regulation on Measures to Prevent Global Warming and Promotion Plan

At the Hokkaido Toyako Summit,[1] which was held in July 2008 (Heisei 20), changes in the environment and climate were discussed as a major theme, and climate change countermeasures attracted much attention. In Hokkaido, this year was designated to be the inaugural year of environmental actions, and the "Hokkaido Environmental Declaration" was announced, which envisions "Eco-island Hokkaido," a sustainable Hokkaido that imposes little burden on the environment by recycling and symbiosis. Upon this opportunity, Hokkaido enacted the "Hokkaido Ordinance on Prevention of and Countermeasures for Global Warming" in 2009 (Heisei 21), the year following the summit, in order to proactively contribute to climate change countermeasures.

Based on this ordinance, the "Hokkaido Plan to Promote Global Warming Countermeasures" was formulated in 2010 (Heisei 22) with the objective of promoting climate change countermeasures in a comprehensive, systematic manner. In 2014 (Heisei 26), the CO_2 emissions reduction goal defined in the plan was revised to be 7% compared to 1990 (Heisei 2) levels. Also, to realize these goals, the following strategic policies were organized.

Table 5　Hokkaido's CO_2 Reduction Goal

Target Year	2020
Reduction Goal	7% reduction (vs. 1990 level) * 17.5% reduction (vs. 2005 level)

Table 6　Strategic Policies in the Hokkaido Plan to Promote Global Warming Countermeasures

Conversion to low-carbon lifestyles and business styles
• Promotion aimed at citizens and businesses to act to prevent global warming • Promotion of actions to prevent global warming by certifying enterprises that contribute to environmental protection • Promotion of CO_2 emissions reduction by utilizing the domestic credit system, etc. • Promotion of public awareness and activity support coordinated and in collaboration with the Hokkaido Center for Climate Change Actions • Promotion of the development of individuals who show consideration to the environment
Introduction of environmentally friendly energy sources that capitalize on the region's characteristics
• Comprehensive promotion of actions to achieve energy conservation and new energy • Promotion of renewable energy use by effectively using the various energy resources within Hokkaido (e.g., solar, hydroelectric, snow and ice, and biomass)
Promotion of maintenance and protection of forests as a carbon dioxide absorption source
• Maintenance and protection in accordance with regional characteristics of forests that demonstrate multifunction roles (e.g., carbon dioxide absorption) continuously, and promotion of forest creation with Hokkaido residents' participation • Promotion of the use of wood and woody biomass • Promotion of protection of green spaces in cities

Promotion of renewable energy use that harnesses the energy resources that exist in various forms within Hokkaido is touted as a major policy. CO_2 emissions reductions are anticipated through solar- and wind-generated electricity as well as the promotion of heat use generated from sources such as snow and ice cold, geothermal energy, and forest biomass.

3-1-2 Hokkaido Ordinance to Promote Energy Conservation and New Energy and the Action Plan

Specific plans to promote renewable energy use were organized in the "Action Plan to Promote Energy Conservation and New Energy" that was devised based on the "Hokkaido Ordinance to Promote Energy Conservation and New Energy."

This ordinance was formulated in January 2001 (Heisei 13), the first of any prefecture in Japan. The preface states, "in view of denuclearization, while passing down our limited resources to future generations as much as possible, Hokkaido has the responsibility to expand the use of new kinds of energy that may be independently procured within Hokkaido," and, to do so, "attempt to stabilize energy supply and demand as well as create a recycle-based socioeconomic system that facilitates sustainable development by proactively increasing the efficiency of energy use and developing and implementing new energy," thus proclaiming Hokkaido's stance of proactively adopting renewable energy.

Plans for the second phase of the "Action Plan to Promote Energy Conservation and New Energy" were formulated in 2012 (Heisei 24), and these were reviewed in March 2016 (Heisei 28), the plan's mid-point. In addition, the "Basic Direction to Expand New Energy Adoption" was drawn up in 2014 (Heisei 26) in consideration of the "Energy Basic Plan"[2] indicated by the government, and policies based on these plans and basic direction are now being laid out.

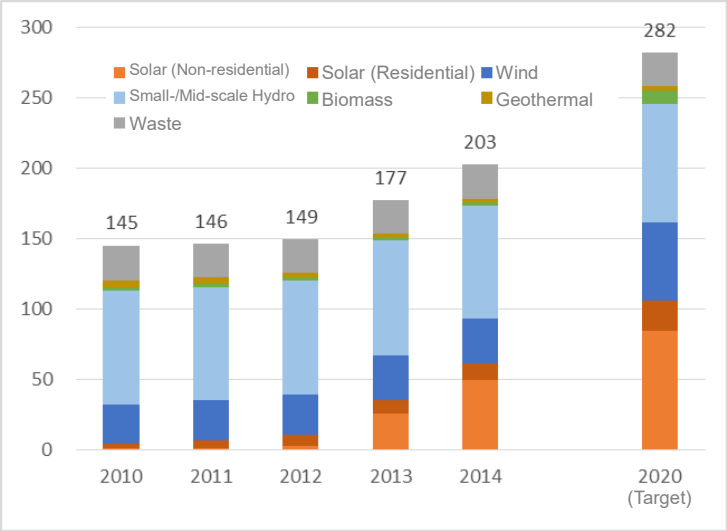
Under this basic direction, thoughts on how to implement renewable energy that makes the most of Hokkaido's potential are summarized below.

Table 7　Basic Direction for Future Undertakings to Unleash Hokkaido's Possibilities

(1) Local Production for Local Consumption of Energy
Expand "local production for local consumption" initiatives that generate regional wealth through recirculation within the region by balancing supply and demand, and by advancing regional consumption through utilizing energy resources that exist in abundance by the region's diversified constituents.
(2) Integration of Proof-of-Concept and Development Projects Related to Energy and Production and R&D Sites
Promote various use of new energy by utilizing Hokkaido's advantages, such as expansive land with a snowy and cold climate blessed with new energy resources (e.g., various biomass), and attempt to integrate proof-of-concept research projects.
(3) Preparation of a Foundation to Unleash New Energy's Possibilities to Their Fullest Extent
To introduce and expand new energy on a large scale, certain constraints must be addressed, such as the small-scale power system, which has limited capability to adjust to power output changes, and the limited system linkage capacity between Hokkaido and the mainland.

As per (1) in Table 7, it is distinctive that it remarks, "expanding efforts to achieve 'local production for local consumption of energy,' which generates regional wealth through recirculation within the region by balancing supply and demand." To promote endeavors for local production for local consumption of energy, Hokkaido offers various supports from the initial and planning stages through to implementation, making the most of the regional characteristics of each of its 179 municipalities.

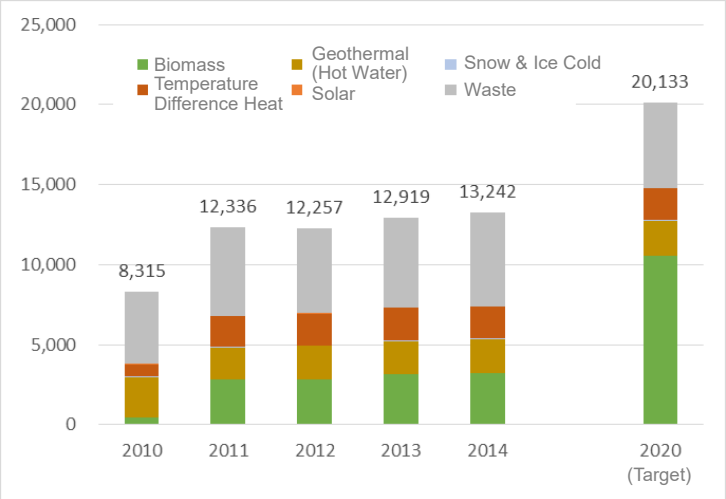
Also, under this plan, with the target fiscal year set for FY2020, tangible numeric goals for renewable energy use have been defined for the areas of power generation and heat utilization. In the area of power generation, the plan calls for an increase of more than 1.9 times the installed capacity versus FY2012 (Heisei 24) actual, and in the area of heat utilization, an increase of more than 1.6 times.



	FY2012 (Actual)	FY2020 (Target)
Solar (Non-residential)	2.4	84.0
Solar (Residential)	8.0	21.5
Wind	28.8	56.0
Small-/Mid-scale Hydroelectric	81.1	83.8
Biomass	2.4	10.0
Geothermal	2.5	2.6
Waste	23.8	24.1
Total	149.0	282.0

Figure 8　Trend in the Renewable Energy Usage Level for Power Generation (Installed Capacity) and Adoption Targets (unit: 10,000 kW)

(Prepared by the Hokkaido Environment Foundation based on the Hokkaido Action Plan to Promote Energy Conservation and New Energy [Phase II] (Hokkaido))



	FY2012 (Actual)	FY2020 (Target)
Biomass	2,853	10,550
Geothermal (Hot Water)	2,068	2,167
Snow & Ice Cold	39	47
Temperature Difference Heat	1,974	2,017
Solar	33	9
Waste	5,290	5,343
Total	12,257	20,133

Figure 9　Trend in the Renewable Energy Usage Level for Heat Generation and Adoption Targets (unit: TJ)

(Prepared by the Hokkaido Environment Foundation based on the Hokkaido Action Plan to Promote Energy Conservation and New Energy [Phase II] (Hokkaido))

3-2 Positioning of Renewable Energy and Its Possibilities in Hokkaido

As will be touched upon later, because of its flourishing natural environment and vast land, Hokkaido is blessed with varied, plentiful renewable energy sources, the likes of which are not seen anywhere else in Japan. Utilizing these regional resources will immensely contribute to efforts to counter climate change, which is becoming increasingly severe. Meanwhile, in Hokkaido, use of renewable energy is being counted on to solve various issues the region faces.

Currently, the population decline and aging society in Hokkaido are proceeding at a rate faster than anywhere else in Japan, and serious issues for local residents, such as the declining quality of services that are essential for daily living (e.g., medical and welfare services), deteriorating community functions, and weakening disaster response capabilities are becoming evident. Thus, this is beginning to have serious repercussions on the regional economy and industry, such as impoverished regional finances, the deteriorating financial status of local administrations, and diminishing employment opportunities. Efforts to utilize local resources and renewable energy sources, which can be found in abundance in Hokkaido, are beginning to expand with the aim of restructuring the regional society and economy. Hokkaido's renewable energy is unique in the way that undertakings are often also a means of solving local issues, such as by creating employment opportunities and regional revitalization.

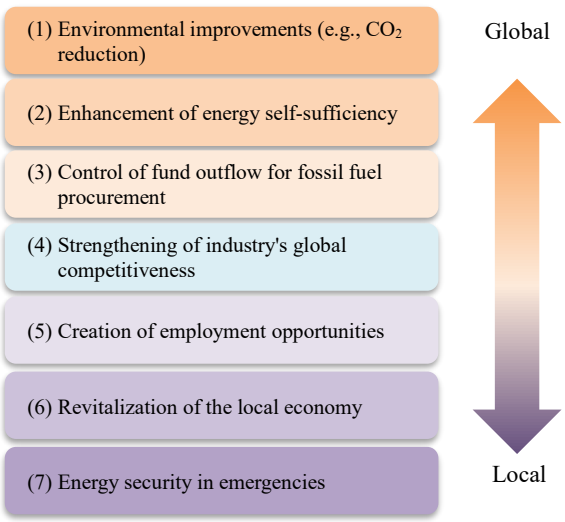


Figure 10　Significance of Renewable Energy Utilization

(Prepared by the Hokkaido Environment Foundation based on the "FY2014 Report on Consignment of Verification and Examination Work on the Possibility of Achieving Widespread Use of Renewable Energy and Other Decentralized Energy Systems in 2050" (MOE)

3-2-1 Various Issues Facing Hokkaido

(1) Declining Population and a Super-Aging Society

According to the "Regional Future Estimated Population of Japan (Estimated in March 2013 (Heisei 25))" released by the National Institute of Population and Social Security Research, Hokkaido's population is predicted to decline by more than 20% by 2040 compared to the 2015 (Heisei 27) level. A more detailed examination reveals that, while it is estimated that there will be a 41% reduction in the segment of people under age 20, and a 34% reduction in 20- to 59-year-olds, those from age 60 to 74 will decline by 19%, and those above 75 will increase by 34%. As the population declines, aging is predicted to advance at a rapid pace.

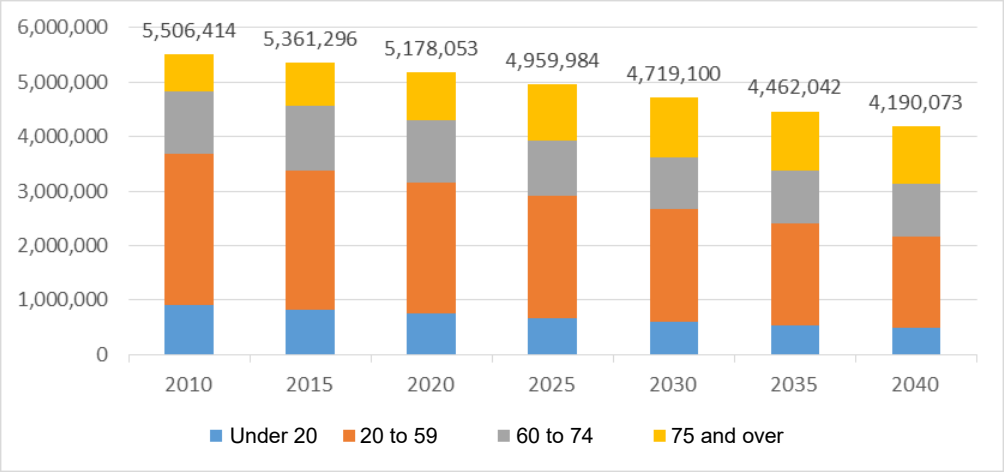


Figure 11 Predicted Change in Population of Hokkaido (unit: persons)

(Prepared by Hokkaido Environment Fund based on national census and data published by National Institute of Population and Social Security Research)

There are significant differences in the population decline and advance of aging among regions within Hokkaido. While it is estimated that there will be a population decline of little more than 20% in Hokkaido overall, according to similar estimates, in 165 municipalities, which account for more than 90% of the total number of 179, a population decline of more than 20% is predicted. In 86 municipalities, which are approximately half of the total number of municipalities, a population decline of more than 40% is predicted. The lower the municipal population, the greater the pace of population decline. Population estimates are fairly reliable, and there is a high likelihood that these population compositions will present a future image of Hokkaido. Given such circumstances, we must take action to reestablish life styles and regional communities, such as ideal life support services, in a way that is sustainable even in the face of a declining population and aging society, as well as a new style of habitat.

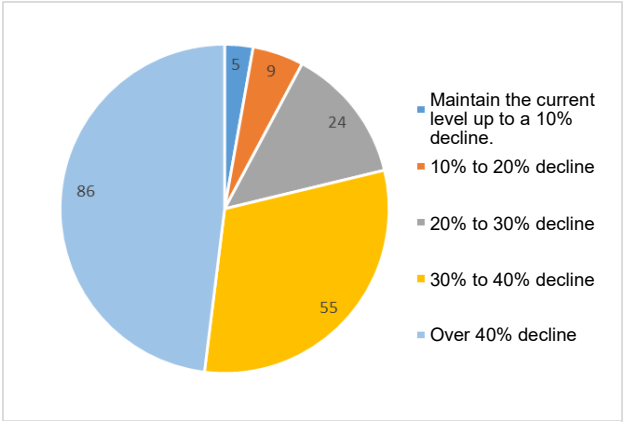
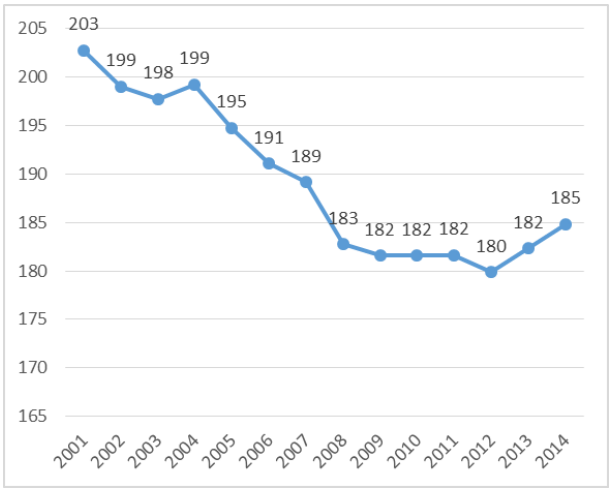


Figure 12 Population Decline Rates in 179 Municipalities

(Prepared by the Hokkaido Environment Fund based on the national census and data published by the National Institute of Population and Social Security Research)

(2) An Impoverished Regional Economy and Employment Situation

Although some recovery has been observed in recent years, Hokkaido's economic level continues to decline; compared to 2001 (Heisei 13), total output has fallen by approximately 10 percent. As represented by the bankruptcy of Yubari City, the operational status of local governments is serious, and most other municipalities are not in any better financial condition. The employment situation also indicates a recovering trend, but it continues to move within a critical range compared to other parts of the country. High expectations remain for using renewable energy as a source of new industry as well as a means of generating employment opportunities in the region.



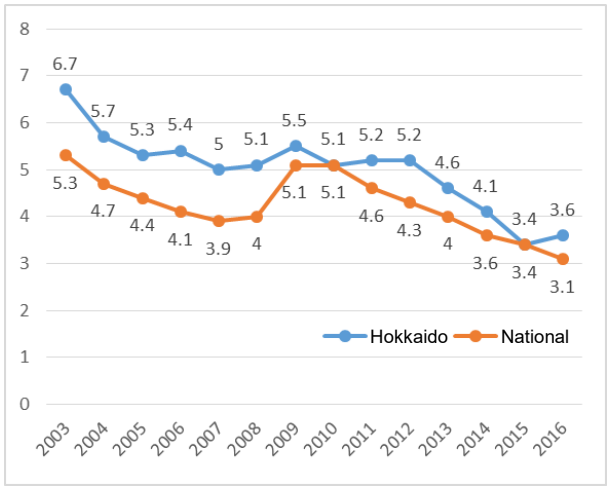


Figure 13 Left: Hokkaido's Gross Product (unit: 100 billion yen)

Right: Change in Unemployment Rate (unit: %)

(Prepared by the Hokkaido Environment Fund based on the FY2014 Hokkaido Accounts Statistics [left] and Labor Force Survey results (2016 averages) [right])

3-2-2 Characteristics and Potential Reserves of Renewable Energy in Hokkaido by Type

Hokkaido is abundantly blessed with various kinds and types of renewable energy, including solar, wind, hydro, and geothermal energy; such blessings are without parallel in Japan. Table 8 shows the adoption potential of major renewable energy in Hokkaido.

Table 8 Adoption Potential of Renewable Energy in Hokkaido

Solar Power Generation (Non-Residential)
• No. 2 prefecture in terms of adoption potential (approximately 5% of national potential) (FY2010 Research on Renewable Energy Adoption Potential (Ministry of the Environment): "Non-residential" refers to public facilities, factories, low-use and unutilized land, etc.)
Wind Power Generation
• Home to 45% of the total suitable terrain in Japan (No. 1 nationwide) with an annual average wind speed in excess of 6.5 m/s (FY2010 Research on Wind Power Adoption Potential (Ministry of Economy, Trade and Industry): Potential B, which deems land with adoption limitations due to regulatory constraints not applicable)
Small- and Mid-Scale Hydroelectric Power Generation
• No. 1 prefecture in terms of adoption potential (approximately 10% of national potential) (FY2010 Research on Renewable Energy Adoption Potential (Ministry of the Environment): Installed capacity below 30,000 kW, rivers and agricultural irrigation canals, water and sewage systems, etc.)
Geothermal Power Generation
• Home to 58% of Japan's hydrothermal resource adoption potential with temperatures exceeding 150°C (No. 1 nationwide) (FY2012 Report on Preparation of Zoning Base Information Concerning Renewable Energy (Ministry of the Environment): Potential with some sections of national and quasi-national parks considered suitable for development, but without any slant drilling)

(Prepared by the Hokkaido Environment Foundation based on Basic Direction to Expand New Energy Adoption (Hokkaido))

In addition, because farming, forestry, and fisheries are thriving industries in Hokkaido, there is a diverse collection of biomass. Among these, in farming, the total area of agricultural land in Hokkaido comprises 25% of Japan's cultivated acreage. The crop acreage of paddy rice and wheat as well as the number of livestock (e.g., dairy cows and beef cattle) are the highest in the country. Agricultural biomass (e.g., rice straw and livestock excrement) can also be found in abundance. Moreover, regarding forestry, the forested area in Hokkaido comprises 22% of the national acreage, and the prefecture is rich in wood-based biomass.

The following summarizes the distribution of renewable energy reserves.

(1) Solar Power Generation

Broadly speaking, the generation efficiency of solar power increases as the temperature drops, which gives Hokkaido an advantage. In particular, eastern Hokkaido (the Tokachi, Kushiro, Nemuro, and Okhotsk regions), which sees lower levels of snowfall, receives a higher

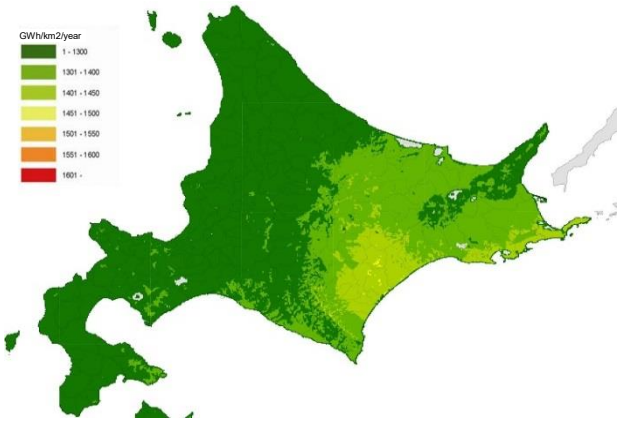


Figure 14 Solar Power Generation Reserve Distribution

(From the Hokkaido website "New Energy Reserve Estimate Support Tool")

amount of solar radiation on average, even compared to the rest of the country. This makes it an optimal location for solar power generation. The unit cost to generate power is JPY 24.3/kW for mega solar facilities and JPY 29.4/kW for residential solar units, but further reductions are expected in the future. This leads us to anticipate even greater expansion.

As of FY2015 (Heisei 27), the installed capacity of completed units is approximately 970,000 kW.

(2) Wind Power Generation

Land suited for wind power generation must receive stable wind that has an average wind speed in excess of 6 m/s. Many sites on the coast facing the Sea of Japan (the Souya, Rumoi, Shiribeshi, and Hiyama regions), where the westerly wind blows strong, are suited for wind power generation. The unit cost to generate power is relatively low at JPY 21.6/kW, and the energy conversion rate is also high, which has prompted construction of large-scale wind farms even before the FIT program began.

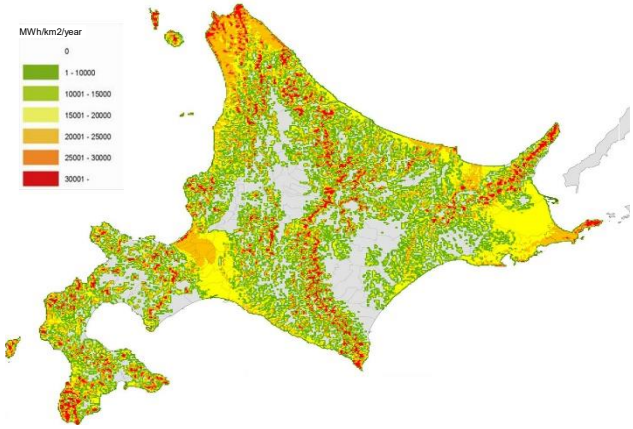


Figure 15 Wind Power Generation Reserve Distribution
(From the Hokkaido website "New Energy Reserve Estimate Support Tool")

As of FY2015 (Heisei 27), the installed capacity of completed units is approximately 320,000 kW, which includes 288 wind generators.

(3) Small- and Mid-Scale Hydroelectric Power Generation

In addition to conventional large-scale hydroelectric power generation, small- and mid-scale hydroelectric power generation, which utilizes small streams in mountainous areas and irrigation water from the region, is attracting attention. The mountains in central Hokkaido (the Kamikawa, Tokachi, and Hidaka region) offer abundant potential for small- and mid-scale hydroelectric power.

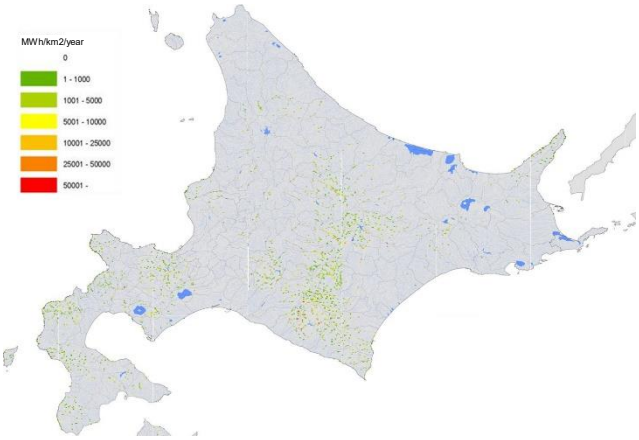


Figure 16 Small- and Mid-Scale Hydroelectric Power Generation Reserve Distribution
(From the Hokkaido website "New Energy Reserve Estimate Support Tool")

As of FY2015 (Heisei 27), the installed capacity of completed units is approximately 830,000 kW, and if we limit this to small- and mid-scale hydroelectric power units with a capacity of less than 10,000 kW, there are 69 sites in operation with a total output capacity of 235,000 kW (as of January 2013 (Heisei 25)).

