Project commissioned by the Ministry of the Environment in 2023

City-to-City Collaboration Programme for Zero-Carbon society in 2023 (Support project for the achievement of SDGs and developing a sustainable decarbonized society: City-to-City Collaboration between Ehime Prefecture and Gorontalo Province)

Report

March 2024

Japan NUS Co., Ltd.

Ehime Prefecture

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List of Abbreviations

Abbreviation	English/Indonesian	Japanese
BAPPEDA	Badan Perencanaan Pembangunan Daerah	地方開発計画局
BAU	Business as usual	成り行きシナリオ
BUMD	Badan Usaha Milik Daerah	地域開発公社
COP26	The 2021 United Nations Climate Change Conference	国連気候変動枠組条約第26回締約国会議
DLHK	Dinas Lingkungan Hidup dan Kebersihan	環境衛生局
DPRD	Dewan Perwakilan Rakyat Daerah	地方国民代表評議会
ESDM	Ministry of Energy and Mineral Resource	エネルギー鉱物資源局
FACT 対話	Forest, Agriculture and Commodity Trade Dialogue	森林・農業・コモディティ貿易対話
GSS	Gas Solid Separator	三相分離装置
IPAL	Instalasi Pengolahan Air Limbah	排水処理設備
JCM	Joint Crediting Mechanism	二国間クレジット制度
KLHK	Kementerian Lingkungan Hidup dan Kehutanan	環境林業局
NDC	Nationally Determined Contribution	自国が決定する貢献
PLN	Perusahaan Listrik Negara	インドネシア電力公社
POME	Palm Oil Mill Effluent	パーム油排水
PUPR	Pekerjaan Umum dan Perumahan Rakyat	公共事業・国民住宅局
RAD-GRK	Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca	地方温室効果ガス排出削減行動計画
RAN-GRK	Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca	国家温室効果ガス排出削減行動計画
REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries	途上国の森林減少・劣化に由来する排出の削減
RKPD	Rencana Kerja Pemerintah Daerah	地方作業計画
RPJMD	Rencana pembangunan jangka menengah daerah	地方中期開発計画
RPJMN	Rencana pembangunan jangka menengah nasional	国家中期開発計画
RUED	Rencana Umum Energi Daerah	地方エネルギー総合計画
RUEN	Rencana Umum Energi Nasional 2015-2050	新国家エネルギー政策
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik	インドネシア電力供給事業計画
SDGs	Sustainable Development Goals	持続可能な開発目標
JANUS	Japan NUS Co., Ltd.	日本エヌ・ユー・エス株式会社（提案事業者）

1. Purpose and background of this project

1.1. Purpose

With a consensus document produced at the 2021 United Nations Climate Change Conference (COP26) held in November 2021, it was confirmed that a new global goal is to keep the increase in air temperature since the industrial revolution from exceeding 1.5℃. In order to attain this goal, it is indispensable to accelerate initiatives at various levels, including provincial, municipal, and ward levels, in each country. The Japanese government, too, declared that it would aim to realize a decarbonized society by decreasing the net emissions of greenhouse gases to zero by 2050, and the number of municipalities that have declared that they will decrease the net CO_2 emissions to zero increased rapidly to over 600 (as of April 30, 2022). Based on the roadmap for decarbonization in each region, which was formulated in June 2021, advanced measures have been designed in each region, and activities for spreading them nationwide are ongoing.

Accordingly, the role of cities and local governments is becoming more important when discussing and implementing specific regional measures and projects against climate change. In order to realize a global decarbonized society, we must accelerate the movement toward building a sustainable decarbonized society, especially in Asia, where economic growth is remarkable. The movement to support the decarbonization and low-carbonization efforts of cities, which are places for activities that support socio-economic development, is being strengthened internationally.

Furthermore, in the midst of the COVID-19 pandemic, cities are under pressure to address issues related to the spread of infection, while readjusting and considering new measures to achieve sustainable development. It is vital to establish new methods for collaboration among cities and build new cities.

Considering the above situation, the purpose of this research project was defined as formulating a plan to realize both decarbonization and development and disseminate technology in Gorontalo Province, where economic growth is remarkable, in cooperation with Ehime Prefecture.

1.2. Background

Gorontalo Province is a region of Indonesia that has experienced particularly remarkable economic growth in recent years. However, it also faces various environmental and social issues such as underdeveloped infrastructure, water pollution, and deforestation. In order to solve these issues, Gorontalo Province recognizes the necessity of formulating a plan for decarbonization due to the need for climate change mitigation. Although the province implemented such a plan, it has been unable to enter the implementation stage. Moving forward, although there are plans for incorporating the perspective of decarbonization in various measures, including the development plan for Gorontalo Province, it is still necessary to take measures that will lead to effective efforts. Gorontalo Province expects Japan's support and cooperation in order to utilize the precedent cases and know-how in such efforts, and is particularly interested in deriving solutions in collaboration with Ehime Prefecture.

In Gorontalo Province and Ehime Prefecture, starting with academic exchanges between Gorontalo State University and Ehime University in 2007, a delegation from Gorontalo Province

visited Ehime Prefecture in 2016 and laid the foundation for industry-academia-government collaboration, including the interaction with Ehime Prefecture, Ehime University, and private companies.

Against this background, Ehime Prefecture received a request for support in deriving solutions based on the formulation of decarbonization policies to address environmental and social issues such as underdeveloped infrastructure, water pollution, and deforestation in Gorontalo Province, which led to the start of the city-to-city collaboration project.

1.3. Implementation system

Figure 1-1 shows the work implementation system for the current fiscal year. Under the framework of city-to-city cooperation, Ehime Prefecture and Gorontalo Province signed a cooperation agreement in which the Regional Development Agency of Gorontalo Province (Badan Perencanaan Pembangunan Daerah: hereinafter referred to as "BAPPEDA") will serve as the contact point. The parties held discussions on sharing know-how and supporting policymaking related to decarbonization policies and planning that promote projects such as the regional water infrastructure development project using decarbonized energy, sustainable forest utilization through cacao cultivation, and other projects under consideration for this survey.

When considering commercialization, we cooperated with corporations based in Ehime Prefecture; specifically, Daiki Axis Co., Ltd., which possesses experience in the installation and maintenance of wastewater treatment plants, and Aiken Kakoki K.K., which possesses experience in wastewater treatment and in the design and construction of methane fermentation facilities for sludge, etc. Moreover, in the project for sustainable forest utilization, we collaborated with Kanematsu Corporation, which has been engaged in Reducing Emissions from Deforestation and Forest Degradation in Developing Countries project (hereinafter referred to as "REDD + project") in the western part of Boalemo Regency since 2011. JANUS managed the entire project, including information gathering related to city-to-city collaboration, support for various surveys, and liaison and coordination of related organizations and companies.

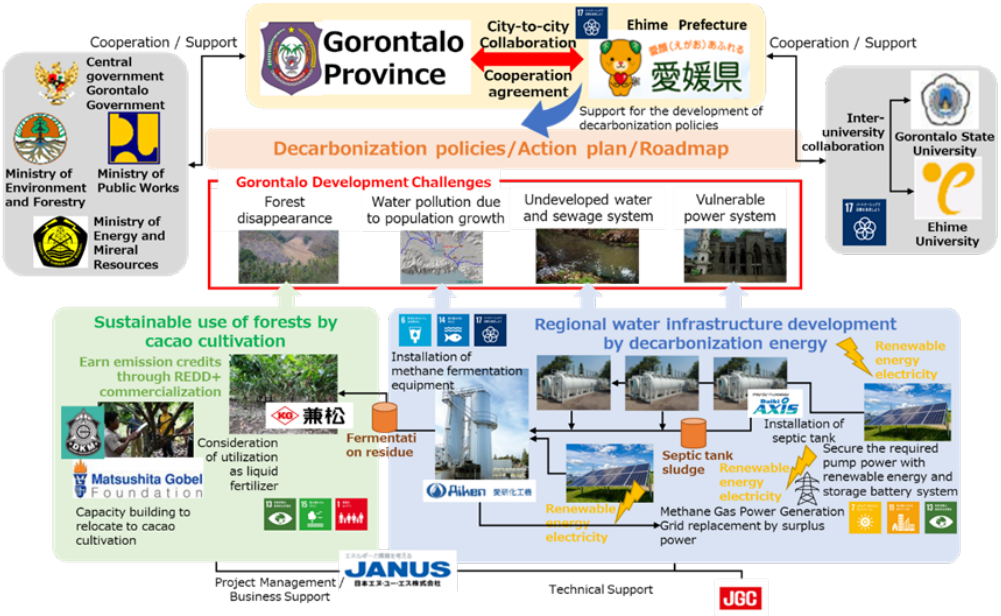

Figure 1-1 Overview and implementation system for this project

2. Overview of Gorontalo Province

2.1. Basic information

Gorontalo Province is located in the northern part of the Sulawesi Island. Gorontalo Province became independent from North Sulawesi in 2000, and is composed of five regencies (Boalemo, Bone Bolango, Gorontalo, North Gorontalo, and Pohuwato) and one city (Gorontalo). Approximately 70% of the entire province is composed of hills ranging from 884 to 2,100 m above sea level, and there is little flat land. The population of Gorontalo Province is currently 1.17 million, and the average population has increased by 1.56% each year from 2010 to 2020. When looking at the population distribution by municipality, Gorontalo Regency has the largest population of 390,000, but the city of Gorontalo has the highest population density of about 2,500/km^2 [1].