(4) Geothermal Power Generation

Hokkaido has Japan's highest reserves of geothermal energy. The only large-scale geothermal power generation facility in operation in Japan is the Mori Geothermal Power Plant operated by the Hokkaido Electric Power Co, Inc. The unit cost to generate power is low at JPY 19.2/kW, and it has the advantage of stable power output. On the other hand, challenges to the development of additional facilities are the high costs and long period required before completing development.

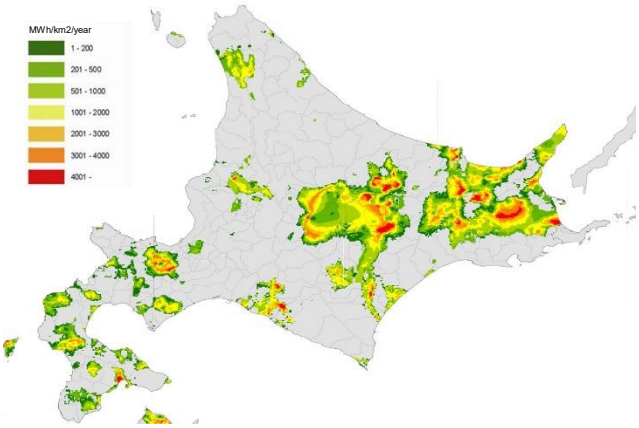


Figure 17　Geothermal (53°C to 120°C) Power Generation Reserve Distribution

(From the Hokkaido website "New Energy Reserve Estimate Support Tool")

Heat sources of relatively low temperatures can be found over a vast area, and initiatives to utilize such heat, such as small-scale binary power generation,[3] are spreading.

(5) Biomass Power Generation

Biomass is distributed over wide areas in each region, but depending on a given region's characteristics (e.g., geographical features and industry), the potential distribution differs by biomass type.

Wood-based biomass (logging residue) can be found in abundance in the Kamikawa, Okhotsk, and Tokachi regions. Advancing the utilization of wood-based biomass was difficult due to the costs associated with collecting underutilized materials (e.g., logging residue), but construction of large-scale wood-based biomass power generation sites is underway prompted by utilization of regional heat sources and the vigorous activity of the FIT program.

Livestock biomass reserves, as represented by bovine excreta from dairy cows, can be found in abundance in the Kushiro and Nemuro regions, where dairy farms stretch over vast tracts of land. Large amounts are already reused through manuring, but advanced usage that converts excreta into biogas and generates electricity are underway.

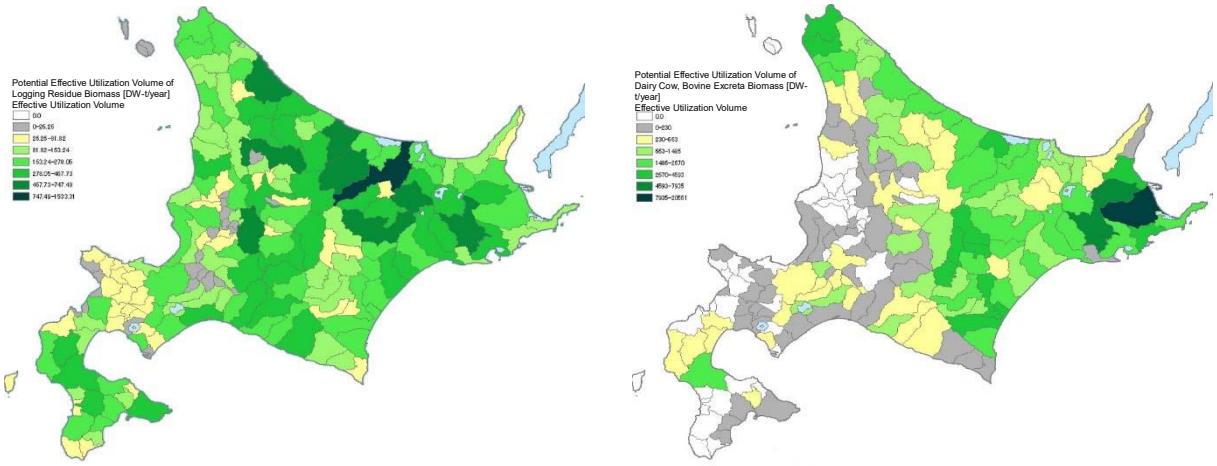


Figure 18　Biomass Reserve Distribution (Left: Logging Residue, Right: Dairy Cow, Bovine Excreta)

(Prepared by the Hokkaido Environment Fund based on NEDO's "Estimate of Biomass Reserves and Potential Effective Utilization Volume (2011 Research))

(6) Snow and Ice Cold

"Snow and ice cold" refers to renewable energy that capitalizes on the regional characteristics of Hokkaido, which has abundant snow and a cold climate; this is used mostly for storage of agricultural products. Many examples of air cooling systems that utilize snow can be seen in the Sorachi, Shiribeshi, and Kamikawa regions, and the same systems that utilize ice are in use in eastern Hokkaido, where the cold is even more severe.

Table 9 organizes the renewable energy reserves distributed among Hokkaido's 14 administrative regions (Subprefectural Bureau).

Table 9 Major Renewable Energy Reserves by Region (Subprefectural Bureau)

(* Underlined and boldface words represent energy with relatively advantageous conditions.)

	Annual Average Solar Radiation ($kWh/m^2 \cdot day$)	Annual Average Wind Velocity (m/s)	Small- and Mid-Scale Hydroelectric Power Generation (GWh)	Geothermal Power Generation (GWh)	Biomass		
					Livestock Waste (TJ)	Sludge and Food Residue (TJ)	Woody (TJ)
Northern Hokkaido							
Kamikawa	3.52	2.18	**1,712**	**59,480**	**641**	**157**	**9,157**
Rumoi	3.45	**3.67**	48	431	138	15	1,628
Souya	3.51	**3.85**	4	287	477	31	2,966
Central Hokkaido							
Sorachi	3.61	3.03	**590**	482	191	90	**7,918**
Ishikari	**3.72**	**3.67**	355	**4,629**	270	**802**	3,773
Shiribeshi	3.44	**3.66**	**619**	1,007	195	76	2,478
Southern Hokkaido							
Iburi	**3.78**	2.93	244	901	380	**132**	3,916
Hidaka	**3.77**	3.06	**1,784**	931	175	21	1,485
Oshima	3.57	**3.57**	365	1,644	445	**122**	2,694
Hiyama	3.35	**4.14**	273	494	74	10	1,630
Eastern Hokkaido							
Okhotsk	**3.85**	2.34	200	**25,836**	**1,274**	**109**	**12,102**
Tokachi	**4.07**	1.93	**2,198**	**43,554**	**2,275**	**115**	**10,871**
Kushiro	**3.97**	2.95	182	**18,008**	**927**	93	**6,297**
Nemuro	**3.85**	2.76	32	**18,921**	**1,182**	34	1,736

(Prepared by the Hokkaido Environment Foundation based on the Basic Direction to Introduce and Expand New Energy (Hokkaido))

3-3 State of Introduction of Renewable Energy by Region in Hokkaido

The Ministry of the Environment and Hokkaido Regional Environment Office compile information on the status of introduction and research on power generation that harnesses renewable energy in Hokkaido. Based on this material, we have summarized the statuses of introduction of renewable energy (excluding those that are still under study) by Hokkaido's 14 regions (Subprefectural Bureau).

(1) Northern Hokkaido Region (Kamikawa, Rumoi, and Souya)

Souya and Rumoi are both regions in Hokkaido blessed with extremely favorable wind conditions. Souya has a number of wind power plants, such as the Eurus Souya Misaki Wind Farm, the largest such facility in Hokkaido. Kamikawa is host to mountains that occupy central Hokkaido, which are home to an abundance of forest resources. Although the number of power plants within the region is only four, cities such as Shimokawa Town, which is Hokkaido's sole FutureCity,[4] proactively engage in use of heat generated by utilization of woody biomass.

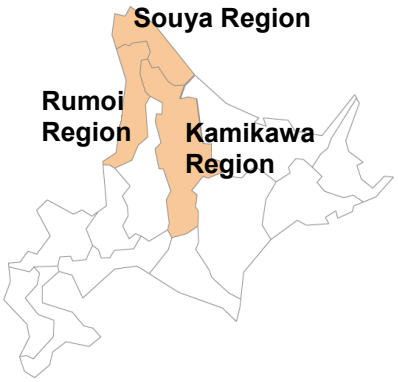


Figure 19 Northern Hokkaido Region

Table 10 Number of Renewable Energy Power Plants (Northern Hokkaido)

Region	Wind	Solar	Geothermal	Biomass Biogas
Kamikawa	0	12	0	4
Rumoi	9	0	0	1
Souya	14	2	0	1

(Prepared by the Hokkaido Environment Foundation based on the Trends in Introduction of Renewable Energy by Hokkaido Municipalities (Hokkaido Regional Environment Office, as of July 1st, 2017))

(2) Central Hokkaido Region (Sorachi, Ishikari, and Shiribeshi)

This region, which contains the largest city in Hokkaido, Sapporo, provides social infrastructure such as the power grid sufficiently. It is thanks to the progressive introduction of renewable energy as represented by solar power generation. In the coastal areas facing the Sea of Japan, such as Ishikari and Shiribeshi, wind power plants operate that capitalize on favorable wind conditions. In addition, because Sorachi sees the highest amount of snowfall in Hokkaido, the region's Numata Town and Bibai City have engaged in utilizing snow and ice cold sources from the early stages.

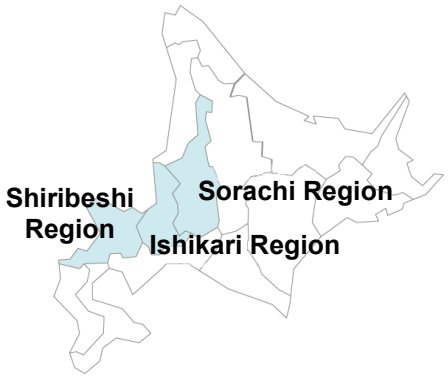


Figure 20 Central Hokkaido Region

Table 11 Number of Renewable Energy Power Plants (Central Hokkaido)

Region	Wind	Solar	Geothermal	Biomass Biogas
Sorachi	0	20	0	2
Ishikari	6	30	0	4
Shiribeshi	5	1	0	0

(Prepared by the Hokkaido Environment Foundation based on the Trends in Introduction of Renewable Energy by Hokkaido Municipalities (Hokkaido Regional Environment Office, as of July 1st, 2017)

(3) Southern Hokkaido Region[5] (Iburi, Hidaka, Oshima, and Hiyama)

Hiyama has the most favorable wind conditions in Hokkaido, and Setana Town is home to the country's first off-shore wind power generation facility, which is still in operation. Mori Town, located in Oshima, is a pioneer in efforts to utilize hot spring geothermal energy; in addition to the active Mori Geothermal Power Plant, the town makes ongoing efforts to utilize thermal power. Moreover, Oshima, Iburi, and Hidaka, which all face the Pacific Ocean, are blessed with abundant sunlight, and in Iburi in particular, the numerous plains allow many solar power plants to operate. The largest mega solar power plant in Japan, "Softbank Tomatoh Abira Solar Park," is also located in this region's Abira Town.

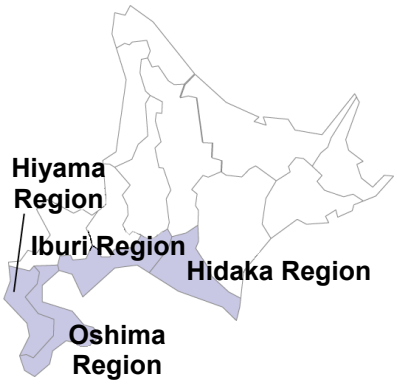


Figure 21 Southern Hokkaido Region

Table 12 Number of Renewable Energy Power Plants (Southern Hokkaido)

Region	Wind	Solar	Geothermal.	Biomass Biogas
Iburi	5	60	1	2
Hidaka	1	8	0	0
Oshima	1	15	1	0
Hiyama	6	2	0	0

(Prepared by the Hokkaido Environment Foundation based on the Trends in Introduction of Renewable Energy by Hokkaido Municipalities (Hokkaido Regional Environment Office, as of July 1st, 2017))

(4) Eastern Hokkaido Region (Okhotsk, Tokachi, Kushiro, and Nemuro)

Eastern Hokkaido is blessed with plenty of sunlight, and given the relatively light snowfall, the region leads in introducing solar power generation. In addition, the region is a major agricultural zone, giving it especially abundant livestock biomass resources. Numerous biogas power plants operate to take advantage of these regional resources, including in Betsukai Town, where Japan's largest operating biogas power generation facility can be found. The region is also rich in forest biomass; in Tsubetsu Town, public and private sectors are utilizing heat generated by wooden biomass.

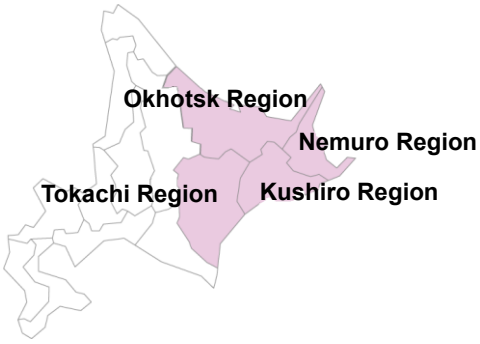


Figure 22 Eastern Hokkaido Region

Table 13 Number of Renewable Energy Power Plants (Eastern Hokkaido)

Region	Wind	Solar	Geothermal	Biomass Biogas
Okhotsk	0	38	0	9
Tokachi	0	58	0	7
Kushiro	2	29	1	4
Nemuro	5	9	0	1

(Prepared by the Hokkaido Environment Foundation based on the Trends in Introduction of Renewable Energy by Hokkaido Municipalities (Hokkaido Regional Environment Office, as of July 1st, 2017))

[1] Refers to the 34th G8 Summit Meeting, which was held in Toyako Town, Hokkaido between July 7th and 9th, 2008. Climate change countermeasures were one of the major discussion themes.
[2] Indicates the basic direction of the country's policy towards energy supply, demand, and usage. Formulated by the government based on the Basic Act on Energy Policy.
[3] A power generation method in which a steam turbine is powered by heating and evaporating a medium with a boiling point that is lower than that of water. This is suitable for generating power using low temperature geothermal fluid.
[4] Chosen by the country on December 22nd, 2011 to resolve issues (e.g., the environment and the super-aging society) based on the new growth strategy as well as to create internationally leading examples of success in areas such as technology and services for the future and for community development.
[5] The regional classification of Hidaka and Iburi is "central Hokkaido" according to Hokkaido Government, but this report reclassifies them as part of "southern Hokkaido."

4. Projects Introducing Renewable Energy

As presented in the previous chapters, Hokkaido is a region of geographical, social, and environmental diversity. Efforts to use renewable energy that meet local needs are being made across the prefecture to tackle climate change and solve problems in various fields, such as economy, employment, and disaster management. We selected the target projects described in this chapter so as to cover such diversity.

In selecting the projects, we focused on whether the projects are or can be considered as community-oriented projects, including community development projects and projects aimed at settling local problems. It was desirable to select communities whose renewable energy efforts are included in their municipality plans, but this was not a requisite.

After gathering a broad range of information through various publicly available documents, we selected the following 14 communities based on the advice of persons and experts involved.

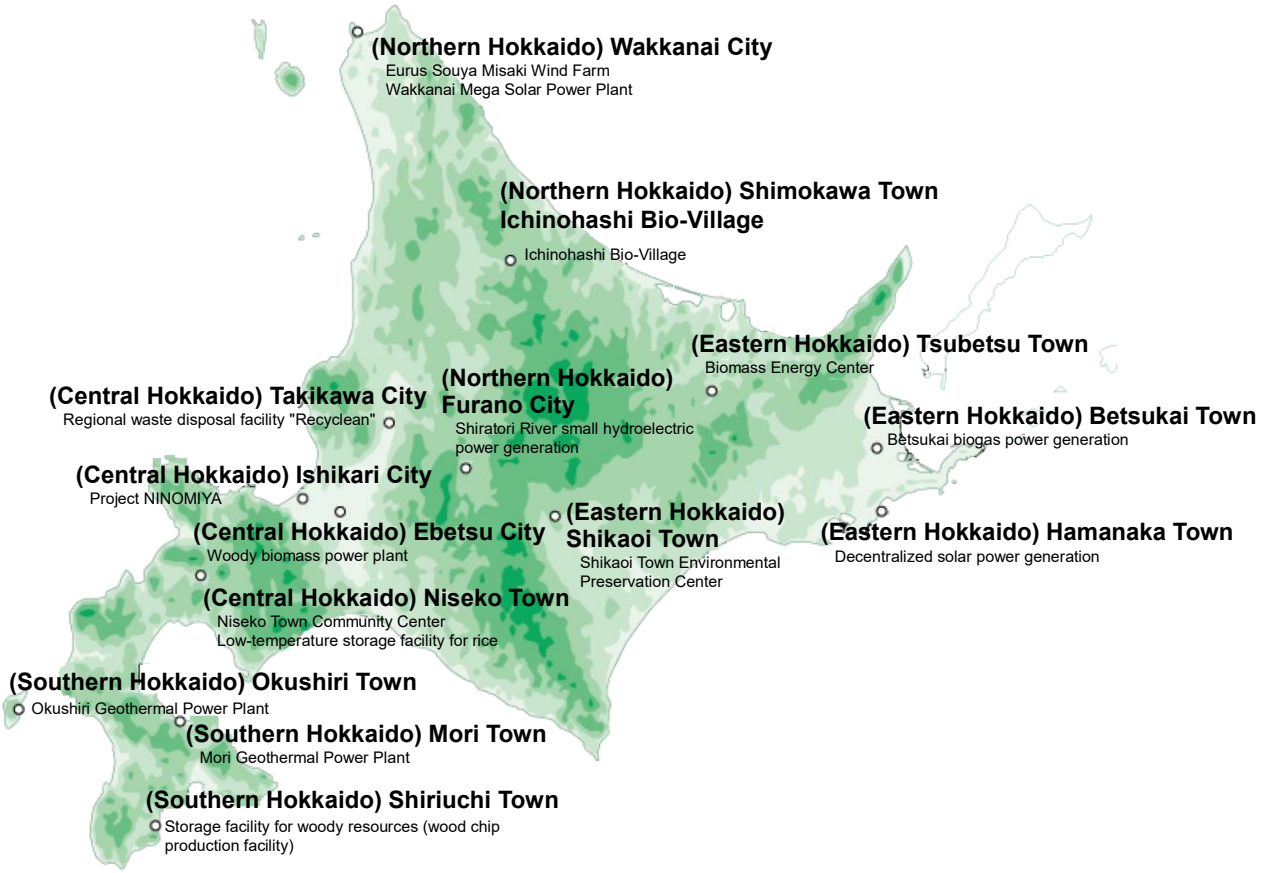


Figure 23 The 14 Surveyed Communities

Described below is the diversity of the projects in these 14 communities in terms of project scale, regional balance, facility operators, and types of renewable energy.

O Diversity in project scale

We selected small- to medium-scale projects that used relatively simple technology because of our goal to apply these projects to developing countries. We also selected projects using cutting-edge technology or large equipment to represent Hokkaido. The project scale is only a qualitative evaluation of the facility scale, not a quantitative evaluation based on heat and electricity supplies, reduced CO_2 emissions, facility construction costs, and other factors.

Table 14 Facility Scale of Selected Projects

Municipality	Project	Small	Medium	Large
Shimokawa Town	Ichinohashi Bio-Village	◀——▶	◀——▶	
Wakkanai City	Eurus Souya Misaki Wind Farm			◀——▶
	Wakkanai Mega Solar Power Plant			◀——▶
Niseko Town	Niseko Town Community Center		◀——▶	
	Low-temperature storage facility for rice		◀——▶	
Takikawa City	Regional waste disposal facility "Recyclean"		◀——▶	
Tsubetsu Town	Biomass Energy Center			◀——▶
Mori Town	Mori Geothermal Power Plant			◀——▶
Shikaoi Town	Shikaoi Town Environmental Preservation Center		◀——▶	
Betsukai Town	Betsukai biogas power generation			◀——▶
Ishikari City	Project NINOMIYA	◀——▶		
Furano City	Shiratori River small hydroelectric power generation	◀——▶		
Okushiri Town	Okushiri Geothermal Power Plant		◀——▶	
Shiriuchi Town	Storage facility for woody resources (wood chip production facility)	◀——▶		
Ebetsu City	Woody biomass power plant			◀——▶
Hamanaka Town	Decentralized solar power generation system	◀——▶	◀——▶	

O Regional balance

Although available renewable energy is unevenly distributed, we selected the 14 projects from across the prefecture and kept a regional balance between the four regions of Northern Hokkaido, Southern Hokkaido, Central Hokkaido, and Eastern Hokkaido.

- Northern Hokkaido: Kamikawa, Souya, and Rumoi
- Southern Hokkaido: Oshima, Hiyama, Hidaka, and Iburi
- Central Hokkaido: Ishikari, Sorachi, and Shiribeshi
- Eastern Hokkaido: Okhotsk, Tokachi, Kushiro, and Nemuro

O Diversity in facility operators

While many renewable energy projects in Hokkaido are led by corporations or local governments, we also selected projects led by NPOs or local residents.

Table 15 Regions and Facility Operators of Surveyed Projects

Municipality	Project	Region	Major facility operator		
			Local government	Corporation	Residents, etc.
Shimokawa Town	Ichinohashi Bio-Village	Northern	○		
Wakkanai City	Eurus Souya Misaki Wind Farm	Northern		○	
	Wakkanai Mega Solar Power Plant		○		
Niseko Town	Niseko Town Community Center	Central	○		
	Low-temperature storage facility for rice			○	
Takikawa City	Regional waste disposal facility "Recyclean"	Central	○		
Tsubetsu Town	Biomass Energy Center	Eastern		○	
Mori Town	Mori Geothermal Power Plant	Southern		○	
Shikaoi Town	Shikaoi Town Environmental Preservation Center	Eastern	○		
Betsukai Town	Betsukai biogas power generation	Eastern		○	
Ishikari City	Project NINOMIYA	Central			○
Furano City	Shiratori River small hydroelectric power generation	Northern			○
Okushiri Town	Okushiri Geothermal Power Plant	Southern		○	
Shiriuchi Town	Storage facility for woody resources (wood chip production facility)	Southern	○		
Ebetsu City	Woody biomass power plant	Central		○	
Hamanaka Town	Decentralized solar power generation system	Eastern		○	

O Diversity in types of renewable energy

While prioritizing abundant wind power and woody and livestock biomass generated from agriculture, forestry, and fisheries given Hokkaido's geographical features, we also selected projects using other renewable energy sources, such as solar power, small-scale hydroelectric power, hot spring heat, and geothermal power.

Table 16 Renewable Energy Used in Surveyed Communities and Introduced Projects

Municipality	Solar power	Wind power	Hydroelectric power	Geothermal power	Woody biomass	Livestock biomass	Snow and ice	Temperature difference heat	Others
Shimokawa Town					◎				
Wakkanai City	◎	◎							
Niseko Town							◎	◎	
Takikawa City									◎Waste
Tsubetsu Town					◎				
Mori Town				◎					
Shikaoi Town						◎			○Hydrogen
Betsukai Town						◎			
Ishikari City		○			◎				
Furano City			◎						○Waste
Okushiri Town				◎	○				
Shiriuchi Town					◎				
Ebetsu City	○				◎				
Hamanaka Town	◎	○							

* ◎ indicates renewable energy used in the "introduction of project" while "○" indicates renewable energy used in the "efforts of municipalities."

In this survey, we visited local government officials, as well as conducted interviews and had on-site inspections of facilities using renewable energy. As described below, we looked into the status of renewable energy in the plans of local governments, the participation of local residents, and other overall project situations. We also gathered as much information as possible with respect to the relationship of the projects with other fields and their funding flows, and examined the secondary effects of introduced renewable energy on the local economy.

- Status of the projects in the plans and policies of local governments

  Given that many training program participants are government officials, we clarified the roles of local governments in the introduction of renewable energy and their plans concerning local renewable energy.

- Participation of local residents

  Since the understanding and participation of local residents are important to promote the sustainable use of renewable energy, we looked into the participation of local residents and the background of the introduced renewable energy.

- Relationship with other fields

  We examined project backgrounds, such as the plans and policies of local governments and the participation of local residents, as well as the secondary effects of the projects, such as those on employment and economy.

- Flow of funds and profitability

  We examined the flow of funds for the projects from the introduction to use of renewable energy to find out their profitability.

- Learning opportunities for Hokkaido

  We looked into whether the cooperating communities of Hokkaido can have opportunities to interact with training program participants and learn from them in hopes that JICA will be able to use such opportunities as training resources.

[Case 1] Shimokawa Town, Hokkaido

○ Shimokawa Town, the sole FutureCity in Hokkaido

Located in the northern part of Hokkaido, Shimokawa Town has a population of about 3,300. The town was once prosperous in the fields of agriculture, forestry, and mining, and had a population over 15,000 at its peak (in 1960 (Showa 35)). However, the town has been suffering a shrinking population due to changes in its industrial structure.

Shimokawa Town has an area almost equal to that of the 23 wards of Metropolitan Tokyo, about 90% of which is covered by forests. Taking advantage of this geographic feature, the town has created a 60-year-cycle sustainable forest management system[1] and worked with local residents to build a society that coexists with forests. As a result, the town was certified by the national government as an Eco Model City[2] in 2008 (Heisei 20) and certified as the sole FutureCity in Hokkaido in 2011 (Heisei 23).

With the FutureCity initiative as its primary goal, the town is working to create an integrated forest industry and promote energy independence through the use of local forest biomass. By 2050, the town plans to reduce its CO_2 emissions by 66% from 1990 (Heisei 2) levels[3] using local woody biomass and other means.

Table 17 General Information on Shimokawa Town

Region	Northern Hokkaido
Population	3,367 (as of August 2017)
Area	644.20 km^2
Contact information	Future City Promotion Group, Future City Promotion Division, Shimokawa Town Office 63 Saiwai-machi, Shimokawa-cho, Kamikawa-gun Tel: 01655-4-2511
○ Shimokawa Town CO_2 emissions reduction	
Target year	2050
Reduction target	Reduction by 66% (from 1990)

○ Use of woody biomass—use of all forest resources

The most significant feature of Shimokawa Town's measures to tackle climate change is that they also aim to create and promote industry, society, and economy through sustainable forest management and use of forest biomass. The town is committed to using all local forest resources from large-diameter trees to branches and leaves, seeing use of woody biomass energy as one of the ways to use local forest resources. In fact, 2,000 to 2,500 m^3 out of the 20,000 m^3 of forest resources annually produced by the town's forests are used as woody biomass energy.

Having an early interest in woody biomass energy as a stable local energy source, Shimokawa Town introduced Hokkaido's first woody biomass boiler into public facilities in 2004 (Heisei 16). The town now has 11 woody biomass boilers, which supply heat to 30 public facilities. The heat supplied by the boilers accounts for 64% of the heat used by local public facilities, reducing 3,000 tons of CO_2 emissions annually.

Figure 24 Forestry Work

○ Use of woody biomass—cooperation with local residents and businesses

Many of the town's woody biomass boilers use wood chips. In the early days, the town used waste wood discharged by local laminated wood factories as woody biomass fuel. To meet the increasing local heat demand, the town later built a woody raw material production facility, which now produces 3,000 to 3,500 tons of wood chip fuel a year. While mainly using local logging residues, the facility also uses pruned trees and logging residues provided by local residents and forest owners. In this way, local forest resources are recycled with the cooperation of local residents.

Figure 25 Chipper of the Raw Material Production Facility (made in Germany)

The facility is operated by an association of local energy companies as a designated administrator[4]. This operating system facilitates the use of local woody biomass supported by local companies selling conventional energy and has provided employment opportunities to six local residents. The town secures facility operating costs by sharing 50% of the proceeds of produced wood chips with the association, and does not spend any taxpayer money. The town's share in the proceeds is pooled for machinery replacement and other purposes.

○ Spillover effects on local economy and employment

Although use of woody biomass directly created only a few jobs, it indirectly created about 50 jobs as the introduced heat supply system gave birth to five corporations in the town.

Energy independence will help the town circulate the money spent to purchase fossil fuel from other areas locally. Data[5] shows that 5% (about 1.2 billion yen) of the town's gross local production of about 21.5 billion yen flowed out of the town to purchase fossil fuel. Promoting energy independence will increase the local circulation of money.

The shift from fossil fuel to woody biomass fuel at public facilities saves purchased energy costs of about 19 million yen annually. The town pools the saved costs and appropriates half of this money for future boiler replacements and the remaining half for childcare support.

○ Community making pioneering efforts to tackle climate change—visualization of carbon balance and carbon offsetting

The support and participation of local residents are needed to promote energy independence using forest biomass and the creation of a low-carbon society. To encourage local residents to reduce CO_2 emissions, the town visualizes and makes public the absorbed, fixed, and reduced amounts of local CO_2 as a carbon balance. This provides local residents with opportunities to check their energy-saving levels to promote domestic energy saving, and gives eco-points to them for their eco-friendly consumption behavior. To give value to the amount of CO_2 absorbed by the forests, the town is also making carbon-offsetting efforts under the J-VER system of the Ministry of the Environment. The town established the Hokkaido Council of Promoting the Use of the Amount of Carbon Dioxide Absorbed by Forest Biomass[6] with three other towns in Hokkaido, which is making forestation and carbon offsetting efforts in cooperation with various local businesses and organizations.

Introduction of Project <<Ichinohashi Bio-Village>>

○ Aiming to solve problems of a super-aging society and reduce carbon dioxide emissions at the same time

The Ichinohashi district is located about 10 km east from the center of Shimokawa Town. The district faced difficulty in maintaining the community as its population, growing to over 2,000 in 1960 (Showa 35) with the prosperity of forestry, its key industry, decreased to 135 by 2010 (Heisei 22), with more than 50% being elderly people. After a series of discussions with local residents to revive the community, the town formulated the Ichinohashi Bio-Village Plan, which aimed to make the district an energy-independent community. Under this plan, an energy-independent residential area was developed in 2013 (Heisei 25).

Table 18 General Information on Ichinohashi Bio-Village

Facility operator	Shimokawa Town
Location	Ichinohashi district of Shimokawa Town
Type	Wood chips
Category	Woody biomass
Supplied energy	Heat
Scale	Small- to medium-scale
Reduced CO_2 emissions	-
Contact information	Future City Promotion Group, Future City Promotion Division, Shimokawa Town Office 63 Saiwai-machi, Shimokawa-cho, Kamikawa-gun Tel: 01655-4-2511

This village uses wood chip biomass boilers, which supply heat not only to the residential area, but also to neighboring facilities. With the help of a community-reactivating cooperator squad[7], the town office and local residents are working to solve the problems of a super-aging society and reduce carbon dioxide emissions at the same time.

○ Heat supplied by wood chip boilers

The village has two 550-kW boilers manufactured by Schmid, a Swiss company. These boilers use wood chips produced by the woody raw material production facility. When wood chips are brought into the fuel bunker, they are supplied by automatic conveyors to the boilers. The community-reactivating cooperator squad is in charge of the routine maintenance of these automatically operated boilers.

Figure 26 Boiler Used in the Biomass Village (made by Schmid, a Swiss company)

While installing the heat supply facility, the town made efforts to attract companies to the district. With the supplied heat, a medicinal plant research facility, a forest product cultivation research facility, and other facilities are conducting corporate activities, providing employment opportunities to 30 to 40 local residents.

These efforts have promoted the creation of a low-carbon society and contributed greatly to community revitalization. From 2010 (Heisei 22), when the discussions for the village plan started, to 2015 (Heisei 27), the population stopped declining and the proportion of elderly people lowered drastically (from 52% to 28%)[8].

○ Finances, profitability, and future challenges

The construction cost of the Ichinohashi Bio-Village is about 200 million yen, including the initial cost of introducing the heat supply system and the boilers. Since the construction cost was mostly covered by municipal bonds and subsidies, Shimokawa Town did not need to bear all of it. Town officials charge the residents of the residential area for their use of heat supplied by the biomass boilers by checking their heat consumption. The rate of the supplied heat, if its calorific value is converted into that of kerosene, is about 50 yen per liter, which is reasonable for users given the current price (about 80 yen per liter). This project is profitable if the initial cost is deducted from the operating cost.

Based on this project in the Ichinohashi district, Shimokawa Town is also implementing a similar bio-village project in the Kaminayoro district, a community with a high proportion of elderly people like the Ichinohashi district. Since the main industry of the Kaminayoro district is farming, the town plans to increase the number of farmers and make better use of unused farmland.

JICA's use of the project and cooperation

As Shimokawa Town is a leading municipality in the use of woody biomass, JICA should actively ask for the town's cooperation in its training programs concerning climate change and forest biomass. As the first municipality in Hokkaido to obtain the FSC forest management certification[9], Shimokawa Town is committed to the sustainable conservation and use of forest resources. Since the town is also working to make effective use of other local resources, their project should be helpful for JICA to study how local resources, as well as forests, can be used in local communities.

The town is aware of the importance of focusing on SDGs in its community development efforts, and desires to work with JICA in various opportunities.

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1 Sustainable forest management for about 4,500 ha of forests owned by the town (3,000 ha of artificial forests and 1,500 ha of natural forests). This system afforests an area of 50 ha every year and cuts the planted trees in 60 years (afforesting an area of 3,000 ha in a cycle of 60 years).

2 Cities setting a target for CO_2 emissions reduction and making pioneering efforts to reduce CO_2 emissions. They are selected by the national government to promote a shift to low-carbon society as climate change countermeasures.

3 Shimokawa Town's Eco Model City Action Plan

4 System introduced by the 2003 revision to the Local Autonomy Act. Until then, public facilities had been administered only by organizations specified by the law. The revision has enabled other corporations and organizations to administer public facilities as designated administrators.

5 *Nikkei Ecology* No. 201, March 2016 (published on February 8, 2016), Nikkei Business Publications, Inc.

6 Statutory council established by four towns in Hokkaido (Ashoro Town, Shimokawa Town, Takinoue Town, and Bihoro Town) to revitalize local communities and contribute to the creation of a low-carbon society by working together to promote sustainable use of forests as common local resources

7 Program under which local governments recruit community-reactivating team members from other regions and encourage them to settle down in order to maintain and increase local vitality while meeting the needs of the recruited members. They are supposed to work for one to three years.

8 Interview with an official of Shimokawa Town

9 Certification granted by the FSC® (Forest Stewardship Council®) for the management of forests producing wood and the processing and distribution stages of wood, branches, leaves, and other forest products. The FSC certification is classified into FM certification for wood produced under forest management that is environmentally responsible, socially beneficial, and economically viable, and CoC certification for the management of the processing and distribution stages of forest products.

[Case 2] Wakkanai City, Hokkaido

○ Eco-Friendly City Wakkanai—from the northernmost city to the most advanced city

Wakkanai City, the northernmost city of Japan, is the key city of the Souya region. Declaration itself the Eco-Friendly City Wakkanai, the city is promoting community development with renewable energy at its core.

The city is very windy throughout the year with an average wind speed of 7 m per second. Local authorities, businesses, and residents are using this wind in power generation. The city has seen various renewable energy projects, such as one of the largest-scale solar power generation operations in Japan in 2006 (Heisei 18), a naturally cooled storehouse using snow and ice cold, biogas power generation using food waste. For these efforts, the entire city is certified as a "next-generation energy park[1]."

The city has shown its commitment to promoting the use of renewable energy in its comprehensive city plan and formulated a global warming action plan (for local measures)[2]. This action plan includes a reduction target for CO_2 emissions, 25% from the FY1990 (Heisei 2) level by FY2020.

Table 19 General Information on Wakkanai City

Region	Northern Hokkaido
Population	35,058 (as of June 2017)
Area	760.89 km^2
Contact information	Environment and Energy Division, Environment and Water Supply Department, Wakkanai City Office 3-13-15 Chuo, Wakkanai-shi Tel: 0162-23-6386
○ Wakkanai City CO_2 emissions reduction	
Target year	FY2020
Reduction target	Reduction by 25% (from FY1990)

○ Using unwanted wind—one of the largest-scale wind power generation operations in Japan

The first windmill in Wakkanai City was completed in 1998 (Heisei 10). Since then, 74 windmills with a total output of 76,355 kW have been built. This output can cover 85% of the city's annual power consumption. In addition, a 30,000-kW wind power plant is under construction and is due to begin operations in the spring of 2018 (Heisei 30). There is another plan to construct a 600,000-kW wind power plant by FY2023. These plants will make the city Japan's largest wind power generation center, with a total output of 700,000 kW.

However, there is criticism that only four wind power generation facilities were mainly financed by the local government, while the other facilities were built with capital from outside the prefecture. With the awareness of the need to establish a system for promoting and using renewable energy that benefits local residents, the city started establishing a model of the local consumption of locally produced renewable energy in FY2017 (Heisei 29).

○ Interaction and cooperation with local residents

Wakkanai City, blessed with favorable wind conditions, drew early attention from the private sector as a place suitable for wind power generation. In around 1998 (Heisei 10), when the first windmill was completed in the city, there were many potential power generation operators. Some local residents were concerned about the impact of wind power generation on local ecosystems and landscapes and launched a campaign against wind power generation.

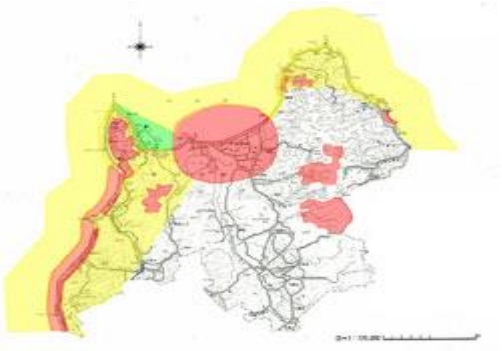

Figure 27 Map of Wakkanai City's Guidelines on Construction of Wind Power Generation Facilities (Red areas indicate areas where facility construction is difficult, yellow areas indicate areas where facility construction is not preferable, and green areas indicate areas where facility construction needs arrangements.)

In these circumstances, the city surveyed local residents' attitudes toward wind power generation and carefully discussed their pursuit of economic development and environmental protection through wind power generation, taking advantage of local geographical features. Based on the survey and these discussions, the city established guidelines on the construction of wind power generation facilities[3] in 2000 (Heisei 12). These guidelines require local authorities to share with local residents details on facility construction, and there have been no major protests.

Since the start of wind power generation, the Wakkanai Alternative and Renewable Energy Group has been involved in many local renewable energy projects, including fuel batteries, snow and ice energy, and the invitation of NEDO's[4] mega solar demonstration facility. This group, consisting of local authorities, businesses, and residents, is working to make Wakkanai a city with advanced renewable energy policies through the cooperation and collaboration of such diverse members.

○ Spillover effects on local economy and employment

As transmission capacity, the biggest factor in preventing the expansion of wind power generation, increases, the construction of a large-scale wind power plant is being considered. This plan is expected to bring short-term economic benefits, including construction works, and, after the start of plant operation, create job opportunities for maintenance and management staff. In the long run, the plan will increase municipal tax revenue and the number of people visiting or touring the power generation facilities.

○ Efforts to promote public understanding and save energy

The Wakkanai Alternative and Renewable Energy Group plays a leading role in working with local residents and promoting their understanding of new energy. The group holds seminars and other events to promote public understanding. It also manages and promotes footbaths using a fuel battery system installed with governmental subsidies. The city office is committed to promoting power-saving and energy-saving efforts and reducing its energy consumption in accordance with the global warming action plan (for administrative services and projects)[5].

Introduction of Project <<Eurus Souya Misaki Wind Farm>>

○ Largest wind power plant in Hokkaido

Souya Cape is located at the northern tip of Souya Hills, a vast periglacial area with one of the most favorable wind conditions in the country and surrounded on three sides by sea. Eurus Souya Misaki Wind Farm is Hokkaido's largest wind power plant, with a total output of 57,000 kW, and was completed in a 1,500-ha pasture of Souya Hills in November 2005 (Heisei 17). The plant can meet the power demand of 52,000 ordinary households, annually reducing 80,000 tons of CO_2 emissions. In the early days of its operation, the plant received many inquiries from local residents about bird strikes [6] due to its proximity to Onuma, so various measures were taken to keep wild birds away from the plant. Although wind power generation creates low-frequency noise[7] and other problems, this plant has not caused such problems because it is far from the urban district.

Table 20 General Information on Eurus Souya Misaki Wind Farm

Facility operator	Eurus Energy Souya Corporation
Location	Oaza Souya Village, Wakkanai City
Type and category	Wind power
Supplied energy	Power (eligible for the FIT program)
Scale	Large scale
Reduced CO_2 emissions	80,000 tons/year
Contact information	Eurus Energy Holdings Corporation 4-3-13 Tranomon, Minato-ku Tokyo Tel: 03-5404-5300

○ Facility overview and selling power

Fifty-seven 1,000 kW windmills with switchable output (250 kW in light wind conditions) stand in an area stretching 5 km from east to west and 3 km from north to south. Forty-seven of them are located in the Souya Misaki Farm (on city-owned land) while the rest are located on state-owned land. The operating company pays land rents to the city and national governments. The location of the windmills was determined so as not to affect the routes of migratory birds flying to Onuma or the nearby radars of the Self-Defense Forces. The windmills were manufactured by Mitsubishi Heavy Industries, Ltd.

Figure 28 Eurus Souya Misaki Wind Farm
(photo provided by Eurus Energy Holdings Corporation)

Generated power is sold to Hokkaido Electric Power Co., Inc. via a 40-km underground power line network. When the facility entered operation, the power company concluded a 20-year contract to purchase generated power, which is eligible for the FIT program.

○ Finances, profitability, and future challenges

Eurus Energy Souya Corporation has 10 employees, two of whom are local residents. The company contracts out some operations to local enterprises, contributing indirectly to job creation. This special purpose company, often deemed as a company not based in Hokkaido, is striving to maintain close communication with the city and local residents as its commitment to contribute to the local community.

The total construction cost of this wind power generation plant is about 12 billion yen, part of which was covered by subsidies supporting new energy business operators granted by the Ministry of Economy, Trade and Industry. As mentioned earlier, the plant operation is stable using the abundant wind resource.

Introduction of Project <<Wakkanai Mega Solar Power Plant>>

○ Northernmost mega solar power plant in Japan

The construction of the Wakkanai Mega Solar Power Plant started in 2006 (Heisei 18) as a NEDO demonstrative research facility (operated by Hokkaido Electric Power Co., Inc. and Wakkanai City). Since its gratuitous transfer to Wakkanai City in March 2011 (Heisei 23), the plant has been maintained and managed by the city. The plant is the core facility of the Wakkanai Next-Generation Energy Park initiative, certified by the Ministry of Economy, Trade and Industry and symbolizes the renewable energy of the city.

The plant has a power capacity of 4,990 kW and generated power of 4,732,512 kWh in FY2016 (Heisei 28). Its capacity factor is about 11%. It annually reduces about 3,000 tons of CO_2 emissions if the latest CO_2 emission factor (0.676 kg of CO_2/kWh for FY2015) released by Hokkaido Electric Power Co., Inc. is used for calculation.

Table 21 General Information on Wakkanai Mega Solar Power Plant

Facility operator	Wakkanai City
Location	Koeto, Wakkanai City
Type and category	Solar power
Supplied energy	Power (eligible for the FIT program)
Scale	Large scale
Reduced CO_2 emissions	3,000 tons/year
Contact information	Environment and Energy Division, Environment and Water Supply Department, Wakkanai City Office 3-13-15 Chuo, Wakkanai City

○ Facility overview and sale of power

About 28,500 solar cell panels are installed on the site, which is about 14 ha (about three times as large as Tokyo Dome). Since the plant used to be a research facility, the panels are made from various materials, such as single-crystal silicon, polycrystal silicon, amorphous silicon, chemical compounds, and multi-layered thin films. The panels are also different in manufacturers, inclinations, the types of platform. (* Most of the panels are made from polycrystal silicon.) Locally produced scallop shells are laid on the premises to reflect light for power generation.

The plant sells generated power under the FIT program and supplies some generated power to neighboring facilities of the city-operated Onuma Stadium and the prefecture-operated Souya Fureai Park as efforts to create a visual landmark for locally generated power to local residents and visitors.

○ Finances, profitability, and future challenges

Since the plant became eligible for the FIT program in FY2012 (Heisei 24), the FIT program has brought a huge profit to the plant as it annually reports sales of about 140 million yen, with an operating cost of 40 million yen. The plant also contributes to the local funds flow and job creation as it outsources maintenance and other operations to local companies.

On the other hand, the plant needs to deal with some future challenges, such as the possible subsidence of the panel platforms caused by the soft ground, and reprocurement of NAS batteries (which last about 15 years) used as storage batteries. For this reason, the potential of solar power plants is still under study.

Figure 29 Wakkanai Mega Solar Power Plant

JICA's use of the projects and cooperation

Wakkanai City is one of the most suitable places to visit for training programs concerning wind power generation.

In Hokkaido, it is possible to learn about the viewpoints of both the operator of the prefecture's largest wind power plant and the local government that formulated guidelines on the construction of wind power generation facilities, as it had done so before other local governments and has strived to maintain good communication with local residents. Since Wakkanai City plans to establish a model of the local consumption of locally produced renewable energy and construct large windmills in or after this fiscal year, the city is likely to continue its pioneering efforts to promote wind power generation.

Wakkanai City is an important partner in JICA's training programs to learn about various efforts and projects because the city is also carrying out other renewable energy projects, including solar power generation and biogas generation using food waste.

1 Certified by the Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry to promote the public understanding of future eco-friendly energy by increasing opportunities for the public to experience and understand next-generation energy sources, including new energy.

2 Local government plan to control local CO_2 emissions. The governments of prefectures, designated cities, core cities, and specially designated cities are obligated to formulate this plan.

3 The guidelines require the local authorities to zone the city for suitable facility construction, conduct a preliminary study on noise and possible impacts on animals, plants, and landscapes, and hold preliminary explanatory meetings for local residents and fishermen's and farmers' associations so that a consensus can be formed.

4 Abbreviation for the New Energy and Industrial Technology Development Organization

5 Local government plan to reduce CO_2 emissions from its administrative services and projects. All local governments are obligated to formulate this plan.

6 Collision of birds with blades or other equipment of wind power generation facilities. Raptors and other birds are often killed in collisions with blades of wind power generation facilities. These accidents hamper wildlife protection efforts and the promotion of wind power generation.

7 Low-frequency sound is very low sound generated by air vibration. Wind power generation facilities sometimes produce unwanted low-frequency sound because their structures change air movement.

[Case 3] Niseko Town, Hokkaido

○ Reducing CO_2 emissions by 86%

Known as Hokkaido's leading tourist destination, Niseko Town is one of a few communities in the prefecture with a growing population. The town established Japan's first basic autonomy ordinance "Niseko Town Machizukuri Basic Ordinance," a constitution for community development, with the goal to create a sense of pride among the residents living in the town. The town is also famous for its resident autonomy, following the two major principles of information sharing and resident participation. The town's key industries are tourism, taking advantage of abundant snow, and agriculture, making use of the natural surroundings, and has made efforts to protect the environment which provide these resources. The town was selected by the national government as an Eco Model City in March 2014 (Heisei 26) for its pioneering efforts to promote tourism and protect the environment at the same time.

Table 22 General Information on Niseko Town

Region	Central Hokkaido
Population	4,958 (2015 national census)
Area	197.13 km^2
Contact information	Eco Model City Promotion Section, Planning and Environment Division, Niseko Town Office 47 Aza Fujimi, Niseko-cho, Abuta-gun Tel: 0136-44-2121
○ Niseko Town Co_2 emissions reduction	
Target year	FY2050
Reduction target	Reduction by 86% (from FY1990)

Having "Environmental Creation City, Niseko" as the basic principle of the town's fifth comprehensive plan, it is taking action to tackle climate change and recycle local resources. Under the comprehensive plan, the town established a secondary basic environmental plan, global warming action plan (for local measures), and eco model city action plan[1]. The global warming action plan has a very ambitious target of reducing CO_2 emissions by 86% (from FY1990 (Heisei 2) levels) by FY2050.

○ Importance of renewable energy for the tourist resort of Niseko

Niseko Town's actions against climate change are characterized by its plan to globally promote itself as an international, eco-friendly resort town. To achieve this, the eco model city action plan prioritizes "energy saving and renewable energy in tourism," "grassroots efforts from homes," and "energy shift (renewable energy commercialization)."

In using renewable energy, the town emphasizes fully understanding local geographical characteristics. From 2003 (Heisei 15) to 2006 (Heisei 18), the town gathered information on various kinds of renewable energy as basic research, and conducted research on potential reserves and feasibility from 2010 (Heisei 22) to 2011 (Heisei 23). Based on the results of this research, the town is now focusing on use of renewable energy for heating.

○ Taking advantage of local geographical characteristics—geothermal heat and snow

Niseko Town is promoting the use of geothermal heat, in the form of geothermal heat pumps, and snow and ice cold, from the heavy snowfall, as renewable energy sources that make use of the local environment.

With the help of the experts involved in the potential reserves research and feasibility research, the town has introduced geothermal heat pumps into five public facilities so far. The town is making these efforts knowing that the geothermal temperature in Niseko is at a stable 11ºC throughout the year, slightly higher than that in other areas. Other projects using geothermal heat include a well-insulated plastic greenhouse project conducted by Niseko High School.

Snow and ice cold, which was found by the potential reserves research to be the renewable energy source with the highest usage potential, is used by two local facilities. A noteworthy feature of the town's use of snow and ice cold is that subsidies are granted to local residents for its usage. These subsidies cover one-third (up to two million yen) of the cost of using snow and ice cold. No other municipality in Hokkaido has such a program.

Figure 30 Micro-Hydroelectric Generator

Though on a small scale, there are also projects using other renewable energy sources, including a micro-hydroelectric power generation project using the abundant water resources and a solar power generation project using the abundant sunlight.

○ Spillover effects on local economy and employment

Geothermal heat pumps, which have been introduced into many places, do not create continuous employment opportunities, except for installation work. However, this installation work does not provide employment opportunities to locals because they cannot be performed by local businesses and are mostly performed by contractors outside the town.