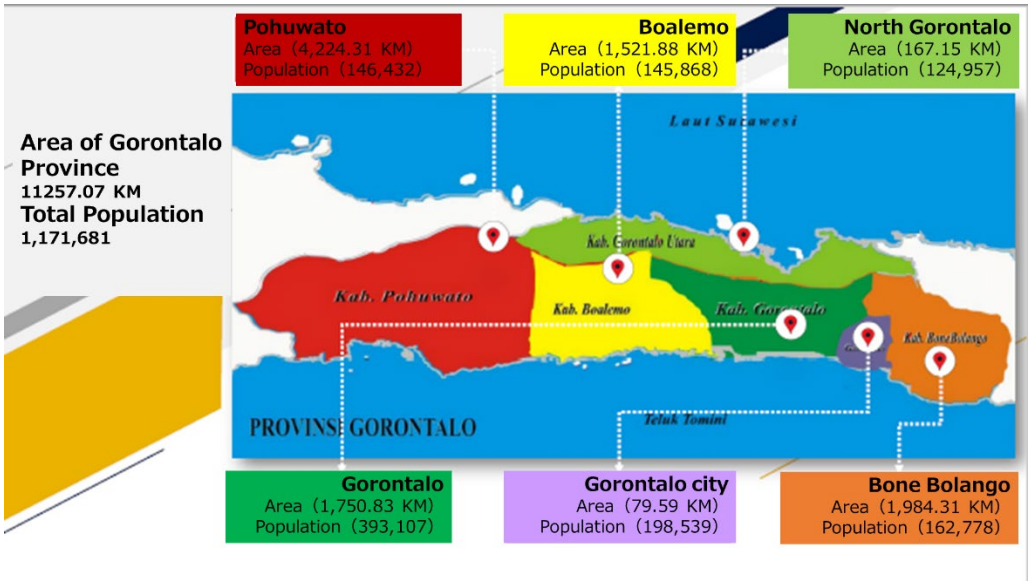

Figure 2-1 Composition of Gorontalo Province[2]

In terms of the economic conditions on the Sulawesi Island, which includes Gorontalo, regional real GDP growth rate from 2014 to 2018 has ranged from 6.7% to 8.2% (with respect to 2010), a level which exceeds the national average. [3] This shows remarkable economic growth in the region. The main industry is agriculture, forestry and fisheries, and the ratio of primary industry to the regional nominal GDP in 2018 was 24.9%, which was twice the national average (12.5%). Among the primary industries, the ratio of agriculture and fisheries is particularly high. Rice and corn are

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[1] BADAN PUSAT STATISTIK PROVINSI GORONTALO (Sep. 2021) "Regional Statistics of Gorontalo Province 2021" (https://gorontalo.bps.go.id/publication/2021/09/27/c7f09b2c19efb8efde4f5221/statistik-daerah-provinsi-gorontalo-2021.html)

[2] Taken from the reference material for a presentation at the workshop of BAPPEDA in Gorontalo Province

[3] JBIC (Dec. 2019) "Investment environment in Indonesia 2019" (https://www.jbic.go.jp/ja/information/investment/images/inv_indonesia201912.pdf)

actively grown in the agriculture industry. Plantation crops, too, are actively grown, including sugar cane, coconut, cacao, coffee, and cloves.

Since Gorontalo Province is located near the equator, it has a warm climate with an average annual temperature of 26 to 28 degrees Celsius and an average annual rainfall of 29.6 mm. The month with maximum precipitation is November, and the month with minimum precipitation is May.

2.2. Government of Gorontalo Province

Gorontalo Province became independent of North Sulawesi Province on December 5, 2000. At the beginning of its independence, the province was composed only of Gorontalo Regency, Boalemo Regency, and the city of Gorontalo. However, in conjunction with regional development, Pohuwato Regency and Bone Bolango Regency were established in 2003, and North Gorontalo Regency was established in 2007. The development of the new regencies and the revitalization of the region have progressed rapidly, and Gorontalo Province is currently composed of five regencies, one city, 77 counties, 72 districts, and 684 villages.

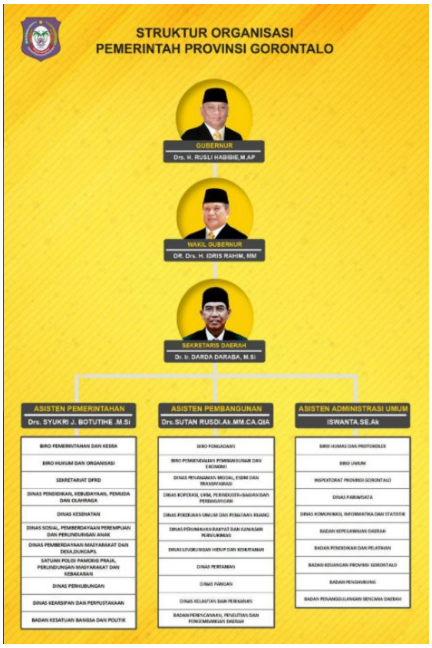

Figure 2-2 Organizational structure of Gorontalo Province government[1]

Since 2017, the governor of Gorontalo Province has been Drs. H. Rusli Habibie MAP and the vice-governor has been DR. Drs. H. Idris Rahim, MM. After assuming office, the governor espoused his vision for the province as "realizing an advanced, outstanding, and prosperous society in Gorontalo." A regional secretariat serves under the governor and vice-governor. Under the regional secretariat, there are three assistants and seven bureaus on politics, economics, and other administration. The organizational structure of the Gorontalo Province government is shown in the right figure.

In addition to the regional secretariat, the provincial government agencies include the secretariat of the Regional People's Representative Council (Dewan Perwakilan Rakyat Daerah: DPRD), as well as ten regional technical agencies, twelve offices, and five regional organizations based on statutory rules and regional needs. These agencies are responsible for the administration in Gorontalo Province[4].

2.2.1. Primary political measures and policies

The primary political measures and policies in Gorontalo Province are formulated in the Regional Long-Term Development Plan (Rencana pembangunan jangka menengah daerah: hereinafter referred to as "RPJMD"). The period of the latest RPJMD is 2017 to 2022. Local governments are required to formulate the RPJMD in accordance with the National Medium-Term Development Plan

[4] DINAS KOMINFO DAN STATISTIK PROVINSI GORONTALO (November 2019) "BUKU PROFIL PROVINSI GORONTALO 2019"

(Rencana pembangunan jangka menengah nasional: hereinafter referred to as "RPJMN") for Indonesia. The latest RPJMN for Indonesia will be explained in detail in the next section.

(1) National Medium-Term Development Plan (RPJMN)

The Indonesian government announced the new RPJMN in January 2020. In the plan, the average annual growth rate of real GDP is expected to be 5.7% to 6.0%. It is estimated that investment of about 35,000 trillion rupiah will be required to achieve the growth target. The plan also sets the goal of raising gross national income per capita to $5,810-$6,000 by 2024[5].

The RPJMN sets the president's nine missions and five directives. Moving forward, the seven development challenges listed below will be dealt with. They pursue development that is environmentally-friendly, improves disaster resilience, and copes with climate change.

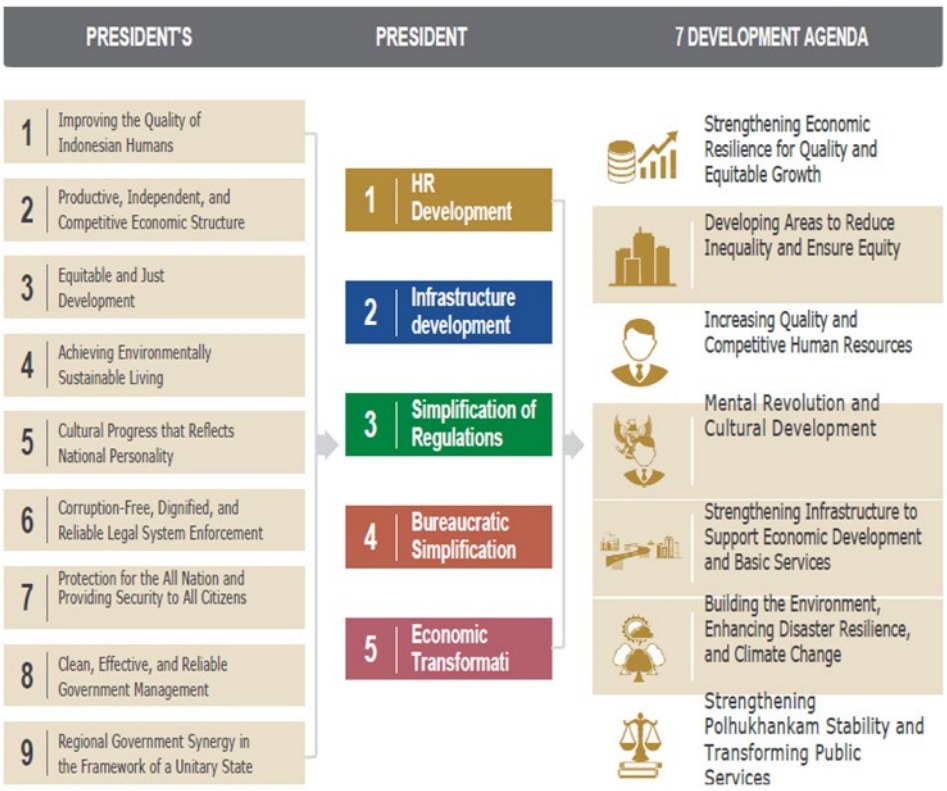

Figure 2-3 President's directives and seven development challenges in the National Medium-Term Development Plan (RPJMN)[5]

The macro development targets of the RPJMN also mention the GHG emissions reduction target. In order to achieve the 29% reduction compared to BAU by 2030 as listed in the NDC, the target GHG reduction amount was set at 27.3% by 2024.

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[5] Ministry of National Development Planning of Indonesia "Rencana Pembangunan Jangka Menengah Nasional 2020-2024, Narasi (National Medium-Term Development Plan)"

Figure 2-4 Macro development targets in the National Medium-Term Development Plan (RPJMN) 2020-2024[5]

In energy development plans, Indonesia still relies on fossil fuels. The country's energy self-sufficiency rate, which was 75% in 2018, is expected to drop to 28% by 2045. To cover this, the country's goal is to promote the spread of renewable energy as set forth in the General Plan for National Energy (Rencana Umum Energi Nasional 2015-2050: hereinafter referred to as "RUEN") that was formulated in 2015, and to increase the ratio of renewable energy to 23% by 2024. RUEN states the following policy for energy development.

(1) Accelerate the development of renewable energy
(2) Increase the amount of biofuel supplied
(3) Secure energy and promote energy conservation
(4) Increase the supply of energy to industry
(5) Develop NRE (New Renewable Energy) and support industry

When working to achieve the target for increased renewable energy, RUEN also clearly states that focus will be placed on the development of renewable energy derived from oil palm. The related investment amount is expected to be 32 trillion rupiah by 2024.

Furthermore, RUEN clearly states that the target for water infrastructure development is to increase the number of households that can use wastewater treatment facilities to 90%. The related investment amount is expected to be 140 trillion rupiah by 2024.

Regarding decarbonization, the trend of NDC based on the Paris Agreement as well as the RPJMD mentioned above is important. As will be described later in Section 4.1, in July 2021, Indonesia announced the latest version of the NDC in accordance with the Paris Agreement and declared its aim for carbon neutrality (the reduction of greenhouse gas emissions to virtually zero) by 2060. Therefore, it is necessary to pay close attention to how the latest trends will impact the political measures and policies of the Indonesian central government, including the current RPJMN.

(2) Gorontalo Province Medium-Term Development Plan (RPJMD)

As mentioned above, the RPJMN was formulated by the Indonesian national government, and a provincial RPJMD was formulated by each province accordingly.

The Gorontalo Province RPJMD (2017-2022) has the following five development missions, which are in line with the RPJMN for 2015 to 2019.

(1) Realize healthy and sustainable tourism, and management of natural resources: While upholding the principle of protecting the environment and forest areas, maintain the safety of energy and water by targeting the management of natural resources, especially tourism, agriculture, fishing, and marine issues.
(2) Ensure the availability of regional infrastructure: Development of technology that enhances the availability of basic infrastructure equipment, telecommunications equipment, and transportation and shipping equipment, and includes the provision of infrastructure equipment in strategic regions, urban areas, and farming villages.
(3) Improve even more fair and equitable regional welfare: Improve regional welfare by increasing per capita GDP, per capita spending, and income distribution, and guarantee the comprehensiveness and sustainability of that regional welfare.
(4) Improve the quality of human resources: Improve the quality of education, health, and regional cultural development in order to cultivate high quality human resources, reduce poverty, and realize the basic rights of regional society in Gorontalo Province.
(5) Creation of good governance and even more services: Develop creative, innovative, and competitive professional government agencies and maintain regional security, order, and political stability.

The following is a table summarizing the development missions, vision, targets set under the missions, and indicators of target achievement for the RPJMD of Gorontalo Province.

Table 2-1 Vision, missions, and targets for the RPJMD of Gorontalo Province

No.	Mission	Objective	Target	Indicator	Initial Status (2016)	Target (2022)
Vision: Realizing an advanced, outstanding, and prosperous society in Gorontalo						
1.	Realize management Environmentally-friendly and sustainable tourism and natural resources	Tourism	Increase of tourists	Number of Japanese and foreign tourists	5,923	7,937
				Number of island tourists	566,398	759,023
				Average stay period of tourists	1.52	4
		Strengthening Management Natural resources for social welfare	Increase contribution of agriculture / plantation sector GDP	Contribution rate in agriculture sector GRDP [trillion rupiah]	11,916.05	14,228.39
			Increase availability and consumption of food supplied by agriculture and marine fisheries that affect the welfare of farmers and fishermen	Exchange rate of farmers	105.63	106.40
				Exchange rate Fishermen/cultivator equipment (NTNP)	101.37	102.1
				Availability of PPH score	65.27	66.89
				Consumption PPH score	76.3	85.5
				Exchange rate of farmers Livestock sub-sector (NTPT)	102.62	104.42
		Maintain the carrying capacity	Forest resources Land	Quality indicator Environment	71.06	73.61
		Sustainable natural resources	Sustainable marine/coastal areas and disaster mitigation	Important land area	706,930 ha	700,930 ha
				Disaster risk indicator	0.66 - 1	0.3 - 0.65
2.	Secure the availability	Strengthening	Improve the quality and	Stable road status [%]	41.15%	70%

	of regional infrastructure	Regional infrastructure for sustainability and economic activities	amount of regional infrastructure	Percentage of length of local road network in good condition [km]	209	278
				Digital government indicator	3.75	3.85
3.	Improve even fairer and more equitable regional welfare	Strengthening Happiness Public	Increase Comprehensive and fair regional welfare	Economic growth	6.52	7.27
				Gini coefficient	0.42	0.36
				Inflation rate [%]	1.30	3.30
				Gross capita GRDP	27,654,339.50	28,155,865.91
				Unemployment rate	3.88	2.86
				Income	1.58	2.99
				Undeveloped villages	103	88
4.	Improve the quality of human resources	Quality improvement Personnel	Improve access and quality of education	Human development indicator	66.29	69.62
				Participation rate SMA/MA/SMK	76.13	78.00
				Literacy rate	99.81	100
				Average score	7.12	7.9
			Improve health and nutrition	Average lifespan	66.59	68
				Total fertility rate	2.60	2.40
			Growth culture and Imtaq	Acquired cultural heritage Domestic and international recognition	3	15
				Ratio of places of worship (mosques) per population unit	0.23	0.25
		Reduce poverty	Reduce poverty rate	Poverty ratio	17.63	14.69

				Residents in poverty [people]	203,831	185,391
			Increased access to drinking water, proper hygiene, and residential areas	Cover ratio for access to proper drinking water	71.59%	83.02%
				Ratio of access to proper hygiene	56.27%	69.41%
				Ratio of reduction for slum regions	-	0%
5.	Outstanding governance and even more services	Even better and more services	Maintenance improvement	Reform indicator	CC	B
				Value of evaluation results Government performance	CC	BB

2.2.2. Environmental issues in Gorontalo Province

In Gorontalo Province, although the economy is growing remarkably, the underdeveloped infrastructure is an issue. In particular, development of the water and sewage infrastructure is lagging behind, and the population increase is causing increasingly serious pollution of rivers and lakes. As of 2018, Manado is the only city on Sulawesi that has a sewage system, which is for only part of the city. Furthermore, according to the PLN Statistics 2019 issued by the State Electric Company (Perusahaan Listrik Negara: hereinafter referred to as "PLN"), the electrification rate in the province is reported to be 97.1%[6]. However, this rate excludes electric companies other than PLN, and there are still non-electrified areas. Also, in electrified areas, the fragile power infrastructure is a barrier to development; for example, there are frequent power outages.