○ Toward the 86% reduction target—local residents and businesses playing a leading role

Although the town government can show good examples of renewable energy use to local people through the potential reserves research and feasibility testing, it cannot achieve the 86% reduction target on its own. For this reason, the town government needs to further promote cooperation with local residents and businesses, including assistance to tourism businesses, large energy consumers, in their introduction of renewable energy. Niseko also has hydroelectric power producers that make use of the abundant local water resources. Such cooperation with local residents and businesses will become increasingly important.

Introduction of Project <<Niseko Town Community Center>>

○ Geothermal heat pump—use of geothermal heat, which is warm even in the cold winter

The Niseko Town Community Center is one of the five facilities into which the town has introduced geothermal heat pumps so far. The geothermal heat pumps replaced the heavy oil boilers in a large-scale improvement project conducted in FY2011 (Heisei 23). This project improved the center's insulation performance and introduced LED lights and other energy-saving lighting. The town also installed automatic sun-tracking solar panels (1.88 kW) on the roofs and carried out a test of solar power generation in heavy snowfall areas.

To promote locals' understanding and use of renewable energy, the town provides community center users with information on the center's use of renewable energy, the resulting CO_2 emissions, and the amount of solar power generated.

Table 23 General Information on Niseko Town Community Center

Facility operator	Niseko Town
Location	Aza Fujimi, Niseko Town
Type and category	Geothermal heat pump
Supplied energy	Heat
Scale	Medium scale
Reduced CO_2 emissions	Reduction by 50% from the level before an improvement project
Contact information	Eco Model City Promotion Section, Planning and Environment Division, Niseko Town Office 47 Aza Fujimi, Niseko-cho, Abuta-gun Tel: 0136-44-2121

The heat pumps reduced the center's CO_2 emissions by more than 50%, from 153 tons per square meter in 2010 (Heisei 22) (before the improvement project) to 70 tons per square meter in 2015 (Heisei 27) (after the project). (* Emissions per unit area are compared because the improvement project changed the size of the center by integrating other facilities into the center.)

○ Facility overview

There are thirty-one 80-m boreholes[2], which provide heating via nineteen 10-kW heat exchangers. As each borehole has a U-shaped tube inside, heat is absorbed or released through these tubes from under the ground, which allows the system to stay at stable temperatures throughout the year. While drilling one borehole costs about one million yen, boreholes are generally usable for about 80 years. On the other hand, heat exchangers need to be replaced every 15 years or so.

Figure 31 Heat Exchangers in the Community Center

○ Finances, profitability, and future challenges

State subsidies covered about 40% of the cost of the large-scale improvement project for the community center, including the cost of the heat pumps. Various subsidies were also used to introduce heat pumps into the four other local facilities. Although it is difficult to assess the economics of the community center because it does not earn money from its energy supply, expert analysis shows that it is possible to secure its profitability if financial assistance, such as subsidies, is available for the introduction of new equipment. The town office plans to continue the introduction of renewable energy, including geothermal heat pumps, into public facilities and other large facilities operated by the town.

Introduction of Project <<JA Youtei's Snow-Cooled Low-Temperature Rice Storage Facility>>

○ Snow cold—renewable energy in a town with heavy snowfall

This is the first snow-cooled rice storage facility in the Shiribeshi region. This facility takes advantage of the heavy local snowfall and consists of a rice storeroom and a snow storeroom. Cold water from stored snow is sent to heat exchangers, which cool the rice storeroom. (Cooling the rice storeroom directly with snow is not suitable for rice storage as this raises the humidity.)

The facility can store 1,300 tons of snow, with snow brought in every March and the remaining melt snow removed around September. Usually, half of the stored snow is left even after the summer season.

Table 24　General Information on JA Youtei's Snow-Cooled Rice Storage Facility

Facility operator	JA Youtei
Location	Aza Satomi, Niseko Town
Type and category	Snow cold
Supplied energy	Heat
Scale	Medium scale
Reduced CO_2 emissions	About 100 tons/year
Contact information	Agricultural Division, Agricultural Sales Department, JA Youtei 2-5-2 Higashi, Minami-1, Kucchan-cho, Abuta-gun Tel: 0136-21-2311

Some of the rice shipped from this facility is sold at Michinoeki rest areas and other places, labeled "rice stored with snow," and sales volumes have been increasing slightly. Although the added value of this rice is yet to be included in its prices, this sales activity can be positively seen as sixth-order industrialization[3] efforts. According to Niseko Town's trial calculation, the use of snow cold reduces more than 100 tons of CO_2 emissions per year.

○ Facility overview

Snow accumulated in the parking space of the facility is carried into the snow storeroom and used for cooling. For humidity control, snow cold is not used directly, but used via heat exchangers. In the Shiribeshi region, Kucchan Town and Rankoshi Town have power-cooled storage facilities, which adjust and optimize rice storage periods and shipment timings.

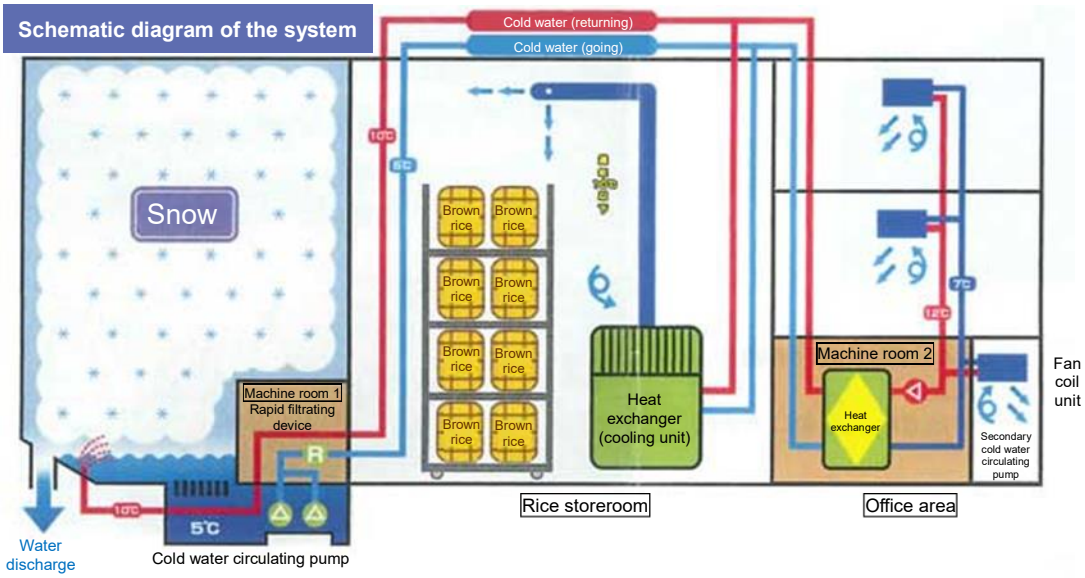

Figure 32　Schematic Diagram of the Snow Cooling System

(Source: Explanatory material about JA Youtei's low-temperature rice storage facility)

○ Finances, profitability, and future challenges

The total construction cost of the facility is 730 million yen, fully covered by state subsidies.

Constructing this kind of facility is very costly because it required an area double an ordinary power-cooled storage facility (for the snow storeroom). Although a snow-cooled storage facility has a lower running cost, it is not low enough to recover the construction cost. This facility aims to make effective use of local resources and reduce environmental loads rather than to reduce energy cost. The storage facility, outsourcing the work of carrying the snow in and out, creates as many employment opportunities as an ordinary power-cooled storage facility.

JICA's use of the project and cooperation

Niseko Town's policy-making process, which led to the introduction of heat pumps (from the basic research to the potential reserves research and feasibility research) should be very helpful in discussing the introduction of any kind of renewable energy.

The town actively accepts study tours. Niseko Resort Tourist Association Co., Ltd. provides opportunities to learn about environmental protection as "eduvacation" (education and vacation). This is a good example of harmony between environmental protection efforts and local tourism business, and will be instructive for JICA.

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1 Plan under which an Eco Model City selected by the national government sets a target for CO_2 emissions reduction and actions are taken to achieve the target

2 Holes made in the ground with a drilling machine. A heat exchanger is inserted into this drilled hole to obtain underground heat.

3 Term coined by agricultural economist Naraomi Imamura. It means a business style of a primary industry (agriculture and fisheries) business that also conducts business in the secondary industry (food processing) and the tertiary industry (distribution and sales). This synergy between businesses in the three industries is proposed as a way to revitalize rural areas and diversify farming business.

[Case 4] Takikawa City, Hokkaido

○ "City of Environment and Networking," where local residents, businesses, and authorities work together

Located roughly in the center of Hokkaido, Takikawa City is a major farming area between the Ishikari River and the Sorachi River. With a population of nearly 42,000, the city is an important transportation hub connecting Sapporo to Asahikawa and the starting point of the Nemuro Main Line, a railway line leading to Nemuro.

The Sorachi region, which includes Takikawa City, has met part of Japan's energy needs as a former coal mining area[1]. The city has been deeply associated with the energy industry as it used to have a coal-fired power plant. The city now has a food waste biogas power plant and facilities using solar power, wind power, and other renewable energy sources, and is recognized as a next-generation energy park.

Issuing the Takikawa City Eco-Friendly City Declaration in 2003 (Heisei 15), the city has made efforts to develop an eco-friendly community. In the year following the declaration, the city established the basic environmental ordinance. Formulating a basic environmental plan and regional action plan under the ordinance, the city has also taken action to protect the environment, including actions against climate change. The basic plan aims to promote environmental protection based on cooperation between local residents, businesses, and authorities, adopting the slogan of "Takikawa, City of Environment and Networking." Although the city has not formulated its global warming action plan (for local measures) and does not have a target for CO_2 emission reductions, it has made its own efforts to tackle climate change under the global warming action plan (for administrative services and projects).

Table 25 General Information on Takikawa City

Region	Central Hokkaido
Population	41,192 (2015 national census)
Area	115.90 km^2
Contact information	Life Support Division, Civic Life Department, Takikawa City Office 1-2-15 Omachi, Takikawa-shi Tel: 0125-28-8013
○ Takikawa City CO_2 emissions reduction	
Target year	-
Reduction target	-

○ Food waste, waste oil, and agricultural residues—renewable energy efforts supported by local residents

Figure 33　Recyclean

Recyclean, of the Nakasorachi Sanitary Facility Association, represents the city's renewable energy projects, and uses biogas[2] to generate power and supply heat. An increasing public interest in dioxin[3] reduction prompted extensive waste disposal to promote effective use and recycling of resources. In these circumstances, this facility was opened in 2003 (Heisei 15) as a food waste disposal facility for the Nakasorachi region (for the three cities and two towns of Takikawa City, Akabira City, Ashibetsu City, Shintotsukawa Town, and Uryu Town). It is Japan's first biogas power generation facility which uses domestic food waste. Through explanatory meetings held before the facility's opening and continuous efforts to promote public awareness, the city has called for public support for proper separation and sorting of food waste (later described in more detail).

In 2006 (Heisei 18), the city formulated the Biomass Town Plan, under which the city produces BDF[4] from rapeseed oil, and the Takikawa Tempura Oil Fuel Project, which uses tempura oil collected from local residents as fuel. The city is also making efforts unique to farming areas, such as the utilization of unused agricultural resources; in 2016 (Heisei 28), a joint study was conducted with private businesses on a small-scale, decentralized heat use system using rice hulls in order to make effective use of the agricultural waste.
Although these efforts and projects do not introduce a renewable energy source to promote actions against climate change, they are good examples of cooperation between local residents and the effective use of local strengths and resources.

○ Spillover effects on local economy and employment

Introduction of renewable energy has not directly created jobs so far. Since Takikawa City, a major farming area, has the potential to create a new energy industry through the innovation of technology which utilize agricultural waste, it will make continued efforts to actively promote the introduction of renewable energy from the viewpoint of industrial promotion and community revitalization.

○ Building environmental communities

Takikawa City focuses on building environmental communities to promote support from local residents and businesses in the collection of food waste and waste oil. Building environmental communities is one of the basic goals of the basic environmental plan. Through the environmental protection activities of "Eco-Life Takikawa" (or "Eco Taki"), the city is working to increase participation by local residents in environmental protection efforts and to expand such efforts. The city's environmental education is unique, as students from three local high schools formed volunteer teams named "Eco Club!" and act as leaders providing local children with opportunities to learn about the environment. The city considers the next-generation energy park as one of the fields for such activities, and is working to expand the network of environmental protection efforts from energy saving to introduction of new energy as part of global environmental protection efforts that meet local needs.

Figure 34 "Eco Taki" Promotional Mascots

(* Created by the art club of Hokkaido Takikawa Nishi High School)

Introduction of Project <<Regional Waste Disposal Facility "Recyclean">>

○ Recyclean, Japan's first biogas power generation facility using domestic food waste

Three cities and two towns of the Nakasorachi region (Takikawa City, Ashibetsu City, Akabira City, Shintotsukawa Town, and Uryu Town) started studying biogas production, a new technology, in order to build a regional waste disposal facility. With expectations for collection and on-site use of electricity and heat energy, the facility started operation in 2003 (Heisei 15) as Japan's first biogas power generation facility using domestic food waste.

Table 26 General Information on Recyclean

Facility operator	Nakasorachi Sanitary Facility Association
Location	Higashi-Takikawa, Takikawa City
Type	Food waste (methane fermentation)
Category	Waste biomass
Supplied energy	Electricity and heat
Scale	Medium to large scale
Reduced CO_2 emissions	-
Contact information	Nakasorachi Sanitary Facility Association 760-1 Higashi-Takikawa, Takikawa-shi Tel: 0125-75-3801

Although the facility is designed to be able to dispose of up to 55 tons of food waste per day, it accepts only 18 tons of food waste per day in recent years. While this is affected by a population decrease, this disposed amount being smaller than originally expected is mainly attributable to reduced waste discharge, caused by paid services for food waste collection (charged according to the weight of waste discharged), which was introduced when the city's food waste collection system was established. Since the actual disposed amount is well below the planned disposal capacity, the amounts of generated power and supplied heat, which use biogas made from the food waste, are smaller than originally planned. Also, thorough separation and sorting of waste and charged waste collection have also reduced other types of waste as indirect impacts. This project can therefore be positively evaluated from the viewpoint of creating a recycling society and reducing waste discharge.

In the process of building the facility, the city worked to maintain good communication with local residents through explanatory meetings, which took place at 400 sites in the city and attracted 13,700 residents (about one-third of the city's population). A report says that more than 95% of households properly separated and sorted their food waste, even immediately after the facility was opened. Improper waste discharge is still very rare.

○ Facility overview and supply of heat and power

Food waste discharged from households and businesses is fermented by the methane fermentation system of the facility, and the methane gas is collected. The sludge generated from the fermentation tanks, in addition to the methane gas, is dried and matured to be sold as compost.

Methane gas is used for heat supply by on-site gas boilers or for power generation by five 80-kW power generators. These power generators are dual-gas power generators, which combust methane gas with light oil (2 L/hour) for stable power generation.

Figure 35 Biogas Power Generators

The facility generated about 1,100 MWh of electricity in FY2016 (Heisei 28). The facility consumes almost all of the electricity it generates, but the generated electricity covers only half of its total electricity consumption (the electricity for the remaining half is purchased from Hokkaido Electric Power). All heat produced is used for on-site heating, air conditioning, and road heating.

The facility's power generators are dual-gas power generators, which combust methane with light oil. Although not all of the generated electricity comes from biogas, the biogas-derived electricity and heat contribute to reduced CO_2 emissions.

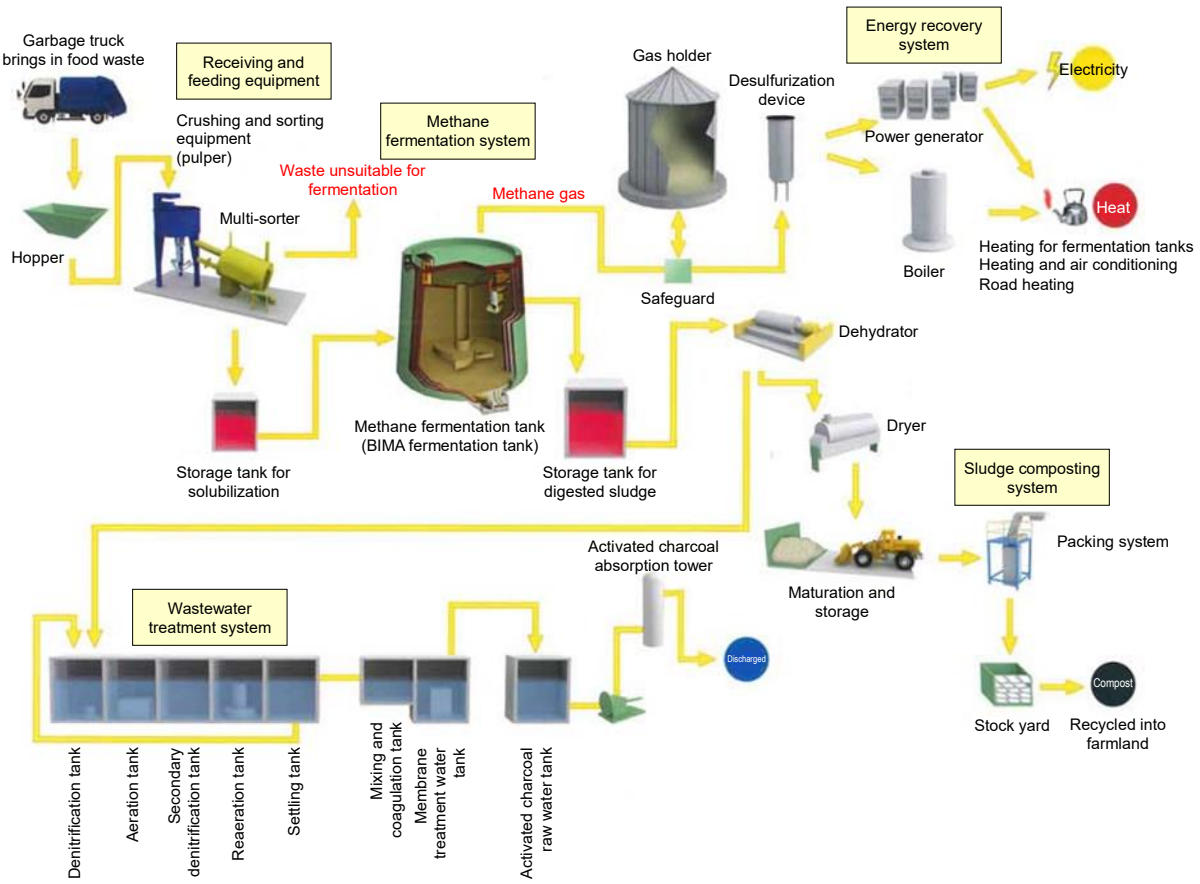


Figure 36 Schematic Diagram of the System of High-Speed Methane Fermentative Treatment Facility

(Source: Brochure of regional waste disposal facility Recyclean)

○ Finances, profitability, and future challenges

The total construction cost of the facility is about 1,720 million yen. This cost was partly covered by subsidies from the Ministry of the Environment and mostly by issued bonds. The general revenue source spent on this project is about 120 million yen. Biogas covers nearly half of the facility's power demand and most of its heat demand, reducing its operating cost.

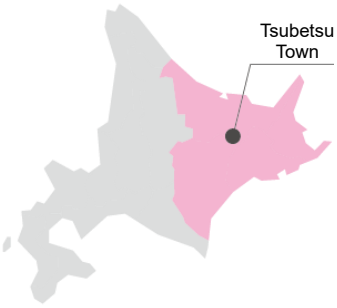
Although many local residents understand the importance of waste separation and sorting, the city needs to continuously call for thorough efforts because other waste is still mixed in the food waste.

JICA's use of the project and cooperation

One of the environmental challenges faced by many developing countries is waste. The project in Takikawa City, a renewable energy project using waste as a resource, is likely to provide an opportunity to learn about waste disposal systems and solutions to daily environmental and sanitary problems, as well as actions against climate change. In addition, the city is making many advanced efforts to promote public understanding and participation, including the creation of environmental communities and environmental education involving students. For these reasons, the city should be a suitable partner in JICA's training programs concerning environmental education and public consensus building.

1 The area used to benefit from coal production.
2 A kind of biofuel generated from the fermentation or anaerobic digestion of excreta from living beings, organic fertilizer, biodegradable substances, sludge, wastewater, waste, energy crops, etc.
3 Artificial chemical compound generated mainly in the incineration process of waste. This substance is said to be highly carcinogenic and teratogenic.
4 Fuel for diesel engines made from plant-derived oil (rapeseed oil and sunflower oil) or waste cooking oil (such as tempura oil).

[Case 5] Tsubetsu Town, Hokkaido



○ A forest-loving town

Tsubetsu Town, 86% of which area is covered by forests, is founded on the agriculture, forestry, and forest products industries. Officially announcing its determination to become a "forest-loving town" in 1982 (Showa 57), the first of its kind in Japan. The town has since made forest-oriented community development efforts.

As the only Forest Therapy Base[1] in Hokkaido, the town uses local forests as an important tourism resource. While the use of woody biomass energy has been promoted in recent years, local authorities and businesses, from manufacturing to tourism and energy, are making their own efforts and working together to conserve and use forests as a local resource.

The town clarified its policy of using woody biomass in the biomass town plan formulated in 2007 (Heisei 19). This plan includes the production of wood pellets, introduction of pellet boilers, and other goals, which have since been achieved. In these circumstances, the town formulated its basic environmental plan in 2014 (Heisei 26), showing its commitment to the introduction and use of regional renewable energy as one of its four basic goals. In its model area creation plan[2], the town also showed its commitment to creating a low-carbon society by promoting the introduction and use of renewable energy, aiming to reduce 2,400 tons of CO_2 from FY2013 (Heisei 25) levels by FY2020.

Table 27 General Information on Tsubetsu Town

Region	Eastern Hokkaido
Population	4,856 (as of November 2017)
Area	716.80 km^2
Contact information	Forest Policy Planning and Renewable Energy Promotion Group, Industrial Promotion Division, Tsubetsu Town Office 41 Aza Saiwai-machi, Tsubestu-cho, Abashiri-gun Tel: 0152-76-2151
○ Tsubetsu Town CO_2 emissions reduction	
Target year	FY2020
Reduction target	Reduction of 2,400 tons (from FY2013)

○ Use of forest resources based on cooperation between local authorities and businesses

In 2007 (Heisei 19), the Tsubetsu Veneer Cooperative started operating a biomass energy center. This center supplies electricity and heat consumed by the company with the use of wood waste and other materials that used to be disposed of as industrial waste, achieving cost reductions (the cost of industrial waste disposal and the cost of energy purchase). The center has also significantly reduced CO_2 emissions as a result of its reduced consumption of fossil fuel (later described in more detail).

A wood pellet production facility was constructed by the town in FY2009 (Heisei 21) and has been operated by the Tsubetsu Town Pellet Cooperative as the designated administrator since then. The cooperative, whose members include foresters, trucking companies, processors, and other business operators in various fields, has a system for promoting the use of local forest resources with such members from upstream processes (suppliers) to downstream processes (users). The town office also plays the role of a user by actively introducing wood pellet boilers into public facilities, indirectly helping the cooperative's production activities. Currently, five local public and private facilities (such as the town office, an accredited children center, and the Nishi-machi Housing Complex) have introduced wood pellet boilers, annually consuming about 600 tons of wood pellets these few years, a little more than half of the cooperative's annual production.

Figure 37 Pellet Production Facility

In 2011 (Heisei 23), the Tsubetsu Town Council for Promoting Use of Forest Biomass was established as a public-private partnership. This organization is discussing a plan to use woody biomass for power and heat sources, as well as other activities with the aim of promoting further use of unused wood left in the woodlands.

○ Spillover effects on local economy and employment

The wood pellet production facility has provided employment opportunities to two local people. It has also enabled the local consumption of locally produced and processed wood, which has recovered a large portion of the money flowing out of the town, which is used for energy purchase. The economic benefits brought to the community by the local circulation of resources and money can be considered as the spillover effects of the facility.

○ Efforts to conserve forest resources

Tsubetsu Town pools donations from Marutama Plywood Co. into the Marutama Plywood Forest Development Fund. Using this fund and its revenue, the town provides financial assistance to the development and management of privately owned forests. This means that the town office provides assistance not only to woody biomass users, but also assistance to suppliers.

The town is also promoting sustainable forest management. About 90% of the town's forests have obtained SGEC certification[3]. In FY2015 (Heisei 27), the town started providing financial assistance for part of certification costs in order to promote certified wood. Other efforts of the town to tackle climate change include selling the amount of CO_2 absorbed by local forests as offset credits; the town annually sells about 700 CO_2-equivalent tons of offset credits.

Introduction of Project <<Biomass Energy Center of Tsubetsu Veneer Cooperative>>

○ Using waste discharged by plants to generate energy for powering them

The Tsubetsu Veneer Cooperative is an association led by Marutama Plywood Co., whose members include the Hokkaido Prefecture Federation of Forestry Cooperatives, Akan Mokuzai Co., and other foresters. This cooperative, which annually produces about 183,000 m^3 of veneer for plywood from about 300,000 m^3 of logs, established the Biomass Energy Center in 2007 (Heisei 19) to use wood waste generated from the production process for cogeneration[4] as a way to make effective use of such wood waste as a resource.

The generated heat and power are both normally used by the cooperative's plants, but part of the generated power has also been sold to Hokkaido Electric Power under the FIT program since FY2013 (Heisei 25). In FY2007 (Heisei 19), the center reduced its consumption of fossil fuel equivalent to 24,000 kL of crude oil per year and 69,000 tons of its CO_2 emissions per year.

Table 28 General Information on Biomass Energy Center

Facility operator	Tsubetsu Veneer Cooperative
Location	Aza Tatsumi, Tsubetsu Town
Type	Mainly wood waste
Category	Woody biomass
Supplied energy	Heat and power (partially sold under the FIT program)
Scale	Large scale
Reduced CO_2 emissions	69,000 tons/year
Contact information	Tsubetsu Veneer Cooperative's Biomass Energy Center 167 Aza Tatsumi, Tsubetsu-cho Tel: 0152-75-5101

○ Facility overview and use of heat and power

All veneers produced by the cooperative are made of wood produced in the prefecture. As fuel, the cooperative mainly uses wood waste generated from veneer production, but also uses local unused wood, which is crushed into wood chips.

The cooperative has a heat-power cogeneration system consisting of a wood chip boiler and a 4,700-kW steam turbine power generator. Since a large amount of heat is used in the veneer drying process, 90% of the generated energy is used as a heat source, while the remaining 10% is used as a power source.

Figure 38 Plants of the Tsubetsu Veneer Cooperative

○ Finances, profitability, and future challenges

The center has created more than 10 full-time jobs for local residents. In addition, the center is considered to have contributed indirectly to job creation as the plant needs to be maintained and managed, and orders also go out to the local ironworks.

State and prefectural subsidies covered about one-third of the center's construction costs. Since the center has made it unnecessary to purchase electricity, it is estimated to have reduced operating costs by about 150 million yen per year.

Since FY2008 (Heisei 20), the power generated by the center has been a green energy certificate[5] product and its environmental added value has been sold to large enterprises and other buyers.

JICA's use of the project and cooperation

This project is an example of cooperative and complementary relations between local authorities and businesses in the conservation and use of forest resources. Tsubetsu Town should be a suitable partner that provides opportunities to learn about the potential roles of various players and their possible cooperation in using local resources. Since the town is actively promoting tourism using abundant forests and nature, JICA can work with them in its training programs concerning tourism and eco-tourism.

In principle, the Biomass Energy Center does not provide study tours because it cannot secure visitors' safety due to the lack of routes for tours or the ability deal with many visitors due to a manpower shortage.

1 Area of forests whose relaxing effects are verified by experts in terms of forestry medicine and whose natural and social conditions, including related facilities, meet certain levels. These areas are certified by Forest Therapy Society, a specified non-profit organization.
2 Plan formulated by Tsubetsu Town after the town was chosen as a model area of the Ministry of the Environment's project of formulating plans to create "low-carbon, recycling-oriented, and nature-harmonious" areas.
3 Certification granted to forests under sustainable management that meets international standards. This certification encourages forest owners and administrators to improve their forest management levels and forest development.
4 General term for systems of producing and supplying both power and heat from a heat source.
5 Tradable certificate of the environmental added value of power generated from renewable energy.

[Case 6] Mori Town, Hokkaido

○ Pioneer in use of hot spring heat

Located in the Oshima Peninsula in Southern Hokkaido, Mori Town has a population of about 16,000. In 2005 (Heisei 17), former Sawara Town and former Mori Town merged into current Mori Town, which is founded on agriculture, fisheries, and marine product processing. With an annual average temperature of 7°C to 8°C, the town is one of the warmest municipalities in Hokkaido and has produced rice for a long time. The town also has many horticultural and livestock farmers.

The Nigorikawa district in the north-western area of the town, where hot springs were discovered in the Edo period, is blessed with abundant geothermal energy. Located in a caldera[1] basin 10 km in circumference, this district produces rice and vegetables. Its vegetable cultivation uses hot spring heat and geothermal water. The district is a pioneer in the use of geothermal energy with the Mori Geothermal Power Plant, the eighth geothermal power plant in Japan and the first in Hokkaido.

In 2007 (Heisei 19), the town formulated the first comprehensive development promotion plan, which aimed to protect "nature and the environment for a comfortable town" and secure "infrastructure and safety for a safe town" as two of six priority goals of town development. To achieve these goals, the town decided to introduce new energy to address energy problems and climate change, establishing the Mori Town New Energy Vision as a concrete plan to introduce new energy in FY2014 (Heisei 26). While still working to formulate its global warming action plan (for local measures), the town has decided to set a CO_2 emissions reduction target for the entire town. On the other hand, the town has formulated its global warming action plan (for administrative services and projects) and is making efforts to reduce CO_2 emissions from public facilities.

Table 29 General Information on Mori Town

Region	Southern Hokkaido
Population	15,919 (as of October 2017)
Area	368.79 km^2
Contact information	Planning and Promotion Division, Mori Town Office 144-1, Aza Miyuki-cho, Mori-machi, Kayabe-gun Tel: 01374-7-1283
○ Mori Town CO_2 emissions reduction	
Target year	-
Reduction target	-

○ Vegetable cultivation using hot spring heat and geothermal water

The most notable renewable energies that the town has been utilizing for a long time are hot spring heat and geothermal water in the Nigorikawa district. The town started to experiment with using hot spring heat for cultivating vegetables and other crops in the late Meiji period, but its full-scale use did not begin until government expenses were spent on their use in the national project of special measures to switch from rice cultivation[2] in 1970 (Showa 45).

(1) Use of hot spring heat by individual farmers

Out of 55 farmers in the district, 31 farmers have currently dug their own hot springs. About 650 greenhouses are heated by hot spring water drawn directly from the hot springs. Mori Town was the first in Hokkaido to use hot spring heat for greenhouses.

(2) Development and use of heat supply system using geothermal water

After Hokkaido Electric Power Co., Inc. decided to build the Mori Geothermal Power Plant in 1974 (Showa 49), Mori Town studied the use of geothermal water, a secondary product of the geothermal power plant. The town now uses geothermal water to supply heat to 16 local farmers who do not own their own hot springs.

Figure 39 Heat Exchanger

Heat is exchanged between 120°C geothermal water and river water, and the river water, heated to around 65°C, is piped to the 97 greenhouses of the 16 farmers for heating. Heat exchangers and pipes to the greenhouses are owned by the town, while the farmers are responsible for their maintenance and management. Their installation costs (1,130 million yen) were shared between the government, the town, and the farmers while the farmers are responsible for their annual operating costs (about 10 million yen), as well as their maintenance and management. (This annual operating cost includes power rates for circulating pumps and the cost of removing silica scale[3] forming inside heat exchangers and pipes. The farmers do not need to pay for their heat use.) Geothermal water is provided by the power company without compensation. The power company concluded an agreement with the town to supply geothermal water at a maximum rate of 220 tons/hour without compensation.

Figure 40 Pipes for Heated Water in a Greenhouse

This use of geothermal water has been promoted with the cooperation of local businesses and authorities, as well as local farmers. The geothermal development project liaison council organized by the town provides gathering opportunities for local farmers, businesses, and authorities to help them maintain good communication with each other.

○ Spillover effects on local economy and employment

Vegetable production in the Nigorikawa district accounts for a large portion of the town's agricultural output because hot spring heat and geothermal water enable the district to produce vegetables throughout the year. Among the vegetables produced in the district, tomatoes contribute greatly to local agriculture, as they are the best-selling crop in the town.

In an effort to promote further use of geothermal water, the town increased the number of pipes and replaced heat exchangers in FY2016 (Heisei 28) to expand the area of heated greenhouses by 20%.

○ **Beyond geothermal energy—finding the potential reserves of renewable energy and promoting public understanding of renewable energy**

In the process of formulating the New Energy Vision, the town analyzed in detail potential local reserves of renewable energy. Based on the analysis results and the results of residents' surveys, the town is studying use of woody biomass mainly as heat sources.

The town is also conducting feasibility experiments of micro-hydroelectric power generation to promote public understanding of renewable energy.

Introduction of Project <<Mori Geothermal Power Plant of Hokkaido Electric Power Co., Inc.>>

○ **Hokkaido's first geothermal power plant**

The potential of geothermal energy in the Nigorikawa district already attracted attention before Japan Metals & Chemicals Co., Ltd. conducted a full-scale development study in 1972 (Showa 47). In 1977 (Showa 52), Southern Hokkaido Geothermal Energy Co., Ltd. which took over business operations from Japan Metals & Chemicals, started geothermal development with Hokkaido Electric Power. In November 1982 (Showa 57), the Mori Geothermal Power Plant started operations.

One notable characteristic of the geothermal power plant is its proximity to private houses; there are 110 farming households near the plant. Although production wells, which emit steam, are located in the center of the district, the plant is on a hill about 1 km away from the wells due to hydrogen sulfide[4] contained in the steam and other environmental problems.

Table 30 General Information on Mori Geothermal Power Plant

Facility operator	Hokkaido Electric Power Co., Inc.
Location	Aza Nigorikawa, Mori Town, Kayabe County
Type	Hot spring heat (steam)
Category	Geothermal energy
Supplied energy	Power
Scale	Large scale
Reduced CO_2 emissions	-
Contact information	Thermal Power Planning Group, Thermal Power Department, Power Generation Headquarters, Hokkaido Electric Power Co., Inc. 1-2 Odori-higashi, Chuo-ku, Sapporo-shi Tel: 011-251-4506

The geothermal energy used by the plant is obtained through the production wells in the form of high-temperature steam and hot water. This steam is the only thing used to drive the turbines for power generation. Hot water, a secondary product, is generated at a rate of 1,500 tons per hour. This large quantity of hot water is partially used as heat sources for greenhouses as agreed between local authorities and residents through discussions when the plant construction. (Up to 220 tons of hot water can be used per hour because returning hot water into injection wells may deposit molten materials and cause other problems if the quantity of heat decreases too much).

The rated output of the plant is 25,000 kW, which accounts for only 0.3% of the total output (by power generation equipment) of Hokkaido Electric Power. Nevertheless, geothermal power generation can be considered as a low-carbon base-load power source[5] because it emits a much smaller amount of CO_2 than thermal power generation or other conventional power generation, and can provide stable power generation 24 hours a day.

○ Facility overview

The steam used for power generation comes from ten production wells at a depth of 500 to 3,000 m below ground. Only this steam is sent to the 25,000-kW steam turbines for power generation, while hot water is returned underground through nine injection wells.

○ Finances, profitability, and future challenges

Group companies of Hokkaido Electric Power, the plant operator, the steam production department, and other related organizations have provided employment opportunities to about 30 local people as staff necessary for plant operation. Whether the plant can continue its operation depends on the stable availability of steam. For this purpose, it is necessary to secure a certain amount of steam and the stable return of hot water into the ground and important to maintain and manage the wells. The plant properly maintains the existing wells so they can be used for a long time, as digging new wells has become costly due to the necessity to dig deeper.

Placing emphasis on relationships between local residents and authorities, the plant monitors groundwater levels with observation wells and shares the results as part of its community contribution efforts.

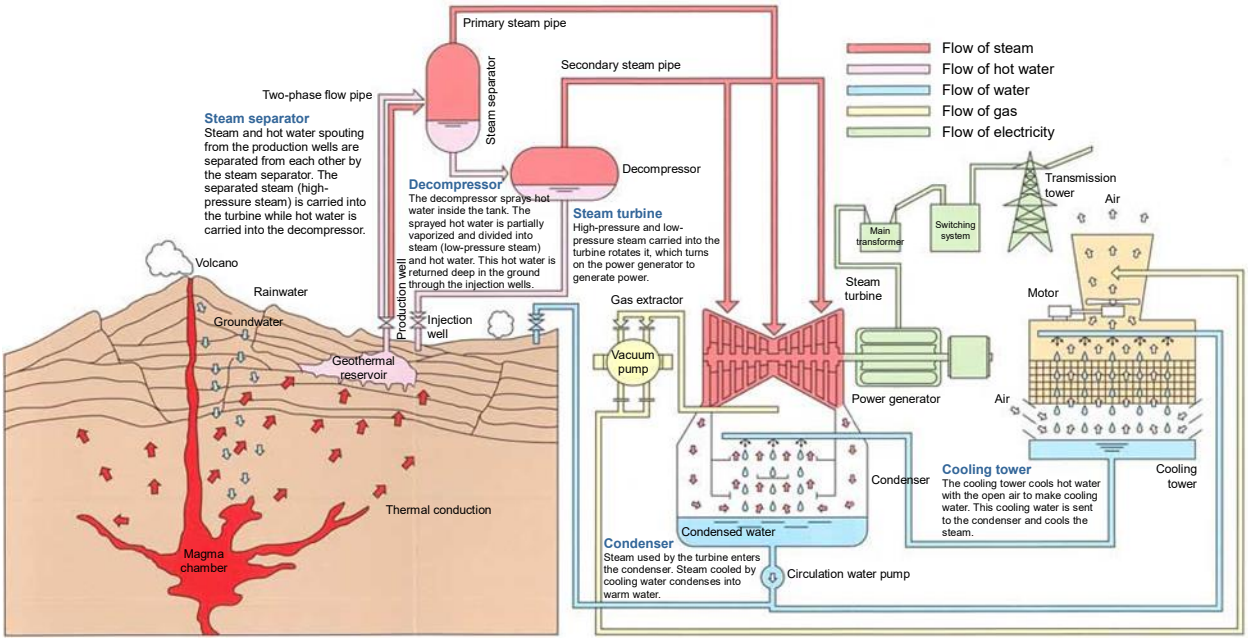


Figure 41　Power Generation System of the Mori Geothermal Power Plant

(Source: Brochure of the Mori Geothermal Power Plant)

JICA's use of the projects and cooperation

Conducting pioneering geothermal projects in the prefecture, Mori Town is a suitable partner in JICA's training programs concerning geothermal power generation and use of geothermal water. In particular, the project using geothermal water to supply heat to greenhouses seems to be very instructive for trainees from developing countries because the project uses a simple maintenance and management system.

Since the construction of the Mori Geothermal Power Plant, unique for its proximity to private houses, local businesses, residents, and authorities have discussed how to use hot water, a secondary product of power generation, and how to protect local farming and the local environment. The processes of such communication and consensus building should also be very useful.

1 Large hollow created by volcanic activities. The caldera in Mori Town is called the Nigorikawa Caldera, a very small caldera with a diameter of about 2 km.

2 Project conducted as part of the national policy to reduce rice acreage and adjust rice production.

3 Silica (silicon dioxide [SiO_2]) forming inside pipes. Such silica is very hard and does not dissolve easily into water.

4 Colorless gas with a rotten egg odor. The chemical formula of this gas is H_2S. It is poisonous and irritates the eyes, skin, and mucous membranes and defined as one of the specified offensive odorous substances by the Offensive Odor Control Act.

5 Power source that can provide a stable supply of a certain amount of power. Base-load power sources include nuclear power generation, coal-fired thermal power generation, hydroelectric power generation, and geothermal power generation.

[Case 7] Shikaoi Town, Hokkaido

○ Town of agriculture and tourism

Located at the southern foot of Daisetsuzan National Park and in the north-west area of the Tokachi region, Shikaoi Town has a population of about 5,500. As a place suitable for stock and crop farming, the town has many dairy and crop farmers. Blessed with rich natural resources, such as the mountains of the Daisetsu mountain system and Lake Shikaribetsu, the town also focuses on tourism.

Treatment of animal waste has long been a major challenge for the town's key industry of agriculture. While local dairy farmers sometimes sprinkle slurry[1] on their pastures as a valuable fertilizer, its smell has prompted urban residents to demand better treatment of animal waste, as the town's urban districts are relatively close to dairy farming areas. For this reason, the town has built biogas plants that use animal waste to improve the local natural and living environment and make effective use of livestock biomass resources.

Under the slogan of "developing economy and promoting well-being" in its comprehensive plan, the town has promoted the creation of an eco-friendly, recycling-oriented living environment using the abundant, local biomass. In February 2009 (Heisei 21), the town established the Shikaoi Town New Energy Vision to promote further introduction of renewable energy. In this vision, the town is committed to introducing new energy sources equivalent to 1,000 kL of crude oil per year by FY2018 (Heisei 30) such as woody biomass, snow and ice cold, and solar power as well as livestock biomass. The town also aims to reduce 2,600 tons of CO_2 per year by introducing these energy sources.

Table 31 General Information on Shikaoi Town

Region	Eastern Hokkaido
Population	5,542 (2015 national census)
Area	404.70 km^2
Contact information	Environmental Preservation Center Section, Agricultural Promotion Division, Shikaoi Town Office 4-5 Shikaoi-kita, Shikaoi-cho, Kato-gun Tel: 0156-66-4111
○ Shikaoi Town CO_2 emissions reduction	
Target year	FY2018
Reduction target	2,600 tons

○ Making methane, hydrogen, and mangoes from cattle

The Shikaoi Town Environmental Preservation Center is the local center of livestock biomass use. The town built its first biogas plant (with a planned waste treatment capacity of 94.8 tons/day provided by one 100-kW power generator and one 190-kW power generator) in the suburbs of its urban districts (the Naka-Shikaoi district) in October 2007 (Heisei 19) and started operating its second biogas plant (with a planned waste treatment capacity of 210 tons/day provided by four 250-kW power generators) in the Urimaku district in 2016 (Heisei 28). These two plants treat about 30% of the total animal waste discharged from local dairy farmers. The plants generate power by combusting biogas, and also effectively use the heat produced from the power generation process. The Naka-Shikaoi district raises sturgeons, cultivates mangoes in greenhouses, and develops other local specialties to revitalize the local community and create jobs (later described in more detail).

In January 2017 (Heisei 29), the Shikaoi Hydrogen Farm, a facility purifying and utilizing hydrogen with biogas supplied by the biogas plant (Naka-Shikaoi), was opened on the premises of the biogas plant. This project, conducted by private enterprises (Air Water Inc. and three others) at the request of the Ministry of the Environment, is Japan's first project for producing, storing, transporting, and using hydrogen in one place by using livestock biomass.

Figure 42 Hydrogen Station of the Shikaoi Hydrogen Farm

The facility monthly produces about 6,000 to 7,000 Nm^3 of hydrogen, which is supplied to fuel cell vehicles and forklifts at the hydrogen station of the Environmental Preservation Center (Naka-Shikaoi). Hydrogen is also supplied to fuel cells used by the Environmental Preservation Center (Naka-Shikaoi), local dairy farmers, and Tokachimura, a food mall of the Obihiro Racecourse for power generation and supply of hot water. In this way, the facility demonstrates various local uses of hydrogen, in addition to producing and transporting hydrogen.

○ Pioneer in use of biogas

The town has about 30,000 heads of dairy and beef cattle, which provide an enormous amount of livestock biomass. Taking advantage of this livestock biomass, the town joined the Tokachi Biomass Industrial City[2] initiative with 19 other municipalities in the Tokachi region in 2013 (Heisei 25), and plans to promote further use of biogas to create a recycling-oriented, low-carbon society.

Figure 43 Shikaoi Town Environmental Preservation Center (Naka-Shikaoi)

The town provides local elementary, junior high, and high school students with an environmental education program named "new earth study," which deals with abundant local natural resources, global environment problems, ESD[3], and other issues. The Environmental Preservation Center is part of the program. These learning opportunities have helped not only local students, but also local adults understand the town's efforts to create a recycling-oriented society and tackle climate change, encouraging the local community to accept many school trips and corporate training tours from outside the town.

Introduction of Project <<Shikaoi Town Environmental Preservation Center>>

○ Biogas plant originating from odor control measures

The Shikaoi Town Environmental Preservation Center (Naka-Shikaoi) accepts animal and food waste and produces biogas through anaerobic fermentation[4] at the biogas plant.

To build this center, the town formed a preparatory committee and discussed with local dairy farmers for seven to eight years to obtain their consent on the construction of the plant. The center is now used by 11 dairy farmers, and treats their animal waste at 12,340 yen per head. The center is not directly operated by the town, but operated by the Shikaoi Town Biogas Plant Users' Association, which was formed by local dairy farmers and the town.

Biogas is used as power and heat sources. Part of the generated power is sold under the FIT program and the rest consumed by the center itself. While by-products (digestive juice used as liquid fertilizer) often become a problem for such livestock biomass treatment facilities, the town has secured sufficient demand from local farmers for these secondary products, promoting the local recycling of resources.

Table 32 General Information on the Shikaoi Town Environmental Preservation Center

Facility operator	Shikaoi Town * Operated by a users' association formed by local dairy farmers and the town
Location	Shikaoi, Shikaoi Town
Type	Animal waste
Category	Livestock biomass
Supplied energy	Heat and power (eligible for the FIT program)
Scale	Medium scale
Reduced CO_2 emissions	1,500 tons/year
Contact information	Environmental Preservation Center Section, Agricultural Promotion Division, Shikaoi Town Office 4-5 Shikaoi-kita, Shikaoi-cho, Kato-gun Tel: 0156-66-4111

The center annually reduces about 1,500 tons of CO_2 emissions (based on the amounts of power and heat generated with biogas in 2014 (Heisei 26)).

○ Facility overview and heat and power supply

The center accepts both slurry and solid animal waste, but uses only slurry for biogas production. Solid animal waste is treated by aerobic fermentation[5] at the center's composting plant for sewage sludge and composting plant for animal and food waste. The center also accepts sewage sludge and food waste.

Slurry is treated by anaerobic fermentation (mesophilic fermentation at 38°C) and the generated biogas is recovered. Methane gas contained in the biogas is used for power generation and heat supply. The center generates about 6,000 kWh of electricity per day. Part of biogas is purified and compressed to fill gas cylinders; this biogas substitutes the propane gas used by the town office, other facilities, and biogas vehicles. The center also supplies 13,500 Mcal of heat per day. This heat is used to heat fermentation tanks and raw material tanks, as well as cultivate mangoes and raise sturgeons.

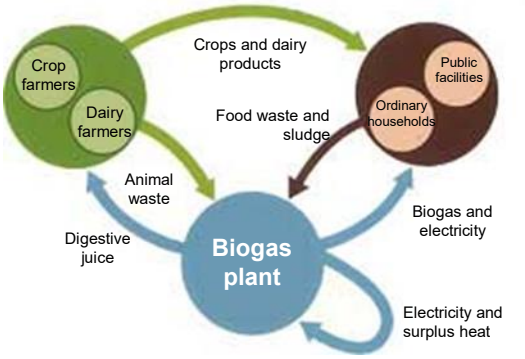


Figure 44 Flow Chart of Circulation with the Biogas Plant at Its Core

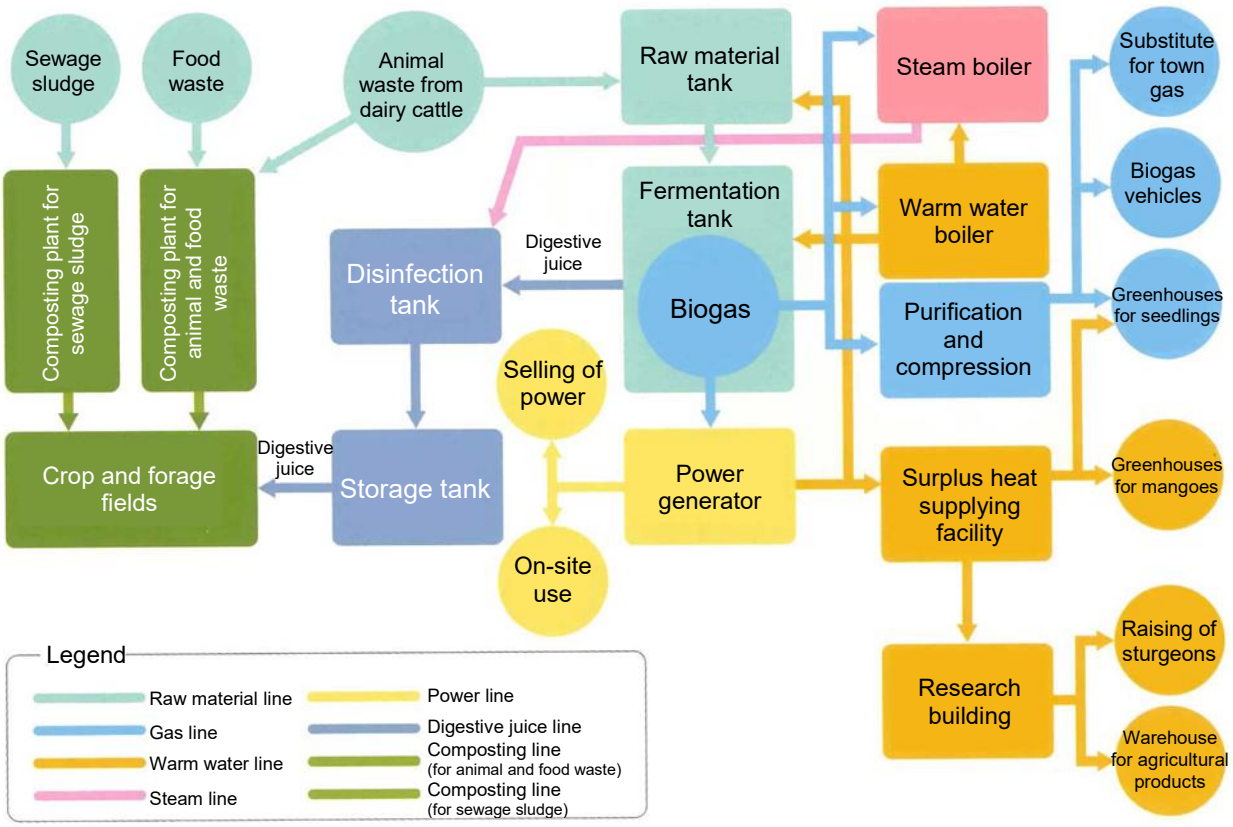


Figure 45　System Chart of the Environmental Preservation Center

(Source: Brochure of the Shikaoi Town Environmental Preservation Center)

○ Finances, profitability, and future challenges

The initial building cost of the center is about 1,700 million yen (including 830 million yen as the initial building cost of the biogas plant). The state and the prefecture bore 55% and 22.5% of the initial building cost, respectively, while the town bore the remainder.