When the government Gorontalo Province became independent from North Sulawesi, it adopted a policy of making corn agriculture the province's main industry and implemented a policy for subsidizing farmers. Consequently, cultivation has expanded not only to plains, but also to areas that are unsuitable for corn cultivation, such as steep slopes in hills and mountainous areas. Moreover, slash-and-burn cultivation has progressed in mountainous areas and caused rapid deforestation. As a result, in addition to the disappearance of CO_2 sinks, the decline in the water holding capacity of forests leads to landslides and frequent floods in urban areas. In particular, the densely-populated city of Gorontalo is located in the central basin and is surrounded by hills and mountainous areas, so the terrain is vulnerable to floods and the accompanying impact is enormous. Additionally, it is estimated that 1,500,000 m^3 of sediment flows into Lake Limboto (located in Gorontalo Regency and the city of Gorontalo) every year due to erosion of agricultural land and riverbanks. Some people predict that the lake will disappear in 2030 due to the lake bottom being buried in sediment. The impact of sediment inflow is also seen on the coast, where the sediment flowing from slopes pollutes seawater and kills coral reefs[7]. The influx of sediment is also affecting the ecosystem. For example, the water hyacinth, which is thought to have been carried from rivers, has rapidly propagated in Lake Limboto since around 2000. This sudden proliferation of the water hyacinth is viewed as a problem because it hinders the activities in the fishing industry and the growth of other plants.

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[6] PLN (Jun. 2020) "PLN STATISTICS 2019"
(https://web.pln.co.id/statics/uploads/2020/11/Statistik-Inggris-2019.pdf)

[7] Kasamatsu et al., 2020 "Prior Study for the Biology and Economic Condition as Rapidly Environmental Change of Limboto Lake in Gorontalo, Indonesia"
(https://iopscience.iop.org/article/10.1088/1755-1315/536/1/012005/pdf)

Slash-and-burn agriculture in mountainous regions

Lake Limboto is becoming shallower due to the inflow of sediment

Rapid propagation of water hyacinth in Lake Limboto

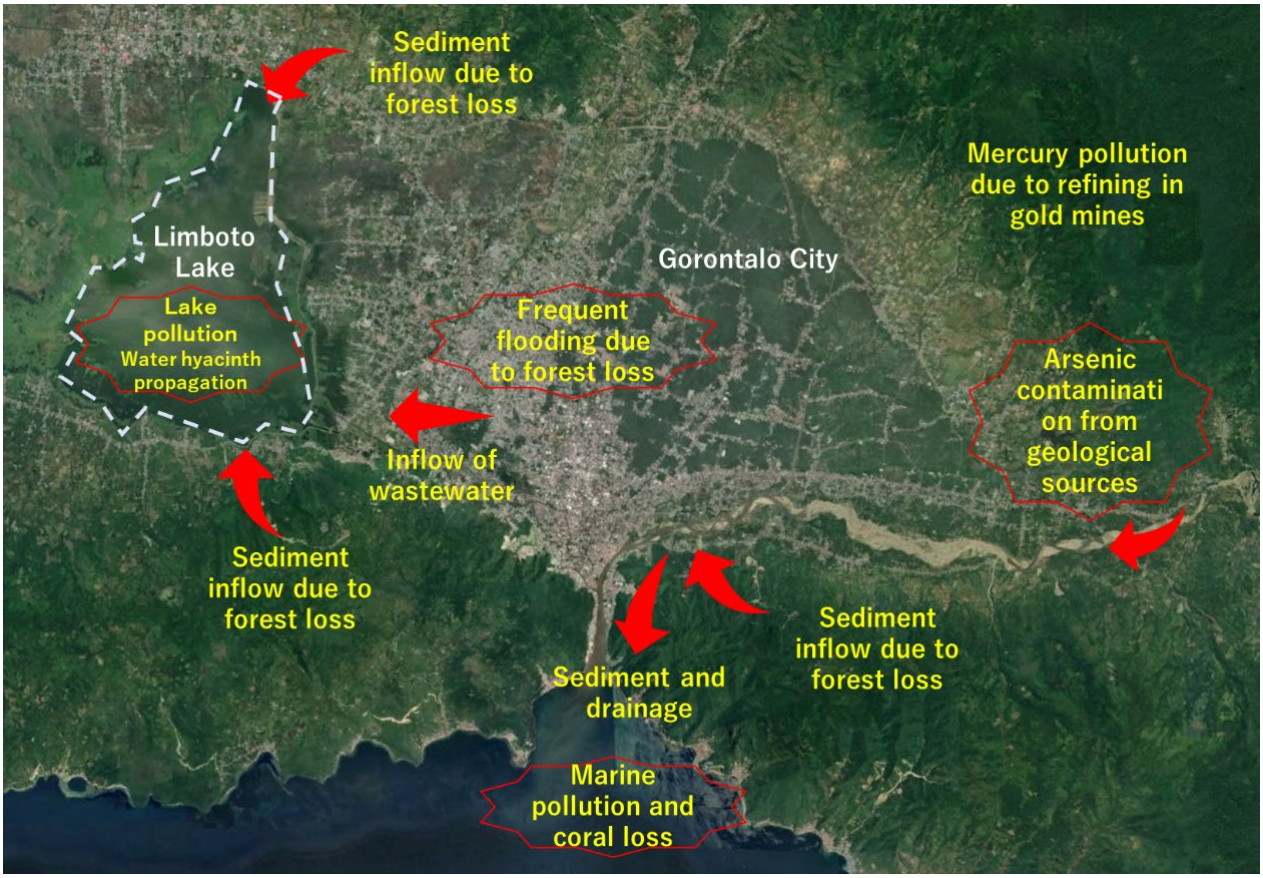
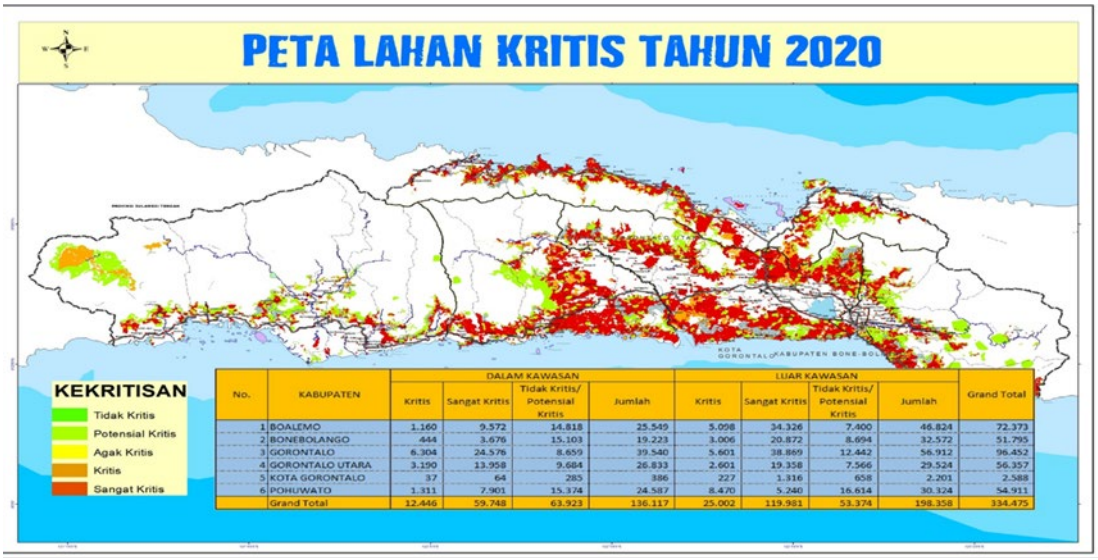


Figure 2-5 Environmental issues and geographic conditions in Gorontalo Province

The government of Gorontalo Province is also concerned about this situation, and starting efforts to grasp the actual situation, predict the impact, and design measures. Figure 2.5 shows only the area around Gorontalo City, but as shown in Figure 2.6, the areas with the above-mentioned problems are spread throughout the province. In the workshop held last fiscal year, Gorontalo Province mentioned that deforestation and other factors have reduced forest water retention capacity and reduced the size of Lake Limboto due to sediment influx, and that the number of critical areas in the province is increasing. Also, the following four major environmental issues were brought up for discussion and Ehime Prefecture was requested to support the resolution of these issues based on decarbonization.