The center annually earns 50 to 80 million yen from selling the generated power. In addition, the center annually earns a total of more than 100 million yen from animal waste treatment, digestive juice spraying, and other services as well as selling the generated power. As the center's operating cost is about 70 to 80 million yen, it is very profitable. This surplus is attributable primarily to the FIT program. The center pools profits into a fund in preparation for future facility repairs.

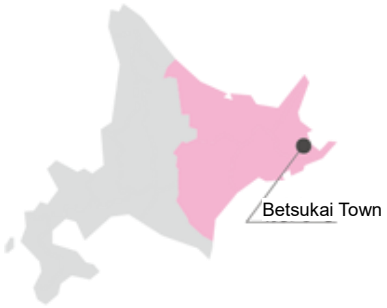
The users' association has nine employees, including plant operators and workers spraying liquid fertilizer and collecting animal waste. The local commercial and industrial association and a community-reactivating cooperator squad are helping to raise sturgeons and cultivate mangoes. Therefore, the center can be considered to have brought economic benefits to the community.

JICA's use of the project and cooperation

This project did not originate from actions against climate change, but from a solution to the local problem of odor. The town's approach to the problem, in which they discussed with local dairy farmers for years to obtain their consent, should be a helpful example for promoting many projects in developing countries, not limited to renewable energy projects. Their efforts to develop new local specialties by making secondary use of generated energy should also be a good example of ways to increase economic spillover effects. Showing the possibility of animal waste treatment and hydrogen purification and supply will provide a precious opportunity to learn about the potential of renewable energy.

1 Liquid mixture of animal waste, litter, and other materials. It has a water content of at least 87%.
2 Community that develops a commercially viable system for the production, collection, transportation, and use of raw materials to make itself an eco-friendly, disaster-resistant community founded on biomass industry.
3 Abbreviation for Education for Sustainable Development. In 2002, this idea was proposed by Japan at the UN World Summit on Sustainable Development, where the years from 2005 to 2014 were declared the Decade of Education for Sustainable Development.
4 Process of decomposing animal waste and other organic matter with microorganisms in the absence of oxygen (an anaerobic environment), generating methane gas.
5 Process in which microorganisms transform animal waste and other organic matter into inorganic matter in the presence of oxygen (an aerobic environment).

[Case 8] Betsukai Town, Hokkaido



○ Town with 100,000 heads of cattle

Betsukai Town is a vast town of 1,320 km^2 with a population of about 15,000. It is a major dairy farming area that has more than 100,000 heads of cattle, seven times the town's population. Blessed with a natural environment not commonly found anywhere in the world, such as Notsuke Bay and Lake Furen (registered wetlands under the Ramsar Convention[1]), the town is actively committed to protecting the natural environment. The 100,000 heads of cattle discharge a large quantity of animal waste amounting to two million tons a year. Treatment and appropriate management of this animal waste has been a big problem for the community. In 2000 (Heisei 12), the town started converting animal waste into biogas by methane fermentation ahead of other municipalities in Hokkaido.

In FY2002 (Heisei 14), the town formulated the Betsukai Town New Energy Vision, in which it concluded that biogas made from animal waste is an effective renewable energy source by researching the potential reserves of renewable energy. On the basis of this conclusion, the town formulated a biomass town plan to promote use of such biogas in 2006 (Heisei 18). The town also formulated a plan for the biomass industry town in 2013 (Heisei 25) and started operating the Betsukai Biogas Power Plant, one of Japan's largest biogas power generation facilities, in 2015 (Heisei 27). By creating the planned biomass industry town, the town aims to reduce 4,500 to 6,000 tons of CO_2 emissions over 10 years starting from 2013 (Heisei 25).

Table 33 General Information on Betsukai Town

Region	Eastern Hokkaido
Population	15,130 (as of October 2017)
Area	1,320 km^2
Contact information	Agricultural Policy Division, Industrial Promotion Department, Betsukai Town Office 280 Betsukai-Tokiwa-cho, Betsukai-cho, Notsuke-gun Tel: 0153-75-2111
○ Betsukai Town CO_2 emissions reduction	
Target year	2023
Reduction target	4,500 to 6,000 tons

○ Protecting the sustainable livestock farming environment

In Hokkaido, animal waste had been often composted or sprayed in fields in the form of slurry. However, this practice caused such problems as river and groundwater pollution and odor because large-scale farming made it difficult to appropriately manage animal waste.

To solve these problems, the government enforced a law concerning livestock manure[2] in 1999 (Heisei 11), requiring farmers to have manure storage facilities by 2004 (Heisei 16). Meanwhile, farmers in Betsukai Town often had difficulty in securing the necessary storage capacity for manure because they have a large number of cattle and cannot spray slurry in fields for many months of the year during which the soil is frozen. In 2014 (Heisei 26), the town established an ordinance on livestock industry environment to promote the protection of the sustainable livestock industry environment. This ordinance was the first in Japan to set limits on the number of livestock animals that can be kept per farming acreage, prohibiting local farmers from keeping more than 2.13 heads of dairy cattle for each hectare. The town's efforts to utilize livestock biomass primarily aim to ensure appropriate animal waste treatment and establish a sustainable livestock industry environment. Shown below are major facilities utilizing biomass in the town.

• Betsukai Town Resource Recycling Center

This center was built by the Civil Engineering Research Institute for Cold Region[3] as a demonstration facility in 2000 (Heisei 12) and is owned by the town and operated by a designated administrator. The center can treat animal waste from about 1,000 heads of dairy cattle and accepts animal waste from nine local dairy farmers (10 dairy farmers in the beginning). It attracted a lot of attention from across the prefecture by enhancing the purity of generated biogas for use as automobile fuel, in addition to generating and selling power. It provides facility users with its by-products of digestive juice and manure as part of its efforts to promote recycling-oriented dairy farming.

Figure 46 Biogas Car in Betsukai Town

• Betsukai biogas power generation

The facility of Betsukai biogas power generation started operation in 2015 (Heisei 27) as one of Japan's largest biogas power generation facilities. It treats animal waste from about 100 local dairy farmers (later described in more detail).

○ <u>Increasing the amount of animal waste treated</u>

This facility treats animal waste from about 4,500 heads of dairy cattle. The town's plan of becoming a biomass industry town aims to increase this number to 12,500 heads (treating more than 800 tons of animal waste per day). To achieve this goal, the town already began discussions toward the construction of a second biogas power generation facility. More dairy farmers are expected to have their own biogas plants[4] if they expand their dairy farming operations. The town welcomes these moves, considering them helpful in protecting the livestock industry environment.

Figure 47 Betsukai Biogas Power Generation Facility

The potential of biogas power generation facilities is highly rated in the town as an approach to protecting the sustainable livestock industry environment. The FIT program is a major factor in making biogas power generation profitable. Since biogas is not a renewable energy source used only for power generation, but the key to sustainable dairy farming, those who devise systems concerning biogas power generation need to fully understand this role of biogas.

Introduction of Project <<Betsukai Biogas Power Generation>>

○ One of the largest biogas power plants in Japan

Betsukai biogas power generation, one of the largest biogas power generation operations in Japan, generates power and supplies heat needed to run the facility with methane gas generated by anaerobic fermentation of animal waste. It also sells the by-products of digestive juice and recycled bedding. The facility is operated by a special purpose company[5] formed by Betsukai Town and agricultural cooperatives, as well as a private enterprise.

Table 34 Betsukai Biogas Power Generation

Facility operator	Betsukai Biogas Power Generation Co., Ltd.
Location	Betsukai, Betsukai Town, Notsuke County
Type	Animal waste
Category	Livestock biomass
Supplied energy	Heat and power (eligible for the FIT program)
Scale	Large scale
Reduced CO_2 emissions	-
Contact information	Betsukai Biogas Power Generation Co., Ltd. 2 Betsukai, Betsukai-cho, Notsuke-gun Tel: 0153-79-5552

The plant plays a part in protecting the local livestock environment as it has contracted with about 100 local dairy farmers to treat their animal waste. It also accepts animal waste from other local dairy farmers who cannot store their animal waste on their own, or are facing some other emergency. The plant operation is designed to benefit the contracted dairy farmers by purchasing their animal waste as raw materials for operation and selling to them the by-products of digestive juice and recycled bedding at low prices.

In Betsukai, a pasture town, digestive juice is not frequently used as liquid fertilizer, but is being recognized as a fertilizer that emits less odor and is more useful than chemical fertilizer. Recycled bedding is in high demand because it is cheaper than sawdust and other ordinary bedding materials. Local circulation of such digestive juice and recycled bedding helps keep sustainable, recycling-oriented dairy farming.

The plant generates 10,000 MWh of power a year. It is expected to reduce thousands of tons of CO_2 emissions because its power generation emits far less CO_2 emissions than thermal power generation.

○ Facility overview and heat and power supply

The plant treats 280 tons of animal waste daily (equivalent to about 4,500 heads of dairy cattle) and 5 tons of industrial food waste and other waste daily. What is unique about the plant is that it accepts both slurry and manure because many local dairy farmers have difficulty in treating manure (it originally accepted slurry and manure at a ratio of six to four, but now accepts them at a ratio of two to eight).

Figure 48 Gas Power Generators

Methane gas is recovered by anaerobic fermentation (thermophilic fermentation at 55°C). This fermentation method, which has been adopted by few facilities in the prefecture, can shorten fermentation time because of the high fermentation temperature, as well as sterilize the by-products of digestive juice and recycled bedding.

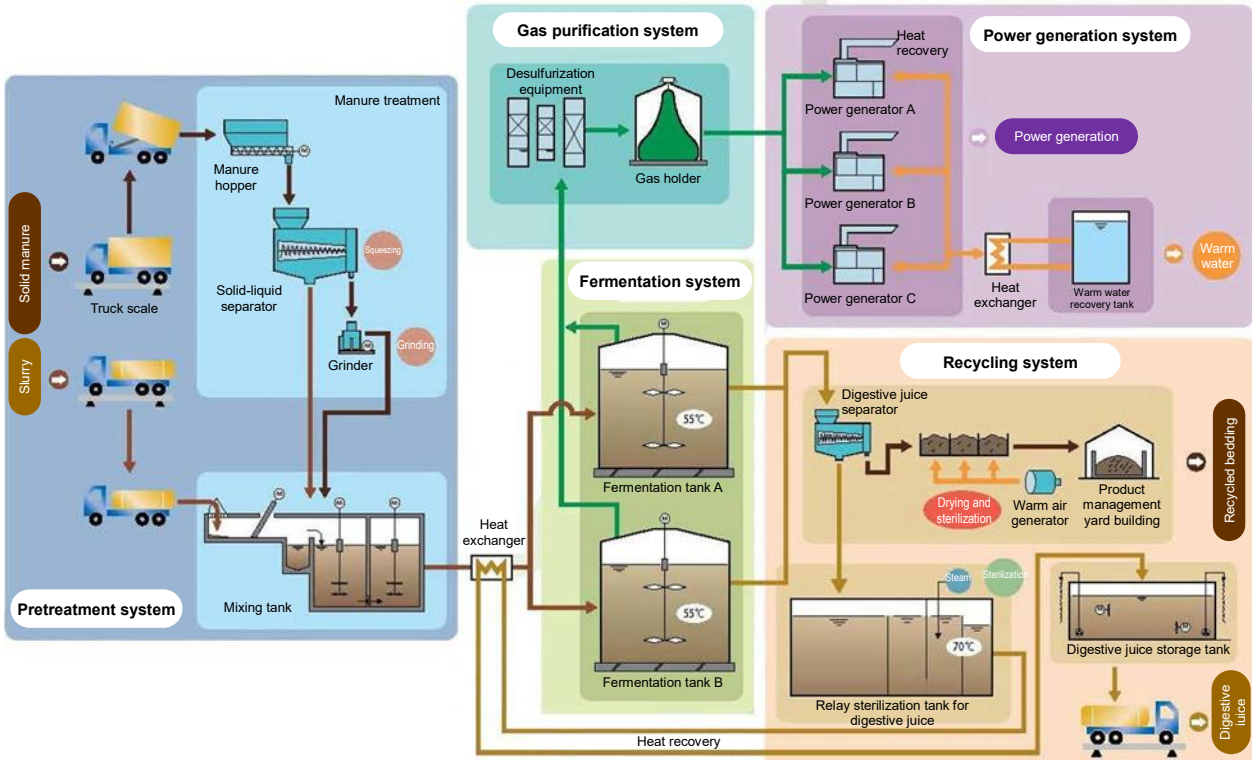


Figure 49　System Chart of Betsukai Biogas Power Generation

(Source: Brochure of Betsukai Biogas Power Generation Co., Ltd.)

The plant is designed to treat 285 tons of animal waste per day and generates 12,000 m^3 of biogas per day. The plant uses two of its three 600-kW gas power generators to generate power and sells the generated power to new power producers and suppliers in Tokyo under the FIT program. Heat generated from the power generation process is recovered to heat the fermentation and sterilization tanks in the plant.

○ Finances, profitability, and future challenges

The construction cost of this plant is about 2.4 billion yen. To become eligible for the FIT program, the plant used state subsidies only for facilities that were not power generation facilities. The plant plans to secure 89% of its operating profits from power sales, 7% from digestive juice and recycled bedding sales, and 4% from industrial waste disposal charges. One of the challenges faced by the power generation plant is that local farmers are not fully aware of how effective the digestive juice by-product is because almost all the farmland of the town is used for dairy farming.

The plant has provided direct employment opportunities to local people by hiring five workers for facility maintenance and management and five workers for animal waste transport. The plant is also expected to create employment opportunities at local constructors and device makers in connection with facility construction, maintenance, and inspection.

JICA's use of the project and cooperation

Betsukai Town, a pioneer in use of livestock biomass, is an important partner in learning about the history of use of biogas in Japan. Since the town, which was the first in Japan to set rules on the number of livestock that can be kept by dairy farmers, is also a pioneer in eco-friendly dairy farming, it will also be a useful partner in study tours and lectures for JICA's training programs concerning agriculture.

1 Wetlands designated by signatory countries to the Ramsar Convention in accordance with the international standards provided in the Convention and included in the List of Wetlands of International Importance managed by the Ramsar Convention Secretariat.
2 Act on the Appropriate Treatment and Promotion of Utilization of Livestock Manure. Established in 1999, this law aims to ensure appropriate treatment and storage of livestock manure and promote its utilization.
3 Civil Engineering Research Institute for Cold Region, Public Works Research Institute (national research and development agency)
4 A biogas plant can be operated either by an individual farmer or by a local government or agricultural association. In individual biogas plant operation, each farmer installs a plant and treats their animal waste on their own. In collective biogas plant operation, a local government or agricultural association installs a plant and collects animal waste from several local farmers. Individual biogas plant operation does not have a cost for transporting animal waste and digestive juice, and enables plant owners to use surplus heat in their farms. Collective biogas plant operation can keep down the unit costs of waste treatment and construction and enables centralized plant operation, maintenance, and management.
5 Company founded for the purpose of asset securitization.

[Case 9] Ishikari City, Hokkaido

○ **Town founded on various industries from agriculture, forestry, and fisheries to commerce and industry**

Ishikari City merged with former Atsuta Village and former Hamamasu Village in 2005 (Heisei 17) to become a long and narrow city stretching about 67 km from north to south. It has a population of about 58,000 and abundant forests.

The northern area of the city (former Atsuta Village and former Hamamasu Village) still retains a particularly rich natural environment. Strong seasonal winds make the area along the Japanese Sea one of the most suitable areas for wind power generation in Japan. The southern area (former Ishikari City), which has the Ishikari Bay New Port, not only serves as a hub for industry and distribution, but also plays another important role as a supplier of energy to the Sapporo region. The city, which used to rely on primary industries such as agriculture, forestry, and fisheries, has seen the development of secondary and tertiary industries since the construction of the new port in the late Showa period, and is now founded on various industries.

The city's basic environmental plan, the top-tier plan of its environmental policy, aims to "build a sustainable society" as one of the basic goals. To achieve this goal, the plan shows the town's commitment to taking action against climate change and promoting renewable energy. Each of these two commitments has an action plan.

As the community's action against climate change, the city established its global warming action plan (for local measures), which includes its commitment to reducing CO_2 emissions per capita by 10% (from FY2001 (Heisei 13) levels) and about 100,000 tons of CO_2 emissions from the entire community by FY2020. The city also established the Ishikari City New Energy Vision to increase use of new energy sources as a measure to promote CO_2 emission reduction.

Table 35 General Information on Ishikari City

Region	Central Hokkaido
Population	58,505 (as of November 2017)
Area	722.42 km^2
Contact information	Environmental Policy Division, Environment and Residents Department, Ishikari City Office 6-1-30-2 Hanakawa-kita, Ishikari-shi Tel: 0133-72-3698
○ Ishikari City CO_2 emissions reduction	
Target year	FY2020
Reduction target	Reduction by 10% per capita (from FY2001)

○ **City office acting as a supporter—taking advantage of abundant human and natural resources and various industrial bases**

Ishikari City is suitable in terms of both natural and social resources for introducing renewable energy because it has abundant renewable resources, such as solar power, wind power, and forests, and a major industrial complex in the Ishikari Bay New Port and energy infrastructures. For these reasons, many enterprises have participated in local renewable energy projects. In the area of the new port, seven companies built solar power plants and three community windmills[1] are currently operating. In addition, it is planned to construct a large wind power generation plant and a biomass power plant in the area.

In these circumstances, the local government only supports the activities of business operators and local residents to introduce renewable energy, instead of playing a leading role, as a way to promote the introduction of renewable energy compatible with the protection of the local environment and the future vision of the community.

Shown below are some renewable energy projects particularly oriented to local communities and led by local residents.

• Wind power generation (returning profits to local communities by creating a fund)

In Japan, many wind power generation facilities are established by enterprises and profits, made from local wind resources, are not returned to local communities. The Hokkaido Green Fund (NPO) has conducted a project to operate windmills funded by local residents (community windmills) as a way to enable local residents to use local resources for their own benefits. Five of Ishikari's seven windmills are community windmills (there are 18 community windmills in Japan).

Figure 50 Atsuta Community Windmill

Two Atsuta Community Windmills, operating in the Atsuta area, have a system to return the benefits of wind power generation to local people, under which some sales profits of generated power are returned to the city and the city pools the profits into a Green Town Fund. This system is a good example of a public-private partnership in the use of local resources (wind power) because the pooled money is used for local forest conservation activities, efforts to improve the energy efficiency of local natural environment conservation facilities, environmental education, and other purposes.

• Woody biomass project (supporting disabled people and recycling resources)

To take advantage of its abundant local forest resources, the city recycles forest resources in cooperation with local welfare facilities. Local welfare facilities used to make sawdust from thinned wood, which was used to make shiitake mushroom beds, and pellets were made from the beds after the mushrooms were cultivated. The resulting pellets were used for themselves. The city office installed pellet boilers and stoves at local community centers and other facilities to promote circulation of local wood and further use of woody biomass by securing more stable pellet consumption. Such mushroom bed pellets made by local welfare facilities are purchased by the city office. This project has helped promote social participation of local people with disabilities, as well as local recycling of forest resources. It has also brought other environmental, industrial, and welfare benefits to the local community.

Figure 51 Pellet Stove at Atsuta Elementary School

• Project "NINOMIYA" (utilizing unused wood)

This is a project to make firewood out of unused wood. With the participation of young people and volunteers from the Sapporo area, this project provides opportunities to experience, learn about, and protect forests through making firewood (later described in more detail).

○ Spillover effects on local economy and employment

Solar and wind power generation plants do not create many jobs after they start operation. On the other hand, local employment and economy will enjoy huge benefits from new energy business, mainly hydrogen business, which may spring up in the city as many enterprises plan to join local renewable energy projects, particularly in the area of the new port.

○ The need for communication with local residents—introducing renewable energy that also protects the local environment

While many enterprises want to participate in local renewable energy projects, particularly wind power generation projects, some local residents are concerned about the environmental impact these projects may have. It is thus necessary to ensure that the introduction of renewable energy does not damage the environment.

After being selected as an area in a zoning study of a model project for wind power generation entrusted by the Ministry of the Environment in FY2017 (Heisei 29), Ishikari City conducted surveys and environmental studies targeting the entire city. Through a workshop-like committee consisting of relevant organizations and members selected through an open application process, the city plans to gather a wide range of information on local natural and social environments and study the future direction of wind power generation that balances the lives of local residents, industry, and the environment.

Introduction of Project <<Project "NINOMIYA">>

○ Learning about the bounty of forests and energy locally used through making firewood

Many valuable woody biomass resources, such as unused wood and obstructive trees logged from urban parks and other places, are not effectively used. This project makes firewood out of such unused wood, aiming primarily to make effective use of unused woody biomass resources.

While energy consumed in Japan is mostly electricity or fossil fuels, such as kerosene and gas, many young people do not know the sources from which their energy come from. In addition, many young people living in urban areas isolated from nature are not aware of the benefits they receive from forests and ecosystem services. This project is a volunteer-based project targeting such young people in urban areas. The project is also a project designed for human resources development and forest environment education that provides opportunities to learn about forests, make firewood, and learn about energy in order to leave rich forests for next generations through making firewood as a way to utilize unused wood.

Table 36 General Information on Project "NINOMIYA"

Project operator	ezorock (NPO)
Location	Bitoi, Ishikari City
Type	Firewood
Category	Woody biomass
Supplied energy	Heat
Scale	Small scale
Reduced CO_2 emissions	20 tons/year
Contact information	Project "NINOMIYA" of ezorock (NPO) Nishi 3-1-7, Minami 9, Chuo-ku, Sapporo-shi Tel: 011-562-0081

Firewood made by volunteers is used mainly by cafes and other places in the Sapporo area. The project demonstrates the potential of firewood as a carbon-neutral[2] heat source to the public to promote their support for the project. The project annually sells about 100 m^3 of firewood. On the assumption that the sold firewood replaces kerosene for heating, the project is estimated to reduce 20 tons of CO_2 emissions a year.

○ Project flow

[Procure materials] Project "NINOMIYA" procures unused wood, the raw materials for firewood, mainly from the Atsuta and Hamamasu areas with the cooperation of the Ishikari City Forestry Cooperative. The project also has other sources of unused wood, such as Sapporo City. Volunteers visit forests to collect unused wood. Their activities help forest owners make effective use of their unused wood while providing themselves with opportunities to learn about the forests' bounty and deepen their understanding of forestry.

Figure 52 Volunteers Chopping Wood

[Making firewood] The project makes firewood out of collected unused wood with the help of volunteers. Every year, about 500 volunteers participate in firewood making. If those who participate in wood chopping activities at music events, commercial facilities, and other places are included, about 1,200 people participate in firewood making annually. Firewood making provides many citizens with opportunities to learn about renewable energy and forest resources producing renewable energy.

[Using the firewood] The firewood is sold to cafes and other places in the Sapporo area. Firewood produced this way has reduced CO_2 emissions as it has actually replaced some fossil fuel for heating. Sales profits of firewood are used to operate the project and provide opportunities to learn more about forests and energy.

○ Profitability, challenges, and prospects

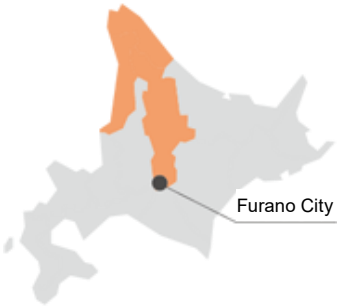
The project not only makes firewood as fuel, but also offers an educational program concerning forestry diversification. This educational program provides an opportunity to learn about forestry processes from wood production, processing, distribution to use and has met many educational and training needs of schools and companies. Although the project has little potential for expansion due to its financial and manpower limitations, its public recognition has provided many volunteers with career development opportunities; some found employment with forestry companies and others became tree doctors.

JICA's use of the project and cooperation

Ishikari City has many renewable energy projects in which business operators or NPOs play a leading role. Since many of such projects have successfully established a good partnership with the local government, they provide good examples of a local government supporting such business operators and NPOs as their partner. As an energy supplier, the city has also conducted many projects in preparation for the future, such as a demonstration experiment of a superconducting direct-current power transmission system and a hydrogen strategy. For this reason, the city will be an important partner in JICA's training programs concerning such cutting-edge projects. Project "NINOMIYA," which aims to promote public understanding of renewable energy by providing various experiences, is the only project that does not involve facilities or equipment in this report. This project should be a good example for learning about various approaches to promoting public understanding and use of renewable energy.

1 Windmill for wind power generation co-funded with local residents.
2 Idea that the amount of CO_2 emitted from production and other activities is equal to that absorbed by forestation and other activities.

[Case 10] Furano City, Hokkaido



○ Developing an eco-friendly city where residents coexist with nature

Located roughly in the center of Hokkaido, Furano City is known as the "belly button city." Recognized across the country as the setting for TV drama series and films, the city is a major tourist destination visited by more than 1.8 million tourists every year. The city is also a major dry-farming region that is one of the top onion and carrot producers in Japan in terms of crop acreage. Tourism and farming are the key industries of the city. Local authorities and residents have made various inventive efforts, including promotion of local food and cuisine and efforts led by the local private sector to revitalize central urban districts.

In 1985 (Showa 60), the city started separate waste collection ahead of other municipalities. In FY1988 (Showa 63), the city started producing RDF[1]. In 2010 (Heisei 22), the city formulated the Furano City New Energy Vision, which highly rates the potential of RDF together with that of solar power and forest biomass. Paying attention to the potential of small hydroelectric power generation by taking advantage of its basin-shaped topography, the city included its commitment to promoting small hydroelectric power generation, as well as the above renewable energy in its basic environmental plan revised in 2011 (Heisei 23) and global warming action plan (for local measures).

The basic environmental plan vows to reduce local CO_2 emissions by 17.5% (from FY2005 (Heisei 17) levels) by FY2020 through promoting such renewable energy efforts.

Table 37 General Information on Furano City

Region	Northern Hokkaido
Population	22,279 (as of November 2017)
Area	600.71 km^2
Contact information	Environmental Division, Residents Department, Furano City Office 1-1 Yayoi-cho, Furano-shi Tel: 0167-39-2308
○ Furano City CO_2 emissions reduction	
Target year	FY2020
Reduction target	Reduction by 17.5% (from FY2005)

○ Using waste as fuel and streams as energy sources

Use of renewable energy is one of the city's actions against climate change. Renewable energy sources include solar power, woody biomass, RDF, and small hydroelectric power. Among these types of renewable energy, RDF and small hydroelectric power characterize Furano City's renewable energy efforts.

• Production and use of RDF

As mentioned above, Furano City started separate waste collection ahead of other municipalities, currently requiring local residents to separate their waste into 14 types[2]. Separate waste collection, with the original goal of hygiene management, has greatly helped create a sustainable recycling-based society as 90% of local waste is recycled. Paper waste, clothes, rubber products, and other waste that can be recycled into fuel are collected as "solid fuel waste" under one of the 14 types and transformed into RDF at a local RDF production facility. Since the city's thorough waste separation prevents food waste from being mixed into solid fuel waste, RDF produced there does not have problems such as heterogeneity or low calorific value, which are often found in RDF produced elsewhere. Furano's RDF has sufficient quality to be sold as fuel to businesses in the prefecture. More

than 2,000 tons of RDF is annually shipped, bringing sales profits of about 1.7 million yen to the city in FY2015 (Heisei 27).

As local use of renewable energy, efforts to promote local use of RDF have started. For example, Highland Furano, a local hotel, and other local facilities have boilers to use RDF for heating and hot water supply. Although only about 20% of RDF produced in the city is used, RDF is expected to annually reduce about 400 tons of CO_2 emissions if RDF replaces the fossil fuel that has been used for boilers. The city aims to promote local recycling of resources by using all locally produced RDF in the city and solving its technical challenges.

Figure 53 RDF Production Plant

• Small hydroelectric power generation on natural rivers

Furano City, located in a basin, has rivers flowing in from surrounding mountains, which give the city great potential for small hydroelectric power generation. Local residents, businesses, and authorities are thus working together on small hydroelectric power generation on natural rivers (later described in more detail).

○ Spillover effects on local economy and employment

Production of RDF needs public support and cooperation in the separation of waste into 14 types. Whenever the number of waste classifications increased, local residents showed resistance. However, repeated communication with the public has led them to accept the thorough and separate waste collection. RDF is a valuable product of public support and cooperation. Once RDF can be locally consumed and recycled, the money that has been spent on fossil fuel will be returned to the community. Local use of RDF will also create jobs, such as boiler operators and administrators.

Small hydroelectric power generation, which is later described in more detail, has made a big move toward commercialization. If this power generation is commercialized, it will bring great benefits to local employment and economy.

Introduction of Project <<Shiratori River Small Hydroelectric Power Generation>>

○ Small hydroelectric power plant on a natural river

As Furano City is located in the Furano Basin and surrounded by mountains, it has many small rivers suitable for small hydroelectric power generation. In fact, the Rokugo district of the city supplied power to local people with small hydroelectric power generation in the early Showa period. In 2005 (Heisei 17), local assembly members took the initiative in establishing a study group to create natural energy with the aim of achieving full energy independence for the city. Since then, the city has discussed the introduction of small hydroelectric power and other renewable energy sources.

In 2010 (Heisei 22), the Furano Small Hydroelectric Power Generation Promotion Association, originating from the study group, conducted a study aimed at introducing small hydroelectric power generation. In December 2011 (Heisei 23), they built a waterwheel on the Shiratori River as a result of the study.

Table 38 General Information on Shiratori River Small Hydroelectric Power Generation

Project operator	Furano Small Hydroelectric Power Generation Promotion Association
Location	Rokugo district of Furano City
Type	Hydroelectric power
Category	Small hydroelectric power generation
Supplied energy	Power
Scale	Small scale
Reduced CO_2 emissions	Less than 1 ton/year
Contact information	Sanso Ltd. 14-3 Nishiki-machi, Furano-shi Tel: 0167-22-0383

Using the natural rivers involves the issue of water rights[3]. Since the water rights to the Shiratori River are owned by Furano City (and downstream areas owned by the University of Tokyo), the waterwheel was installed by the association. The waterwheel, though with a very small output, is very useful for promoting small hydroelectric power generation and environmental education.

The waterwheel generates about 850 kWh of power a year. Although this facility directly reduces no more than one ton of CO_2 emissions, waterwheels have the potential to be used elsewhere as off-grid sources of locally produced energy for local consumption.

○ Facility overview and use of generated power

The waterwheel and its management shed were built without subsidies; instead, they were built with voluntary donations from local people and with the cooperation of local residents and tourism associations. This project, which aims to share knowledge and challenges related to the installation of small hydroelectric power generation facilities on natural rivers, has been conducted through trial and error, from arrangements and negotiations for the installation of the waterwheel to its making. The project adopted an open-flume undershot waterwheel so that it can be used for the promotion of small hydroelectric power generation and environmental education. This represents the project's policy that waterwheels should be

Figure 54 Waterwheel No. 1 of Shiratori River Small Hydroelectric Power Generation

easily understandable and maintainable. The waterwheel has an output of 100 W. The generated power is used for nearby outdoor lights and the management and maintenance of the waterwheel itself.
The river also has another waterwheel, which was built by the city office with subsidies from the Ministry of the Environment. This 1.9-kW waterwheel supplies emergency power to a nearby elementary school.

○ Profitability, employment, and future challenges

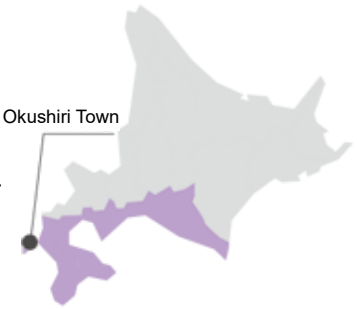
Although the small hydroelectric power generators have not contributed directly to local employment or economy, the successful operation of small hydroelectric power generation on a natural river has presented great potential for future commercialization. In Furano City, an organization to study the commercialization of environmental energy is working on commercializing small hydroelectric power generation. Once such commercialization efforts shift into high gear, small hydroelectric power generation will create jobs and bring other economic benefits. As this type of power generation does not need special cutting-edge technology, it is highly likely that this knowledge can apply to developing countries and many other regions.

JICA's use of the projects and cooperation

RDF is renewable energy using waste, one of the environmental problems faced by many developing countries. The policy processes to achieve a recycling rate of 90% and communication with local residents give many tips.
Small hydroelectric power generation, technically easier than other types of power generation, has great application potential in developing countries. Trainees from developing countries will find it useful to learn the significance of local independent efforts not dependent on subsidies in which local residents, businesses, and authorities worked together to study, install, operate, and maintain waterwheels.

1 Abbreviation for refuse-derived fuel.
2 Under the basic policy of "no combustion, no landfill," Furano City requires local residents to separate waste into the following 14 types: (1) food waste, (2) branches and grass, (3) solid fuel waste, (4) plastic bottles, (5) plastics, (6) empty cans and metals, (7) empty glass bottles, ceramics, and glass, (8) dry-cell batteries, (9) newspapers and magazines, (10) bulky waste and electric appliances, (11) sanitary goods and pets' excrement, (12) ashes, (13) animal dead bodies, and (14) matters that are difficult to be disposed of.
3 Rights of specific enterprise operators, public organizations, or residents, farmland, or forest owners in specific areas to continuously make exclusive use of the water or water surface of a river for specific purposes (such as hydroelectric power generation, irrigation, and water supply).

[Case 11] Okushiri Town, Hokkaido



○ Promoting industry with new energy

Located in southern Hokkaido, Okushiri Town is an isolated island in the Sea of Japan 61 km northwest of Esashi Town and 42 km southwest of Setana Town. The town has a population of about 2,700 and is founded on fisheries and tourism. The island is known for the devastating damage it took from the 1993 (Heisei 5) Hokkaido Nansei-oki Earthquake[1]. Since the island was very close to the epicenter, the entire island was hit by tsunamis and suffered many casualties and considerable property damage. Learning from this earthquake, the town rebuilt with disaster preparedness in mind. Five years after the earthquake, in 1998 (Heisei 10), the town declared that it had fully recovered from the disaster. The town is now recognized nationwide as a pioneer in disaster management and community development due to its reconstruction efforts. In fact, the town actively accepts study tours of its disaster management program[2].

Isolated islands with an independent electric power system need to secure independent energy sources, as a method of disaster management. The town has promoted renewable energy efforts out of such a need for disaster management and for the purpose of revitalizing its local community through the new energy industry. In 2017 (Heisei 29), a local private company started operating a geothermal power plant, the second of such plants on an isolated island in Japan after Hachijo Island (Tokyo).

Table 39 General Information on Okushiri Town

Region	Southern Hokkaido
Population	2,742 (as of November 2017)
Area	142.98 km^2
Contact information	Local Policy Division, Okushiri Town Office 806 Aza Okushiri, Okushiri-cho, Okushiri-gun Tel: 01397-2-3111
○ Okushiri Town CO_2 emissions reduction	
Target year	-
Reduction target	-

The town's comprehensive plan and other plans vow to promote new energy, primarily to promote industry and increase employment. As a concrete policy to promote new energy, the town established the Okushiri Town New Energy Vision in FY2010 (Heisei 22). For the use of geothermal resources, the town established the Okushiri Town Vision for Use of Geothermal Resources in FY2013 (Heisei 25) and has prioritized efforts on this policy since then. The town plans to formulate its global warming action plan, as required by the Act on Promotion of Global Warming Countermeasures, and has yet to set its target for CO_2 emissions reduction.

○ Independent energy sources needed for an isolated island and disaster management

Although many isolated islands construct self-contained power plants that do not need energy sources from outside the islands, receive power supply via undersea cables, or use other means to secure necessary power, none of these way are reliable in the event of a disaster. From the viewpoint of disaster management, it is very important for isolated communities to build a system that enables them to secure power independently in emergency situations.

To overcome this challenge peculiar to isolated islands, Okushiri Town discussed the introduction of renewable energy. They initially considered introducing wind power generation because the island faces the Sea of Japan and has very favorable wind conditions, but they found it difficult to introduce this type of power generation into

their self-contained power system because the output of wind power generation fluctuates wildly. NEDO, which paid early attention to the island's geothermal resources, dug two experimental production wells in 2006 (Heisei 18) and 2007 (Heisei 19). These production wells are now used to operate the Okushiri Geothermal Power Plant (later described in more detail).

The town also promotes the use of woody biomass, taking advantage of its abundant forests, which cover 76% of the island. There is a wood chip production facility, which makes wood chips from the lumber remnants of local lumber mills and used as boiler fuel. Local elementary schools are equipped with woody biomass boilers which burn such wood chips. The town also introduced pellet production equipment to promote further use of woody biomass, including unused wood left in the woodlands, and is working to equip public and other facilities with pellet stoves and increase the number of ordinary households with pellet stoves.

Figure 55 Wood Chip Boiler

The town is continuing its efforts to secure independent energy sources and promoting use of renewable energy derived from various local resources. In the long run, they aim to promote the island as an "eco-island" as well as develop local industry and create jobs by promoting renewable energy.

○ Spillover effects on local economy and employment

The geothermal power plant has not directly created new employment opportunities. Neither has the woody biomass project. However, it is more important for the isolated island, suffering from a population decrease, to maintain local employment; their renewable energy efforts have contributed to the creation of continued employment opportunities.

By replacing the energy which has been procured from outside the island with geothermal resources and other local renewable energy, the power plant has great potential to help actions against climate change and revitalize the community by promoting local circulation of money. Since the establishment of the power plant, the town has seen an increase in its nonresident population, such as domestic and foreign visitors to the plant. This increase has probably brought some economic benefits to the community.

○ Cooperation with local businesses and people

In promoting the use of geothermal resources, the town had discussions with local businesses and organizations and representatives of local residents, held workshops for businesses and seminars for residents, and issued PR magazines in order to gain public understanding. In promoting the use of woody biomass, the town set up a council with foresters and local businesses. This council serves as a place for consensus building.

Communication with local businesses has been the key to the joint efforts by public and private sectors to promote use of renewable energy. Both the geothermal power plant and the wood pellet and chip production facilities have created the continued employment opportunities because they have been operated by the private sector.

Introduction of Project <<Okushiri Geothermal Power Plant>>

○ Japan's second geothermal power plant on an isolated island

Okushiri Town has promoted efforts to use geothermal resources as secure independent energy sources and revitalize the community. As part of these efforts, the Okushiri Geothermal Power Plant was constructed in 2017 (Heisei 29) by Koshimori Petroleum and Electric Appliance Co., Ltd.

This local petroleum wholesaler found it necessary to have independent energy sources in preparation for disasters because the Hokkaido Nansei-oki Earthquake temporarily cut off local energy supply by damaging the company's oil tanks and partially destroying the port so that oil tankers could not dock. After studying the profitability of geothermal power generation in the town's renewable energy projects, which included the use of geothermal resources, the company decided to embark on geothermal power generation.

Table 40 Okushiri Geothermal Power Plant

Facility operator	Koshimori Petroleum and Electric Appliance Co., Ltd.
Location	Western part of the island, Okushiri Town, Okushiri County
Type and category	Geothermal power
Supplied energy	Power (generated by binary-cycle generation and eligible for the FIT program)
Scale	Medium scale
Reduced CO_2 emissions	About 1,000 tons/year
Contact information	Regional Policy Division, Okushiri Town Office 806 Aza Okushiri, Okushiri-cho, Okushiri-gun Tel: 01397-2-3111

In 2012 (Heisei 24), this geothermal power generation project used two production wells transferred by NEDO to the town. The town leases the wells to the company for about one million yen a year. The power plant is expected to generate about 1.5 million kWh of power annually. If this geothermal power generation emits no CO_2 and the latest emission factor released by Hokkaido Electric Power (0.676 kg CO_2 equivalent/kWh for FY2015) is used for calculation, the power plant is estimated to reduce about 1,000 tons of CO_2 emissions a year.

○ Facility overview and use of power

Since the geothermal water obtained from the production wells is about 150°C, which is not hot enough to flash-cycle[3] geothermal power generation, the power plant adopts a binary-cycle power generation system, which vaporizes a low boiling point chlorofluorocarbon substitute and drives the turbines with the steam. Only one of the two production wells is used for power generation, with the other being a spare. The production wells are about 1,600 meters deep and produce about 50 tons of geothermal water per hour. Waste hot water left after being used for power generation is not recycled; it is discharged into the nearby river after being diluted so as to comply with environmental regulations and cooled.

This power plant has two 125-kW power generators manufactured by Daiichi Jitsugyo Co., Ltd. The plant consumes part of generated power, and sells all the remaining power to the Okushiri Power Plant of Hokkaido Electric Power at 40 yen/kW for 15 years under the FIT program.

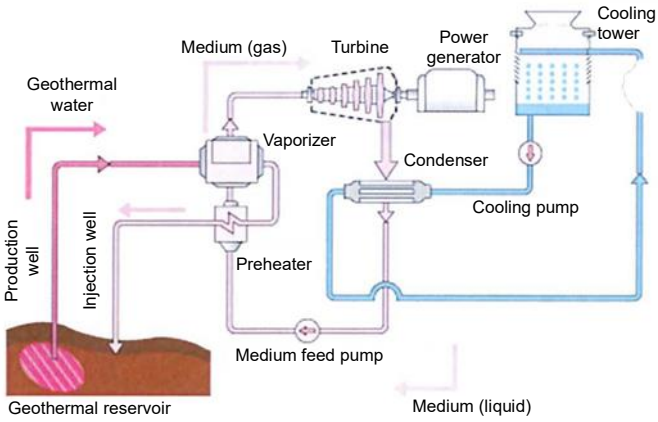


Figure 56 Binary-Cycle Power Generation
(Source: Okushiri Geothermal Power Plant)

○ Finances, profitability, and future challenges

The initial construction cost of the geothermal power plant is about 440 million yen, which was fully financed by loans without use of state subsidies. The plant is projected to earn about 60 million yen annually from sales of generated power and about 900 million yen over 15 years, the period eligible for the FIT program. Running costs include rent for the production wells (fixed cost) and the cost of troubleshooting problems, such as drops in the geothermal water levels of the production wells and mechanical failure (variable costs). If the operation continues smoothly, the initial cost is expected to be recovered within the first half of the period.

A major problem of the plant is that no progress has been made into the plan to recycle the waste hot water. The town is aware that it is essential to recycle the waste hot water to revitalize the community via the plant, and it is discussing a better recycling plan with local businesses.

JICA's use of the projects and cooperation

This project, a new movement in Hokkaido, is a renewable energy project that considers the unique circumstances of isolated islands and disaster management. Many developing countries will show considerable interest in this project. Okushiri Town, which actively accepts study tours for its disaster management program based on their disaster experience, will be a suitable partner in JICA's training programs concerning disaster management. Since the project is taking place on the island, a closed environment, it will help trainees understand the need for the circulation of woody biomass, energy balance, and other issues related to actions against climate change.

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1 A 7.8 magnitude earthquake that occurred off the southwest coast of Hokkaido at around 10:17 p.m. on July 12, 1993. Many people died or went missing on Okushiri Island, which was close to the epicenter, due to tsunamis, fires, landslides, and other disasters.

2 Okushiri Town accepts study tours in its disaster management promotion project to pass down their experience of the earthquake to future generations and show their disaster awareness to many people.

3 A power generation system that drives turbines directly with steam contained in geothermal fluid. This system is suitable mainly for power generation using geothermal fluid at 200°C or higher.

[Case 12] Shiriuchi Town, Hokkaido

○ Becoming a sustainable, independent, and self-reliant town

Located in southern Hokkaido, Shiriuchi Town has a population of about 4,500 and is blessed with abundant nature, fisheries and forestry resources. Although the town has long enjoyed its prosperity mainly with agriculture, forestry, and fisheries, it has recently faced challenges such as a brain drain to urban areas and an aging population with a declining birthrate, like other regions in the prefecture.

To tackle these challenges, the town is working to introduce renewable energy using the local forests (woody biomass), which cover about 80% of the town. The town's efforts include establishing a woody biomass supply system using local unused wood in cooperation with local businesses, introducing woody biomass boilers into its facilities, and building a storage facility for woody resources. Through these efforts, the town aims to be a "'sustainable, independent, and self-reliant town' that makes effective use of its local resources."

The town's comprehensive plan vows to revitalize the community by promoting the development of a low-carbon community and use of woody biomass energy. As renewable energy efforts using woody biomass are an important part of the town's policy, the town established the Shiriuchi Town Biomass Use Promotion Plan (Shiriuchi Town Biomass Industry City Plan) as a concrete plan for promoting the efforts in FY2016 (Heisei 28).

Table 41 General Information on Shiriuchi Town

Region	Southern Hokkaido
Population	4,477 (as of November 2017)
Area	196.75 km^2
Contact information	Community Revitalization Promotion Office, Shiriuchi Town Office 21-1 Aza Omonai, Shiriuchi-cho, Kamiiso-gun Tel: 01392-5-6161
○ Shiriuchi Town CO_2 emissions reduction	
Target year	FY2019
Reduction target	350 tons/year (from FY2015) * 199 tons/year by biomass boilers

This plan aims to reduce 199 tons of CO_2 emissions from FY2015 (Heisei 27) levels by FY2019 with the introduction of more biomass boilers. A plan to create a "low-carbon, recycling-oriented, and nature-harmonious" community established in FY2015 (Heisei 27) to promote the development of a low-carbon community also aims to reduce 350 tons of CO_2 emissions from FY2015 (Heisei 27) levels by FY2019 by reducing CO_2 emissions from key industries as well as introducing biomass boilers.

○ Local circulation of local resources and economy

The town's woody biomass efforts originated from its forest resource reserves study in FY2013 (Heisei 25). As this study found it possible for the town to have a stable supply of forest resources, the town built a wood chip boiler facility used to heat the town office and the town pool, and also built a storage facility for woody resources that produces the wood chips used for the boiler facility in FY2014 (Heisei 26) (later described in more detail).

In recent years, the town has also promoted use of woody biomass at local ordinary houses and business establishments. The town has been building Shiriuchi-style low-carbon model houses since FY2015 (Heisei 27) as part of its measures to promote migration to the community and has been providing financial assistance since FY2016 (Heisei 28) to local residents who want to have a wood stove.

These Shiriuchi-style low-carbon model houses are semi-custom houses provided to families with small children and other people who want to migrate to the town on the condition that they install a wood stove. These houses are rented to them as town-managed housing for the first 20 years and then provided to them without compensation as long as they purchase the land. Houses are built by local builders with locally produced wood. In addition, local forest resources are used for firewood. In this way, the local circulation of local resources and economy has been achieved. The town is also studying a low-carbon farming model that can help aging farmers lighten their workloads and promote the use of woody biomass in cultivation of Chinese chives, a local specialty.

Figure 57　Shiriuchi-style Low-carbon House

All of these efforts by the town are characterized by its commitment to solving local problems, such as a shrinking population, and tackling climate change at the same time.

○ Spillover effects on local economy and employment

The storage facility for woody resources has created several jobs for the Shiriuchi Town Forestry Association. The facility can be considered to have contributed to local employment and economy, though indirectly, as use of locally produced wood has increased the work of local foresters and carriers. The facility can also be given credit for local economic benefits brought by use of local resources and an increase in the town's nonresident population brought by visitors to the facility.

○ Efforts to develop human resources and promote their interactions

The town offers woody biomass classes to local junior high school students and is making other efforts to share an understanding of woody biomass to all generations. The town is also developing an experience-oriented eduvacation program using woody biomass and other local resources in an effort to develop human resources involved in low-carbon community development and promote their interactions.

While continuing the introduction of woody biomass boilers, the town plans to study a cogeneration system, which simultaneously produces heat and power, from economic and other perspectives.

Introduction of Project <<Storage Facility for Woody Resources (Wood Chip Production Facility)>>

○ Storage facility for woody resources, a center of biomass use in Shiriuchi

In FY2014 (Heisei 26), a wood chip boiler facility was built to heat the town office and the town pool. This facility uses a 360-kW chip boiler manufactured by Schmid and supplies heat energy throughout the year for heating buildings in the winter and pools in the summer.

Together with this chip boiler, the town built a storage facility for woody resources, which collects wood, then produces and transports wood chips to be used as fuel. This storage facility is operated by SB Forest, a joint venture of the Shiriuchi Town Forestry Association and Butsurin Co., Ltd. (Tokyo-based company), as a designated administrator. The forestry association collects and ships locally produced wood while the company collects low-quality wood[1] as raw materials for wood chips. It collects not only from the local community, but also from other areas in the prefecture. In FY2016 (Heisei 28), the facility produced about 1,000 tons of wood chips; about 400 tons of the produced wood chips were consumed by the wood chip boiler and the remainder was sold to large biomass power plants in the prefecture. In FY2015 (Heisei 27), the wood chips consumed in the town replaced heavy fuel oil and reduced about 151 tons of CO_2 emissions. The town plans to introduce a woody biomass boiler into 10 local facilities. The storage facility is expected to play a major role as the central supplier of wood chips to such facilities.

Table 42 General Information on Storage Facility for Woody Resources (Wood Chip Production Facility)

Facility operator	Shiriuchi Town (Designated administrator: SB Forest)
Location	Aza Omonai, Shiriuchi Town, Kamiiso County
Type and category	Wood chip
Supplied energy	Heat (produced by the wood chip boiler facility)
Scale	Small scale
Reduced CO_2 emissions	About 151 tons/year (actually reduced emissions in FY2015)
Contact information	Community Revitalization Promotion Office, Shiriuchi Town Office 21-1 Aza Omonai, Shiriuchi-cho, Kamiiso-gun Tel: 01392-5-6161

○ Facility overview

Unused wood for wood chip production is accepted by the storage facility as-is. This unused wood is crushed into wood chips with an on-site chipper (Wood Hacker), which can crush 60 m^3 of wood per day. Then the wood chips are dried at the storage facility before being shipped as fuel.

In addition to the 360-kW chip boiler (manufactured by the Swiss manufacturer Schmid), the wood chip boiler facility has a 360-kW backup boiler, a 40-m^3 chip silo, and a 40-kW emergency generator, which enable the facility to operate even if power supply is cut off in the event of a disaster.

Figure 58 Storage Facility for Woody Resources

○ Finance, profitability, and future challenges

The initial construction cost of the two facilities built in 2014 (Heisei 26) is about 300 million yen. About 100 million yen of this cost was spent on the storage facility for woody resources while the remainder was spent on the woody biomass boiler facility. Most of the initial construction cost of the latter facility was the cost of piping and wiring for heat supply. The total initial construction cost was mostly covered by prefectural subsidies and issued bonds, and only partially by the town's general revenue source.