No.	KABUPATEN	DALAM KAWASAN				LUAR KAWASAN				Grand Total
		Kritis	Sangat Kritis	Tidak Kritis/ Potensial Kritis	Jumlah	Kritis	Sangat Kritis	Tidak Kritis/ Potensial Kritis	Jumlah	
1	BOALEMO	1.160	9.572	14.818	25.549	5.098	34.326	7.400	46.824	72.373
2	BONEBOLANGO	444	3.676	15.103	19.223	3.006	20.872	8.694	32.572	51.795
3	GORONTALO	6.304	24.576	8.659	39.540	5.601	38.869	12.442	56.912	96.452
4	GORONTALO UTARA	3.190	13.958	9.684	26.833	2.601	19.358	7.566	29.524	56.357
5	KOTA GORONTALO	37	64	285	386	227	1.316	658	2.201	2.588
6	POHUWATO	1.311	7.901	15.374	24.587	8.470	5.240	16.614	30.324	54.911
	Grand Total	12.446	59.748	63.923	136.117	25.002	119.981	53.374	198.358	334.475

*Sumber: BPDASHL Provinsi Gorontalo-2020

Figure 2-6 Environmentally endangered areas in Gorontalo Province2

Figure 2-7 Priority environmental issues in Gorontalo Province2

At the time of exchange of opinions with BAPPEDA, the public works bureau, environment bureau, and agricultural bureau of Gorontalo Province last fiscal year, we asked about the environmental issues and political measures listed below to reconfirm the issues and needs, and visited related offices to grasp the actual situation.

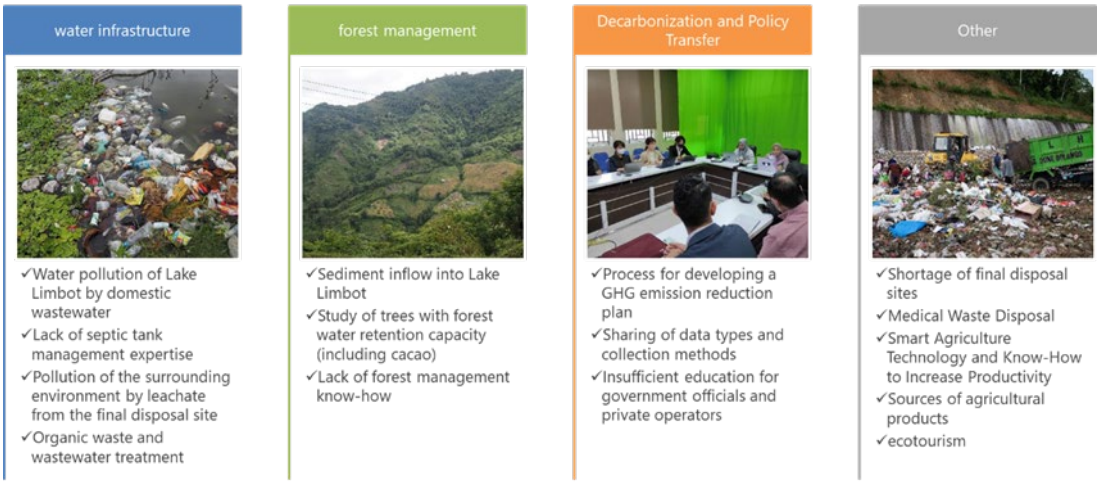


Figure 2-8 Environmental issues and needs confirmed through the interview with the government of Gorontalo Province

2.3. Background of collaboration with Ehime Prefecture

2.3.1. Background for interaction

Figure 2-9 Entering into the Three-Party Memorandum in 2016

The relationship between Ehime Prefecture and Gorontalo Province has been fostered since Ehime University and Gorontalo State University entered into an academic exchange agreement in 2007. In 2013, Ehime Prefecture entered into a “Memorandum for Joint Research and Human Resource Cultivation Through Three-Party Collaboration” with Gorontalo State University and North Gorontalo Regency, and then entered into the same memorandum with Gorontalo State University and Gorontalo Province in 2016. In this way, Ehime Prefecture has fulfilled a role of promoting inter-regional collaboration in industry, academia, and government. In 2016, a delegation from Gorontalo Province paid a courtesy call on the deputy governor of Ehime Prefecture. The visit led to deepened mutual understanding between the two regions and confirmation of the cooperative relationship that contributes to development of both regions.

Moreover, significant efforts were made by Mr. Rachmad Gobel, an expert on Japan who currently serves as vice-chairman of the People's Representative Council of the Republic of Indonesia and chairman of the Indonesia and Japan Friendship Association. Mr. Gobel’s family is from Gorontalo Province, which is his base of support. Furthermore, after graduating from Chuo University abroad, Mr. Gobel underwent practical training in Ehime Prefecture at the Toon Plant of Matsushita Kotobuki Electronics Industries. He also met with the current governor of Ehime Prefecture seven times, exchanging opinions on how to use technology held by corporations in Gorontalo Prefecture to improve the environment and industry in Gorontalo Province. Mr. Gobel’s strong interest in the

environmental technology of corporations in Ehime Prefecture led to the realization of presentations on environmental technology being given to the Minister of Environment and Forestry by corporations in Ehime Prefecture, and to business coaching between Ehime corporations and Indonesian corporations. In terms of this project, Mr. Gobel has requested support for the realization of a carbon-free society in Gorontalo Province, and he has promised full support for the implementation of the project.

At the start of this project, we exchanged opinions twice with the government of Gorontalo Province and received their consent on project contents aimed at solving environmental issues based on decarbonization. The second meeting to exchange opinions featured participation by officials from Gorontalo State University and Ehime University, who agreed to implement the project through industry-government-academia collaboration. Regarding efforts for decarbonization, we have confirmed that each department has plans, but lacks effective implementation ability, and that there is strong interest in including a development plan for decarbonization in the next Regional Long-Term Development Plan (RPJMD). Additionally, it was commented that there are great expectations for the technology of corporations in Ehime Prefecture in regard to water pollution, which is one of the serious environmental issues of Gorontalo Province. Accordingly, Ehime Prefecture has stated that it is possible to provide support for decarbonization policies and technical cooperation for water treatment. Since COVID-19 has made travel difficult, an agreement was reached to continue the frequent exchange of opinions, including discussions held online.

2.3.2. Conclusion of a memorandum for city-to-city collaboration and cooperation

In 2020, the Indonesian Ministry of Interior issued the "Minister of Interior Ordinance 2020 (No. 25) of the Republic of Indonesia: Procedures for Regional Cooperation with Overseas Local Governments and Regional Cooperation with Overseas Organizations (PERATURAN MENTERI DALAM NEGERI REPUBLIK INDONESIA NOMOR 25 TAHUN 2020) "TENTANG TATA CARA KERJA SAMA AERAH DENGAN PEMERINTAH DAERAH DI LUAR NEGERI DAN KERJA SAMA DAERAH DENGAN LEMBAGA DI LUAR NEGERI"). Consequently, when cooperating with overseas local governments, it is now required to perform various procedures such as submitting a plan, entering into an MOU, and receiving approval from the Indonesian Minister of the Interior.

BERITA NEGARA
REPUBLIK INDONESIA

No.513, 2020 KEMENDAGRI. Kerja Sama Daerah. Pemerintah Daerah di Luar Negeri. Lembaga di Luar Negeri. Tata Cara. Pencabutan.

PERATURAN MENTERI DALAM NEGERI REPUBLIK INDONESIA
NOMOR 25 TAHUN 2020
TENTANG
TATA CARA KERJA SAMA DAERAH DENGAN PEMERINTAH DAERAH DI LUAR NEGERI DAN KERJA SAMA DAERAH DENGAN LEMBAGA DI LUAR NEGERI

DENGAN RAHMAT TUHAN YANG MAHA ESA

MENTERI DALAM NEGERI REPUBLIK INDONESIA,

Menimbang : bahwa untuk melaksanakan ketentuan Pasal 35 dan Pasal 42 Peraturan Pemerintah Nomor 28 Tahun 2018 tentang Kerja Sama Daerah, perlu menetapkan Peraturan Menteri Dalam Negeri tentang Tata Cara Kerja Sama Daerah dengan Pemerintah Daerah di Luar Negeri dan Kerja Sama Daerah dengan Lembaga di Luar Negeri;

Mengingat : 1. Pasal 17 ayat (3) Undang-Undang Dasar Negara Republik Indonesia Tahun 1945;
2. Undang-Undang Nomor 39 Tahun 2008 tentang Kementerian Negara (Lembaran Negara Republik Indonesia Tahun 2008 Nomor 166, Tambahan Lembaran Negara Republik Indonesia Nomor 4916);
3. Undang-Undang Nomor 23 Tahun 2014 tentang Pemerintahan Daerah (Lembaran Negara Republik Indonesia Tahun 2014 Nomor 244, Tambahan Lembaran

www.peraturan.go.id

Figure 2-10 PERATURAN MENTERI DALAM NEGERI REPUBLIK INDONESIA NOMOR 25 TAHUN 2020

Chapter 2, Paragraph 6-(1) of this law specifies the coverage as follows.

a. Cooperation with sister provinces
b. Cooperation sister cities/districts
c. Other cooperation

Paragraph 6-(2) states that cooperation undertaken by Indonesian local governments with overseas

local governments in order to focus on cooperation in a specific field falls under category c. as listed above. Based on that classification, Paragraph 9 demands cooperation in the following procedures.

> The inter-regional cooperation (omitted) mentioned in Paragraph 6-(1) must be implemented in the following stages.
>
> a. Concept
> b. Survey
> c. Declaration of intention to cooperate
> d. Creation of a cooperation plan
> e. Approval for DPRD (Regional People's Representative Council)
> f. Verification
> g. Creation of a cooperation document draft
> h. Discussion on a cooperation document
> i. Approval by the minister
> j. Signing of the cooperation document
> k. Implementation of cooperation

In this project, at the kick-off meeting with Gorontalo Province after adoption of the project, the MOU with Ehime Prefecture for this project was referenced. The decision was made to enter into a memorandum in order to comply with laws and regulations, and to ensure smooth implementation of the project. As shown below, the memorandum was signed on December 15, 2021 by the governor of Gorontalo Province and the governor of Ehime Prefecture. Additionally, a written plan was prepared together with Gorontalo Province and submitted to the Ministry of Home Affairs by Gorontalo Province together with the original MOU, and it was approved.

In addition, the contents of the letter of intent (LOI) to cooperate were discussed by Ehime Prefecture, Gorontalo Province, the Ministry of Home Affairs, and the Ministry of Foreign Affairs, and the MOU was concluded on September 23, 2022. Through the LOI and MOU, we reached agreements in the four fields: environmental management, economic & industrial development, agriculture & forestry, and education & training. In each field, we set an action program including the items to be discussed in this project, produced an action plan summarizing expected results, the roles of organizations that will execute it and others, etc., had many discussions with the Ministry of External Affairs, the Ministry of Home Affairs, Gorontalo Province, and Ehime Prefecture, and made their contents approved by the Ministry of External Affairs and the Ministry of Home Affairs.

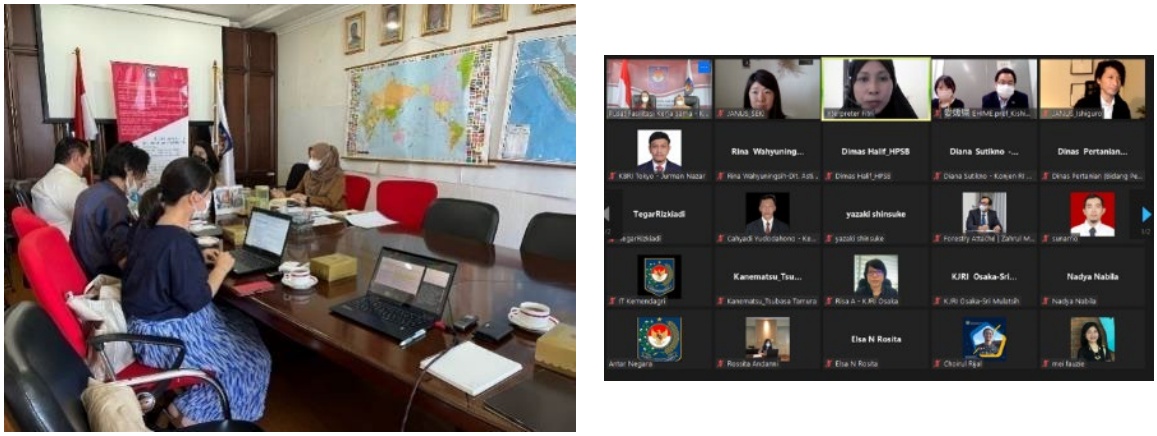


Figure 2-11 Discussion about the MoU with Ehime Prefecture and Gorontalo Province with the Ministry of External Affairs and the Ministry of Home Affairs

The action plan describes projects to be commercialized, the support for the formulation of a decarbonization plan in Gorontalo Province, and concrete support from Ehime Prefecture for realizing a decarbonized society in Gorontalo Province. The following shows the results of cooperation between Ehime Prefecture and Gorontalo Province in this project, which are described in the action plan.

Environmental management

- Information on identification and prediction of major sources of greenhouse gases in Gorontalo Province
- Data for purifying the Limboto Lake
- Results of the study on feasibility of the adoption of wastewater treatment technology for seepage water at the final disposal site (TPA Talmelito)

Economic and industrial development

- Results of the study on feasibility of the adoption of wastewater treatment technology by a business operator that discharges a lot of industrial wastewater (a coconut processing plant)
- Results of the study on feasibility of biomass power generation by a business operator that consumes a lot of energy (a coconut processing plant)
- Information on products and technologies of enterprises in Ehime Prefecture and Gorontalo Province
- Business matchmaking in both municipalities

Agriculture and forestry

- Forest conservation plan in Gorontalo Province
- Empowerment of farmers for conserving forests and important land
- Results of feasibility study on ideal hillside farming

Education and training

- Education of stakeholders about the maintenance and management of water infrastructure systems
- Holding seminars on cacao farming targeted at enterprises and farmers in Gorontalo Province
- Holding seminars on the environment targeted at Gorontalo State University

A ceremony for signing an MOU was held on January 19, 2023 and attended by the governors of Ehime Prefecture and Gorontalo Province as well as the deputy speaker Gobel of the People's Representative Council of Indonesia, when the squad of the mission for the economic exchange between Ehime Prefecture and Indonesia visited Gorontalo Province.

Figure 2-12 Ceremony for concluding an MoU for the city-to-city collaboration project (Jan. 19, 2023)

3. Field of regional water infrastructure establishment using decarbonized energy

In most areas of Gorontalo Province, human waste and domestic wastewater flow untreated into rivers through gutters, causing water pollution in rivers, lakes, and oceans. As discussed later in this report, there are plans to develop water and sewage infrastructure throughout Indonesia and Gorontalo Province, but they have not been put into practice.

In this project, we focused on advanced wastewater treatment technology and discussed the adoption of wastewater treatment plants as distributed water treatment equipment. We also discussed the possibility of use of wastewater treatment plant sludge for power generation using the biogas obtained through the methane fermentation of the sludge. In Gorontalo Province, we confirmed the intention to incorporate a decarbonization viewpoint into the development plan, so we selected decarbonization technology for equipment to be installed and considered the goal of realizing decarbonized water infrastructure at the development stage. Therefore, we decided to use solar power, etc., to generate the electricity required for operating the wastewater treatment plant and methane fermentation equipment, thus achieving zero emissions. The following diagram shows the currently envisioned flow of regional water infrastructure development using decarbonized energy.

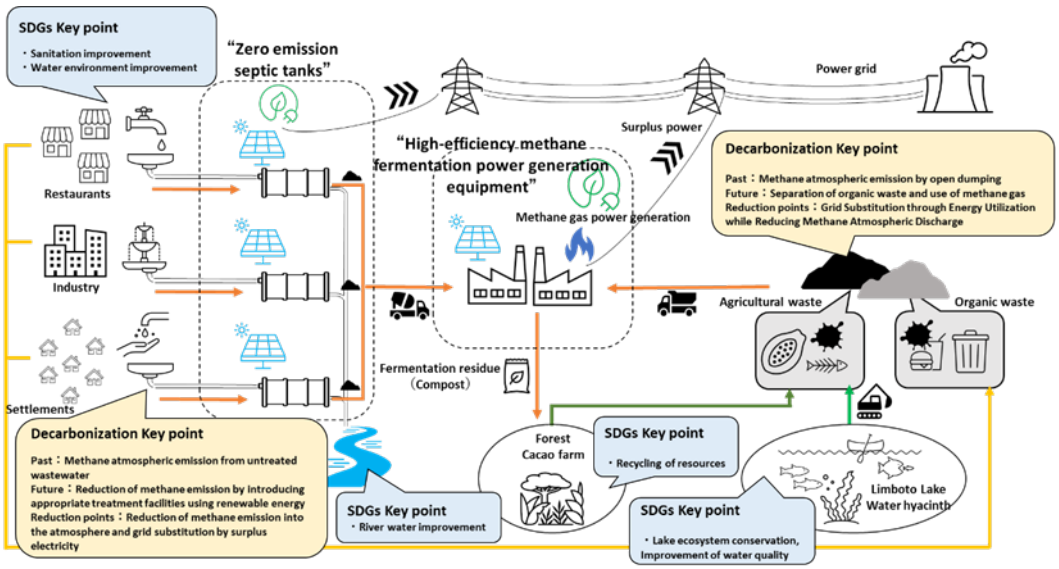


Figure 3-1 Regional water infrastructure development using decarbonized energy: Schematic diagram of reducing CO_2 emissions

Since water infrastructure is a public one, we expect that water infrastructure will be developed based on the budgets of the national and local governments. Accordingly, the province has the authority to select technologies and formulate plans, so we can be involved easily. In the project in FY 2021, we studied the policies and plans of Gorontalo Province, Indonesia and discussed the feasibility of installation of wastewater treatment plants and methane fermentation equipment, which would become the foundation for water infrastructure development. In the project in FY 2022, we extracted concrete potential sites, and summarized business models that can be brought up for discussion. In the project in FY 2023, we discussed more details for commercialization based on the

results of previous studies.