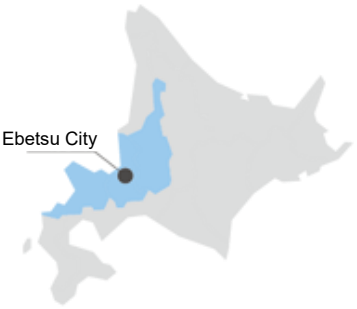
The storage facility for woody resources sells produced wood chips locally for 16,000 yen per ton. Since the designated administrator SB Forest reported a net profit of about two million yen in FY2016 (Heisei 28), the facility operation can cover all of its operating cost.

JICA's use of the projects and cooperation

The town's efforts are relatively recent efforts aiming to tackle climate change and revitalize the community by using woody biomass. While the town has many projects still under consideration, including cooperation with local key industries of agriculture and fisheries, these projects will provide trainees with a meaningful opportunity to learn about the process from project planning to implementation. Since the town also has very unique projects, such as the Shiriuchi-style low-carbon model house project, which helps promote the use of locally produced building materials, the town will attract the interest of trainees from developing countries who have various backgrounds. The town will be a suitable partner in JICA's training programs concerning tourism because it is also active in providing an experience-oriented eduvacation program on low-carbon community development.

1 Bent wood or wood with rotten cores unsuitable for civil engineering work, waste wood discharged from lumbering, or wood from natural forests unusable for lumbering.

[Case 13] Ebetsu City, Hokkaido



○ Working with industrial, academic, public, and private sectors

Located in the center of the Ishikari Plain, Ebetsu City has a rich natural environment represented by the Nopporo Forest Park southwest of the city, one of the best-known lowland primeval forests in Japan. Ebetsu City is a city of active research and corporate activities as it has four universities[1] and other educational and research facilities, as well as a large industrial complex.

Together with local industrial, academic, public, and private sectors, the city is promoting low-carbon community development to create a sustainable city. As part of such efforts, the city has various ongoing projects to introduce renewable energy, including a solar power generation project by private enterprises on city-owned land, use of biogas by local farmers, and a large woody biomass power generation project by a paper manufacturer.

The city's sixth comprehensive plan (FY2013 (Heisei 25)) vows to protect the environment through cooperation and promotes renewable energy efforts in order to reduce environmental loads and create a sustainable city. The Ebetsu City Environmental Management Plan (the last-phase promotion plan formulated in FY2013 (Heisei 25)), a plan to protect the environment, presents concrete measures and efforts. Although the city is yet to formulate its global warming action plan (for local measures), the environmental management plan aims to reduce CO_2 emissions by 5% from FY2011 (Heisei 23) levels (646,700 tons) by FY2023 (614,400 tons).

Table 43 General Information on Ebetsu City

Region	Central Hokkaido
Population	119,073 (as of November 2017)
Area	187.38 km^2
Contact information	Environmental Section, Environmental Office, Living Environmental Department, Ebetsu City Office 14-3 Koei-cho, Ebetsu-shi Tel: 011-381-1019
○ Ebetsu City CO_2 emissions reduction	
Target year	FY2023
Reduction target	Reduction by 5% (from FY2011)

○ Introduction of renewable energy by private enterprises

Sufficient power supply facilities and other favorable social conditions have attracted many private enterprises to the city's solar power generation, woody biomass power generation, and other projects. The city is assisting with their activities, for example, by providing project information to local residents to ensure that introduction of the particular renewable energy is supported by locals.

• Woody biomass power plant

The Oji Group[2], which has a paper mill in the city, has operated a woody biomass power plant since January 2016 (Heisei 28). As fuel, this plant mainly uses unused wood, such as wood thinned from the group's abundant forests in Hokkaido (later described in more detail).

All of the generated power is sold to new power producers and suppliers[3]. The city purchases power from a new power producer and supplier using power generated by this plant as one of its power sources, and uses the purchased power at 42 local public facilities. The city is working to attract the attention of local residents and businesses to woody biomass and other renewable energy sources to raise their awareness of actions against climate change.

• Ebetsu Northern Frontier Power Plant

This 1.5-MW solar power plant has been operated by private enterprises since February 2013 (Heisei 25) on the premises of a local waste disposal facility Environment Cleaning Center.
The city assisted with the construction of this power plant by leasing its land to promote use of renewable energy and provide local people with an opportunity to learn about the environment. In fact, many schools and organizations have visited this plant. In this way, this plant has helped develop a low-carbon community and promote locals' understanding of renewable energy.

Figure 59 Ebetsu Northern Frontier Power Plant

○ Cooperation in developing a low-carbon community

In addition to renewable energy efforts, the city has various efforts to create a low-carbon society with the cooperation of industrial, academic, public, and private sectors. Each of these efforts is based on cooperation, in which each sector plays its own role.

• Ebetsu Regional Council for Action against Global Warming and Ebetsu Environmental Expo

In 2004 (Heisei 16), local residents, organizations, businesses, and authorities established the Ebetsu Regional Council for Action against Global Warming [4]. Its steering committee, which meets once a month, plays an important role in discussions and consensus building, which are needed to efficiently take local action against climate change. The council holds the annual Ebetsu Environmental Expo, which provides local environmental groups, businesses, and residents with an opportunity to interact with each other. The council's efforts have greatly helped raise public awareness of environmental protection as surveys show that about 70% of local residents are highly concerned about environmental problems.

Figure 60 Ebetsu Environmental Expo

• Bicycle-sharing service "Nocchari"

As a part of the city's redevelopment project around Nopporo Station, the "Nocchari" bicycle-sharing service has started to create a low-carbon society and reduce the number of abandoned bicycles. This service is operated by the Nopporo Area Bicycle-sharing Steering Council formed by local authorities, trade associations, universities, and other groups, providing a low-carbon transportation system to the local community.
This service, which lends 50 bicycles, is widely recognized by local residents as its annual membership limit is closed soon after they begin accepting application every year.

Figure 61 Nocchari

○ Spillover effects on local economy and employment

Renewable energy facilities bring some tax revenue to the city. In addition, the expanded operation of such facilities helps increase local employment opportunities. The city plans to pursue community-wide renewable energy efforts by promoting cooperation with local residents and businesses, instead of providing financial assistance to individuals in purchasing solar power or other renewable energy equipment.

Introduction of Project <<Woody Biomass Power Plant of Oji Green Energy Ebetsu Co., Ltd.>>

○ One of the largest woody biomass power plants in Hokkaido

The Ebetsu plant of Oji F-Tex Co., Ltd., which manufactures paper and pulp, is the oldest plant in the prefecture, and will celebrate its 110th anniversary in 2018 (Heisei 30). This plant has worked to save energy and reduce environmental load in its production activities and been actively committed to tackling climate change, such as cogeneration using steam derived from woody biomass generated in the paper and pulp production processes.

As part of such efforts, one of the prefecture's largest woody biomass power plants started operation on the premises of the Ebetsu plant in January 2016 (Heisei 28). This woody biomass power plant uses the infrastructure and cogeneration technology of the Ebetsu plant. Its planned annual output is 150 GWh (which can meet the power demand of 40,000 ordinary households). Under the FIT program, all of the generated power is sold to Oji-Itochu Enex power retailing Co., Ltd., a company financed by the Oji Group. Taking advantage of the group's abundant forest resources in Hokkaido and its wood collecting system, this power plant mainly uses wood thinned from forests in the prefecture and other unused wood as fuel. In this way, the power plant helps revitalize local forestry, promote forest development, and promote related industries as well as actions against climate change.

Table 44 General Information on Woody Biomass Power Plant

Facility operator	Oji Green Energy Ebetsu Co., Ltd.
Location	Oji, Ebetsu City
Type and category	Woody biomass
Supplied energy	Power
Scale	Large scale
Reduced CO_2 emissions	-
Contact information	Oji Green Resources Co., Ltd. 7th floor of Oji Holdings Main Building, 4-7-5 Ginza, Chuo-ku, Tokyo Tel: 03-3563-4392

When constructing the power plant, the plant operator held explanatory meetings for locals in cooperation with the city office. Its construction and operation has been supported by local people partly because it is located within the Ebetsu plant. As already mentioned, the city purchases power from Oji-Itochu Enex power retailing and uses it at 42 local public facilities.

○ Facility overview and generated power

The woody biomass power plant generates power with steam. Its boilers combust woody biomass to generate high-temperature, high-pressure steam, and this steam drives steam turbines to generate power. Its rated capacity is 25,400 kW.

The largest amount of woody biomass used as fuel (in FY2016 (Heisei 28)), in terms of the ratio of input fuel[5], was woody fuel (mainly unused wood from the prefecture) (79%), followed by palm shells[6] (14%) and coal (7%). As stable combustion of woody fuel, which does not have a stable calorific value, needs fossil fuel, the

plant was designed to combust woody fuel with coal at a ratio of 8 to 2. Coal is partially replaced with palm shells, a carbon-neutral fuel.

○ Finances, profitability, and future challenges

The initial cost of the plant totaled about 8.5 billion yen, and its annual sales were expected to reach about 4 billion yen. Subsidies covered only a small part of the initial cost. The initial cost will be fully recovered within the application period of the FIT program.

The plant has directly employed about 20 people for its operation. The plant will also create employment opportunities indirectly and bring other economic benefits, as it has contributed greatly to revitalizing forestry and promoting forest development across the prefecture through its procurement of large quantities of woody biomass.

Figure 62 The Woody Biomass Power Plant

One of the plant's future challenges is a stable supply of biomass fuel, given that biomass power generation projects are increasing across the country. Another future challenge is possible changes to the FIT program, which may significantly affect the power generation operation because all of the generated power is sold under the program.

JICA's use of the projects and cooperation

Since Ebetsu City is more willing to work with local residents in environmental protection efforts than other municipalities in the prefecture, the city is a suitable partner in JICA's training programs to learn about resident cooperation and participation. The city can also provide an opportunity to learn about various efforts to tackle climate change as it has biogas power generation projects using livestock biomass, in addition to the biomass power plant and solar power plant mentioned earlier. It will be possible to plan training programs including interactions with local universities with environmental majors and their students. Note that the biomass power plant does not respond positively to study tours for safety reasons.

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1 Hokkaido Information University, Sapporo Gakuin University, Hokusho University, and Rakuno Gakuen University in Ebetsu City. Rakuno Gakuen University has the Department of Environmental and Symbiotic Science as a department of environmental studies and a demonstration plant for a cogeneration system consisting of livestock biomass power generation facilities and heat pumps.

2 Corporate group that started business with paper manufacturing more than 140 years ago and now provides products and services in various fields.

3 Specified-scale electricity utilities that are not general electricity utilities—regional major power companies (Hokkaido Electric Power, Tohoku Electric Power, Tokyo Electric Power, Hokuriku Electric Power, Chubu Electric Power, Kansai Electric Power, Chugoku Electric Power, Shikoku Electric Power, Kyushu Electric Power, and Okinawa Electric Power).

4 Under paragraph 1 of Article 40 of the Act on Promotion of Global Warming Countermeasures, a regional council for action against global warming can be established to discuss control of CO_2 emissions in daily life and take concrete action. The Ebetsu Regional Council for Action against Global Warming was established under this framework.

5 Ratio of fuel input to generate power.

6 Shells of palm seeds (by-product) left behind after palm oil (main product) is extracted. Palm shells, which contain oil, are used as a high calorific value fuel.

[Case 14] Hamanaka Town, Hokkaido

○ A town that coexists with nature

Located in eastern Hokkaido, Hamanaka Town has a population of about 6,000. The town is blessed with abundant nature as there is Kiritappu Wetland, a registered wetland under the Ramsar Convention, in the middle of its southern coastline. The town boasts a primary industry that takes advantage of this, particularly dairy farming and fishing; the former produces quality raw milk used in high-grade ice creams while the latter is primarily known for coastal fishing represented by one of the largest kelp-producing areas in Japan. The town has a great potential for solar power generation because it has a cool climate with an annual average temperature of 5°C to 6°C and is blessed with good weather from autumn to winter.

Table 45 General Information on Hamanaka Town

Region	Eastern Hokkaido
Population	6,018 (as of November 2017)
Area	423.63 km^2
Contact information	Environmental Policy Section, Planning and Fiscal Division, Hamanaka Town Office 1-35-1 Higashi-4, Kiritappu, Hamanaka-cho, Akkeshi-gun Tel: 0153-62-2194
○ Hamanaka Town CO_2 emissions reduction	
Target year	-
Reduction target	-

The town's comprehensive plan includes its future vision of "town coexisting with nature," clarifying its commitment to use solar power and other renewable energy sources. As a plan for environmental protection, the town established the Second Hamanaka Town Basic Environmental Plan in FY2016 (Heisei 28). Not having set its reduction target for CO_2 emissions, the town considers the promotion of renewable energy as one of its major actions for a better living environment. The town has actually shown its commitment to conducting studies to promote not only use of wind power generation already introduced, but also use of biomass, solar power, and other renewable energy sources. Since the town is suitable for solar power generation as mentioned above, more and more local residents and businesses have a solar power generation system.

○ Use of renewable energy originating from wind power generation

The town's renewable energy efforts originated from a wind power plant of the Hamanaka Town Interaction and Recreation Center, which was built by the town. This plant was built in FY2000 (Heisei 12) to secure an independent energy source needed in the event of a disaster and promote use of renewable energy. The 600-kW wind power plant was built on land adjacent to the center, supplying power to it. The surplus generated power is sold to Hokkaido Electric Power under the FIT program.

In 2006 (Heisei 18), a Hokkaido-based company and the town jointly built the Hamanaka Town Wind Power Plant (with an output of 1,500 kW). In the town, these two windmills are operating with the involvement of the local government.

Figure 63 Windmill of the Hamanaka Town Interaction and Recreation Center

As a place suitable for solar power generation, the town has also encouraged local residents to introduce a solar power generation system by granting subsidies for solar home systems. The town attracted a lot of nationwide attention in 2010 (Heisei 22) when 105 dairy farmers, who are members of JA Hamanaka (the Chusankan Hamanaka-Bekanbeushi community), introduced a solar power generation system with an output of 10 kW per farmer and a total output of 1,050 kW (later described in more detail).

○ Spillover effects on local economy and employment

After installation, both windmills and solar power generation systems do not directly create employment opportunities because they need no manpower for operation. On the other hand, their installation indirectly creates jobs in their transport and various works. For this reason, the town requires applicants for the subsidy to choose a local business for the installation of a solar home system so that as many economic benefits as possible will be brought to the community.

○ Balancing promotion of renewable energy with protection of local nature and scenery

In the town, many private enterprises have recently built a solar power plant to sell generated power under the FIT program. Solar panels installed in the Kiritappu Wetland and along the coastline have spoiled the local scenery and views. The town is therefore considering enacting a landscape ordinance as it needs to protect local nature and scenery while promoting renewable energy. There are NPOs and other groups working to protect the wetlands and their rich natural environment. The town has worked together with such groups to promote lifestyles and develop communities that coexist with nature, and also needs to discuss with them about how to promote renewable energy.

The town plans to promote renewable energy, keeping in mind natural and landscape conservation as a future direction of its renewable energy efforts, and needs to make effective use of abundant livestock biomass resources as one of its challenges.

Introduction of Project <<Introduction of Decentralized Solar Power Generation System by JA Hamanaka>>

This is a small-scale decentralized mega solar power generation project in which 105 dairy farmers from JA Hamanaka (the Chusankan Hamanaka-Bekanbeushi community) are participating.

Hamanaka Town, a major dairy farming area, has long been making efforts to balance dairy farming with environmental protection because dairy farming needs to rely on the local ecosystem. These efforts include forestation, planting, installing septic tanks and animal waste storage tanks as well as creating a green corridor[1], a nature conservation area where humans and wildlife can coexist. Through these efforts, the town has promoted dairy farming that coexists with nature. This small-scale decentralized mega solar system moves forward with these efforts and leads dairy farming using renewable energy.

Table 46 General Information on Decentralized Solar Power Generation System

Project operator	JA Hamanaka and its members
Location	From Hamanaka Town to the Toraibetsu district of Akkeshi Town
Type and category	Solar power
Supplied energy	Power
Scale	Small to medium scale
Reduced CO_2 emissions	945 tons/year * In comparison with coal-fired power generation
Contact information	JA Hamanaka 5 Chanai-sakae, Hamanaka-cho, Akkeshi-gun Tel: 0153-65-2141

A major feature of this system is that it is "decentralized," not "centralized." The community's solidarity and great environmental awareness nurtured through its efforts to create the green corridor and protect the environment have encouraged more farmers than initially expected to participate in this project.

The annual average output of each farmer, with some differences among the farmers, is about 10,000 kWh. In terms of CO_2 emissions from product/service lifecycles[2], this system is estimated to reduce about 9 tons of CO_2 emissions annually per farmer and about 945 tons for all 105 farmers if the emission factor of solar power generation (53-g CO_2 equivalent/kWh) is compared with that of coal-fired power generation (975-g CO_2 equivalent/kWh).

○ Facility overview and use of power

Each farmer participating in the project has a 10-kW solar power generation system and the entire community (105 farmers) can generate 1,050 kW of power. All solar panels used have the same specifications and are 3 m high by 20 m wide. Since it does not snow heavily there, the panels are unlikely to be buried by snow.

Generated power is used for bulk coolers[3] that deep-freeze raw milk produced with milking machines and ventilators and other equipment of cowsheds and other farming facilities, and not used at homes (farming subsidies were used to install the systems). Surplus power is sold to Hokkaido Electric Power, but not eligible for the FIT program due to the subsidies.

○ Finances, profitability, and future challenges

The installation of solar panels created short-term jobs as it was contracted out to local businesses, but failed to create continuous employment opportunities. The project's economic benefits to the community have been limited to the farmers' proceeds from sales of generated power. What is most important, however, is that the town is recognized as a community practicing dairy farming that coexists with nature. The town hopes that such recognition will increase the value of local brands and enhance the reputation of locally produced raw milk.

Figure 64 Solar Power Generation System
(* Every farmer has the same system.)

The total project cost for each farmer was seven million yen, which included the price of the solar power generation system, the system installation cost, and the cost of increasing distribution capacity. Since half the cost was covered by a subsidy from the Ministry of Agriculture, Forestry and Fisheries and a quarter was covered by the government's direct payment program for hilly and mountainous areas, each farmer actually bore only 1.5 million yen of the total cost. To ease this financial burden, they could borrow money from the Clean Energy Fund of JA Hamanaka. They were informed that they would be able to recover their investment in seven years on the assumption that the solar power generation system would bring them about 200,000 yen a year. Seven years after their introduction of the system, they have almost recovered their investments, as expected.

JICA's use of the projects and cooperation

Balancing the promotion of renewable energy with protection of rich nature and scenery, which Hamanaka Town considers one of its challenges, will also be a future challenge for many developing countries. In the town, environmental NPOs and other local groups play a major role in community development and the conservation of the Kiritappu Wetlands. It will be greatly helpful to learn about the philosophies and roles of such groups and various other stakeholders.

This decentralized mega solar project is based on the support and participation of local farmers. It is a good example of local use of abundant local solar power resources. Since the community-wide efforts to introduce small solar power systems have brought megawatt output, the town will be a suitable partner in learning about the importance of local solidarity and cooperation resulting from long-term environmental protection and communication efforts.

1 Attempt to connect wildlife populations separated by human activities, secure genetic diversity, and protect biodiversity by facilitating the movement of wildlife (mainly animal species) between forests, expanding their habitats, and promoting their interactions.
2 Processes from procurement of raw materials of products/services to disposal of products or other steps.
3 Large metal containers for freezing and storing raw milk.

5. Conclusion and Suggestions

Recent years have seen an increasing number of renewable energy projects led by outside organizations under the FIT program (outside initiative). These projects are generally large-scale projects and contribute greatly to reduction of CO_2 emissions using renewable energy.

It is also important for local communities to take the initiative as far as possible or cooperate with outside organizations in order to solve local problems and revitalize themselves by making sustainable use of renewable energy.

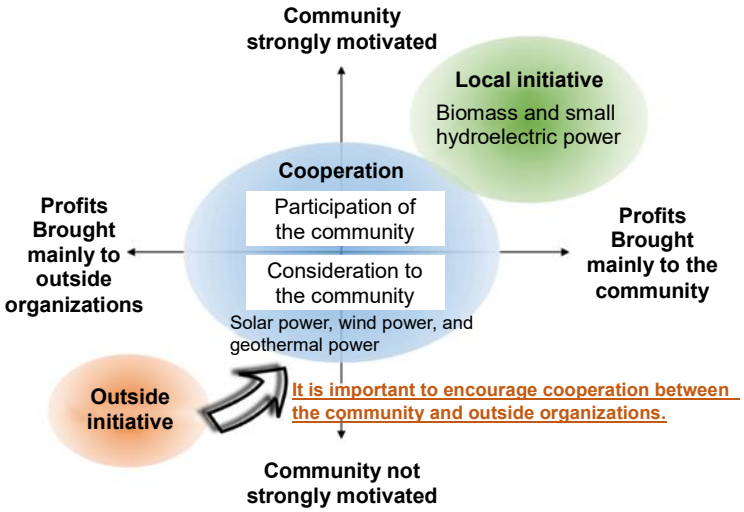

Figure 65 Classification of Initiative in Introducing Renewable Energy

(Report of the Conference on Future Introduction of Renewable Energy by Rural Communities for Agriculture, Forestry, and Fisheries [the Ministry of Agriculture, Forestry and Fisheries] partially changed by the Hokkaido Environment Foundation)

Hokkaido has various renewable energy projects that take advantage of locally abundant resources. In many of these projects, local communities take the initiative or cooperate with businesses in introducing renewable energy or operating facilities. The projects and efforts of the 14 communities introduced in this report give us some suggestions. Shown below are important suggestions about making sustainable use of renewable energy to solve local problems and revitalize local communities, as well as to reduce CO_2 emissions.

(1) Evaluate and understand local resources that can be used to counteract climate change

Every community has resources that can be used to counteract climate change. Nevertheless, many of such local resources are not used; some of them are even seen as local problems or challenges. In Wakkanai City, for example, strong wind used to be a nuisance, but is now used as valuable local resources. Snow and ice cold widely used in the prefecture is also a good example of using the local snowy and cold climate as local resources. It is necessary to rediscover local natural and social characteristics and quantify local resources whenever possible to find out what local resources can be used.

(2) Set the community's visions and goals

It is important to clarify what the community wants to achieve by introducing renewable energy. Many renewable energy projects in Hokkaido aim to solve local problems or revitalize the local community. For example, Shimokawa Town aims to promote local forestry and solve the problems of their super-aging society while Betsukai Town aims to create a sustainable dairy farming environment. If the community has visions that cover industry and lifestyles, it can objectively see what efforts it needs to take and discuss the future direction of said efforts.

(3) Maintain good communication with local residents and stakeholders

When introducing renewable energy derived from local resources, the local government and businesses participating in the project should work with local residents as much as possible. Even if residents cannot take the initiative in the project, it is still important to gain their overall support for the project. For example, Mori Town, which has a geothermal power plant in proximity to private houses, makes effective use of geothermal water as a result of repeated discussions about use of geothermal heat among the town office, local businesses, and local farmers. Encouraging residents to have an interest in local renewable energy projects through communication lays the foundation for efforts to realize the community's visions.

(4) Focus on the benefits of projects brought to the community, such as local revitalization, contribution to local economy, and job creation

The purposes of introducing renewable energy should include job creation, local revitalization, disaster management, or other benefits to the community. Since actions against climate change are a matter of global urgency, there is no doubt that local communities need to work to reduce CO_2 emissions. However, they often have no choice but to give local issues priority over such global issues, so it is important for them to focus on such secondary benefits when introducing renewable energy. For example, the geothermal power plant in Okushiri Town helps overcome the fragility of energy supply peculiar to an isolated island while Hamanaka Town aims to increase the brand value of its local dairy farming through various environmental conservation efforts, including the installation of solar power generation systems. It is thus important to evaluate the possible benefits of efforts to promote introduction of renewable energy from various perspectives.

(5) Decide the direction of efforts, manage project progress, and play other roles

What is important in suggestions (1) to (4) is the roles of the local government. In both community-led projects and projects conducted in cooperation with enterprises and other entities, the local government needs to take the initiative in managing project progress and communicating with local residents. In the projects introduced in this report, each local government has some plans or visions concerning environmental protection, actions against climate change, and introduction of renewable energy and plays various roles, such as managing the progress of the projects, leading the projects, settling differences between enterprises involved and local residents, and assisting with the activities of various stakeholders. The roles of local governments close to local resources are significant for use of local resources.

Renewable energy introduced to meet various local needs is the product of repeated trial-and-error and inventive approaches that meet the local needs, not limited to the approaches suggested in (1) to (5). When applying the renewable energy projects in Hokkaido to JICA's projects and training programs, JICA should see the introduction of renewable energy not only as actions against climate change, but also as community development efforts. They should include the processes of solving local problems that prompted local communities to introduce renewable energy and the secondary benefits of the projects they expect beyond the introduction of renewable energy (such as local revitalization, job creation, and disaster management).

Since the number of renewable energy projects that have been introduced in Hokkaido is not large compared with the prefecture's abundant potential reserves of renewable energy, the prefecture can still expand its use of renewable energy. By interacting with JICA's human network and participants in its training programs, local communities may be able to rediscover their local resources and find clues to solving their local problems with the help of outside perspectives. For this reason, working with JICA through renewable energy projects is likely to bring significant benefits to many local communities in Hokkaido.

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