The following sections show the details and results of our studies.

3.1. Equipment to be installed

3.1.1. Wastewater treatment plants

(1) **Mechanism of a Wastewater treatment plant**

A wastewater treatment plant is a decentralized (on-site type) domestic wastewater treatment technology/facility developed in Japan. It is equipment that uses a solid-liquid separation function and a microbial treatment function to purify human waste and domestic wastewater.

The general treatment process in a wastewater treatment plant is as follows. First, the supernatant and solid matter in influent sewage is settled in a sedimentation separation tank. Next, a portion of organic matter is decomposed by anaerobic microorganisms in an anaerobic filter bed tank and the nitrified water returned from the moving bed biofilm tank is denitrified. Then, air is blown in by a blower in the carrier flow tank. The organic substances are decomposed by aerobic microorganisms, and ammonia is nitrified, then the treated water is divided into the sludge and supernatant liquid in the settling tank. Finally, the treated water is disinfected with chlorine in the disinfection tank and then released. The basic structure of a wastewater treatment plant is shown below.

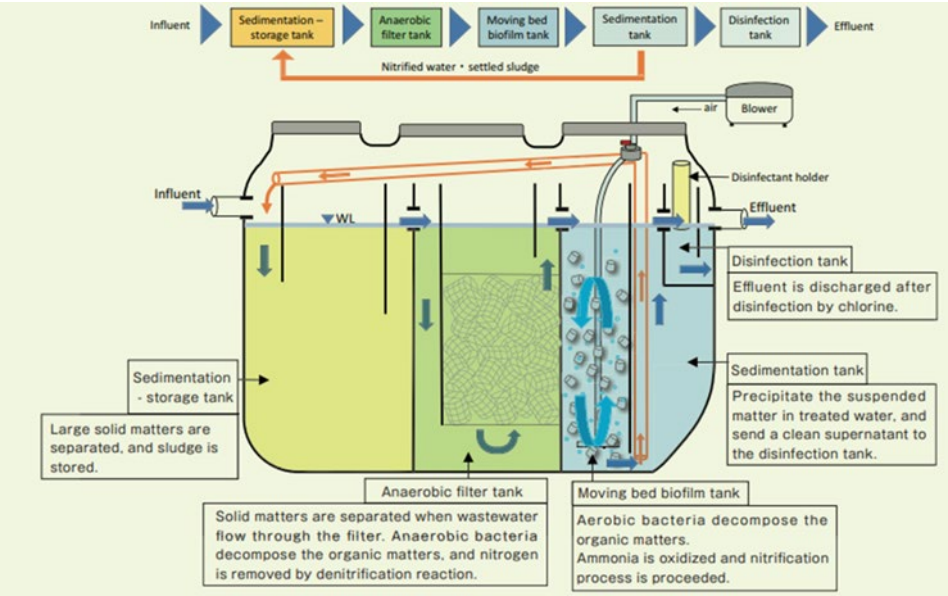


Figure 3-2 Structure and mechanism of a wastewater treatment plant[8]

Furthermore, the size, treatment method, materials of the wastewater treatment plant body, etc. can be selected according to the purposes of use of buildings, the quantity and quality of the sewage to be treated, the water quality regulation status of the discharge destination, etc. Wastewater

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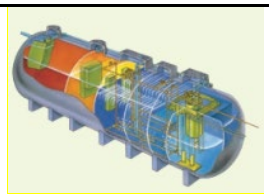
[8] Ministry of Environment Japan (March 2019) "Urine Treatment and Decentralized Domestic Wastewater Treatment Systems in Japan"
(http://www.env.go.jp/recycle/jokaso/basic/pamph/pdf/wts-jp_full.pdf)

treatment plants are classified as follows depending on the size of their treatment capacity.

Table 3-1 General classification of wastewater treatment plants [8]

Classification	Appearance	Overview
Compact Wastewater treatment plant		Used for detached houses and small-scale wastewater treatment by tanks for up to 50 people (10 m^3 per day for daily average sewage amount). The tank is normally manufactured at a factory from the plastics FRP (fiber reinforced plastic) or DCPD (dicyclopentadien).
Mid-size Wastewater treatment plant		Used for medium-scale wastewater treatment by tanks for 51 to 500 people (100 m^3 per day for daily average sewage amount). The tank is normally manufactured at a factory from the plastic FRP, or installed on-site using reinforced concrete (RC).
Large Wastewater treatment plant		Used for large assembly processing by tanks for 501 people or more. Then tank is usually installed on-site using reinforced concrete (RC).

In Japan, Article 3 of the Purification Tank Act stipulates that human waste and domestic wastewater shall be treated by a wastewater treatment plant if a sewerage system or human waste treatment facility is not used. As of the end of FY 2019, about 7.6 million wastewater treatment plants have been installed throughout Japan. [9] Also, in the Export Strategy for Infrastructure Systems 2025 [10] formulated in 2020, the installation of wastewater treatment plants is listed as one of the actions in each field. We are supporting the overseas deployment of wastewater treatment plants (including those of SMEs) for public health and water environment conservation in the Southeast Asian region.

In Indonesia, simple wastewater treatment plants are commonly used for treating wastewater discharged from households, and we cannot expect that they will purify the water. Because of the tropical rainforest climate, where air temperature is warm throughout the year, we can expect that the wastewater from thinly populated farming villages, etc. will be purified naturally by the ecosystem's degradation capability, even when the equipment is very simple or wastewater is not treated. In urban areas, even the strong organic matter decomposition capability of the tropical ecosystem cannot cover the pollution burden, so it is essential to treat the wastewater with purification tanks, etc. At present,

[9] Ministry of the Environment (February 2021) "Press Release Materials" (https://www.env.go.jp/press/109154.html)
[10] Prime Minister's Official Residence (June 2021) "Export Strategy for Infrastructure Systems 2025" (revised in June 2021) (https://www.kantei.go.jp/jp/singi/keikyou/pdf/infra2025.pdf)

septic tanks are commonly used, and distinguished from wastewater treatment plants.

(2) **Overview of wastewater treatment plants manufactured by Daiki Axis Co., Ltd.**

In this project, we will discuss the introduction of a wastewater treatment plant manufactured by Daiki Axis Co., Ltd.

Ever since it developed the industry's first lightweight and durable FRP wastewater treatment plant, Daiki Axis has been developing low-cost and efficient products. For example, in January 2014, at the "Eco Mark Award 2013" hosted by the Eco Mark Office of the Japan Environment Association, the company's XE household wastewater treatment plant became the first wastewater treatment plant to obtain Eco Mark certification. In addition to achieving the target value of minus 46% set by the Ministry of the Environment, it realized power saving performance and stable wastewater treatment capacity, and reduced the total capacity to about 85% compared to the conventional product by using recyclable polypropylene. In this way, the XE household wastewater treatment plant contributes to on-site work reduction and cost reduction. The structure and functions of the company's FRP wastewater treatment plants are shown below.

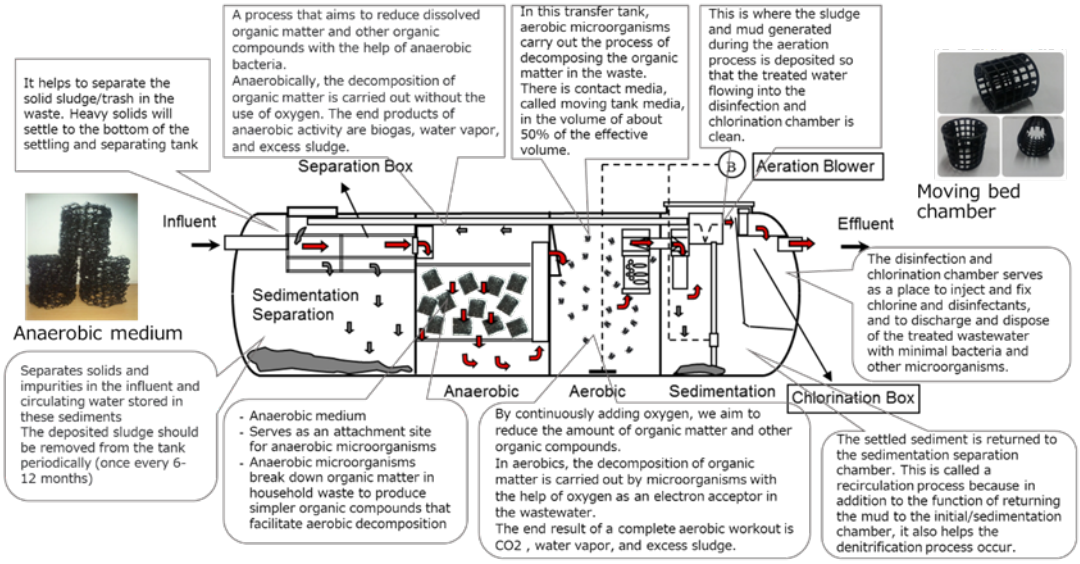


Figure 3-3 Structure and Functions of Daiki-Axis' FRP Wastewater treatment plants[11]

Moreover, since Daiki Axis has an affiliated company in Indonesia and is operating a wastewater treatment plant installation business mainly in Jakarta in accordance with the above-mentioned Indonesian laws and regulations, the company has a strong technical advantage in introducing wastewater treatment plants that meet local issues. The following shows the Indonesian domestic wastewater standards and the treatment performance of the company's wastewater treatment plants shown in Table 3-1.

[11] Material provided by Daiki-Axis

Table 3-2　Treatment Performance of Daiki Axis' Wastewater treatment plants and Indonesian Domestic Wastewater Standards[11]

パラメータ	単位	流入	放流BA（LHKの基準に該当しないもの）	放流BJ（LHKの基準に該当するもの）	基準*
pH	[-]	6 – 9	6 – 9	6 – 9	6 – 9
BOD	[mg / L]	300	20	20	30
COD	[mg / L]	400	100	80	100
TSS	[mg / L]	240	30	20	30
アンモニア	[mg / L]	50	-	10	10
油脂	[mg / L]	40	10	5	5
総大腸菌数	【数/ 100ml】	-	3000	3000	3000

The company's business in Indonesia was reported at the Indonesia-Japan Environmental Week hosted by Japan and the Ministry of Environment and Forestry of the Republic of Indonesia in January 2021. [12]

Daiki Axis Co., Ltd. has a track record of installing its products in facilities of various sizes, some of which are listed below.

[12] Presentation Material from Indonesia-Japan Environmental Week (January 2021)
"Introduction of Decentralized Small Scale Waste Water Treatment Technology in Indonesia"
（https://www.oecc.or.jp/jprsi/event/envweek/program/files/20210114_sem_2-6_pt_daiki_axis.pdf）

Figure 3-4 Examples of Products of Daiki-Axis Installed in Indonesia[11]

	
Compact Wastewater treatment plant (for up to ten people)	Large Wastewater treatment plant (for use at offices, apartments, hotels, etc.)

Figure 3-5 Wastewater treatment plants installed in Indonesia by Daiki Axis Co., Ltd.

Furthermore, in this project, from the viewpoint of decarbonization, we consider a system that uses solar power to obtain the power required for the operation of wastewater treatment plants. Regarding the solar power system, we will procure solar panels in Indonesia and consider an integrated introduction format in which Daiki Axis handles all stages from installation to management. Since this project has a public nature, there is a high possibility that the equipment will be procured

publicly. Although price issues exist, it is possible to create a favorable competitive environment for installation based on the utilization of the JCM facility investment subsidy and Daiki Axis's experience in general contracting business and construction. The company also possesses the experience of the design and construction of wastewater treatment plants based on solar power generation equipment in mountainous areas in Japan.

(3) **Items to be discussed before installation**

When installing a wastewater treatment plant, it is necessary to clearly grasp and set the inputs and outputs, to use the set values for selecting products of appropriate size, and examine the feasibility of installing a system. We will review requirements for each of the three stages as follows [13].

- Input (conditions for acceptance of domestic wastewater)

  At the time of installing facilities, acceptance conditions are set while considering the actual conditions, process, and output of wastewater treatment. Examples of conditions include wastewater discharge status, wastewater properties, identification of substances for which treatment is inappropriate, and acceptance form.

- Process conditions (conditions for setting treatment technology)

  These are specific conditions necessary when discussing the size and installation of the product. These conditions determine the basic performance of facilities that satisfy conditions for input and output, and also take into account regulatory standards and emergency response.

- Output (conditions for using wastewater treatment plant sludge)

  These are conditions necessary for utilizing the wastewater treatment plant sludge generated as a result of the treatment. In addition to the properties and amount of wastewater treatment plant sludge, these conditions include the method of transportation to the destination, the transportation route, and seasonal variation in the amount.

The following table summarizes the specific contents of the three stages listed above.

Table 3-3 Specific contents of requirements for Wastewater treatment plant installation

Requirement category	Requirement contents	
Input (conditions for acceptance of domestic wastewater)	Discharge status of wastewater	Discharge amount and characteristics of wastewater (daily fluctuations, seasonal fluctuations, discharge types by region), Emission sources (general households, commercial facilities, etc.)
	Properties of wastewater	pH, TSS, BOD, CODcr, NH4-N, TN, TP, N-Hex (or Oil & Grease), etc.

[13] Supervised by Toru Furuichi, edited by the Organic Waste Recycling Association (OWRA) (March 2006) Biogas Technology and Systems, p. 76

		Presence or absence of fluctuation in properties (seasonal fluctuations, etc.)
	Identification of substances for which treatment is inappropriate	Type, mixing ratio (%), concentration (mg/L)
	Acceptance form	Method of receipt: Method of piping from homes, etc.
Process conditions (conditions for setting treatment technology)	Conditions of location scheduled for construction	Distance from the main source and difference in height Distance and height difference from treated water discharge destination Site area, topography, geology, climatic conditions Legal regulations, surrounding environment, access Conditions for receipt of electricity, water services, etc.
	Processing capability	Processing capacity [m^3 per day] Annual working days [days per year] Capacity of receiving and storing equipment (corresponding to the maximum receipt amount)
	Pollution control standards, etc.	Regulatory standards Existence/absence of requested criteria from local residents, etc.
	Pre-treatment	Necessity of pre-treatment equipment and treatment method
	Treatment method	Separated contact aeration method, anaerobic filter floor contact aeration method, denitrification filter floor contact aeration method, phosphorus removal/denitrification floor contact aeration method, etc. Necessity and quantity of treatment auxiliary materials
	Wastewater treatment	Discharge destination Properties of discharged water: BOD, nitrogen concentration, salt concentration
	Electrical instrumentation specifications	Central monitoring control items (type and number of items), field operation items (type and number of items) Contents of automatic operation control for labor-saving
Output (conditions for using Wastewater treatment plant	Sludge Generation	Amount generated [m^3 per day or m^3 per month]
	Properties of sludge	pH, TSS, BOD, COD, NH4-N, TN, TP, etc. Apparent specific density [t/m^3], moisture content [%] Presence or absence of fluctuation in properties (seasonal fluctuations, etc.)

sludge)	Transportation method for sludge	Sludge carry-out: frequency, quantity, transportation route, distance Annual carry-out plan, management/maintenance system, etc. Carry-out method, carry-out vehicle specifications
	Destination for sludge usage	Usage conditions: Usage destination, usage form, demand amount, properties, seasonal fluctuations in quantity, purchase price (paid or free)

3.1.2. Methane fermentation equipment

(1) Mechanism of methane fermentation equipment

The main purpose of the methane fermentation process is to recover methane safely and efficiently from waste biomass such as organic wastewater, sewage sludge, livestock waste, and kitchen waste. This is done using an anaerobic microbial reaction. The process is also intended to reduce the volume of waste sludge.

In general, in order to use methane fermentation equipment, it is necessary to remove foreign substances that are not suitable for fermentation from the received material. It also requires a sorting process by manual sorting, mechanical crushing and sorting, or a combination of both.

Next, a solubilization process may be performed as a pre-treatment to promote fermentation. The process after the pre-treatment requires a methane fermenter for fermenting organic substances, a desulfurization device necessary for utilization of the generated biogas for power generation, a gas holder, a power generation facility, a boiler, a surplus gas combustion device, and other equipment. The type of equipment to be installed for the fermentation residue varies depending on the purpose of use.

For example, there is a case in which the fermentation residue is sprayed as a whole liquid fertilizer. The equipment required in that case includes a liquid fertilizer storage tank, a liquid fertilizer carrier, and a sprayer for the case where the business operator itself sprays the liquid fertilizer. For some other facilities, solid-liquid separation treatment is performed and the solid part is composted, converted to solid fuel, or dried and then incinerated as industrial waste. The liquid part is treated as wastewater and then discharged into sewage. In this way, the installed equipment varies depending on the method for treating the fermentation residue. The following diagram shows the basic structure of the methane fermentation process.

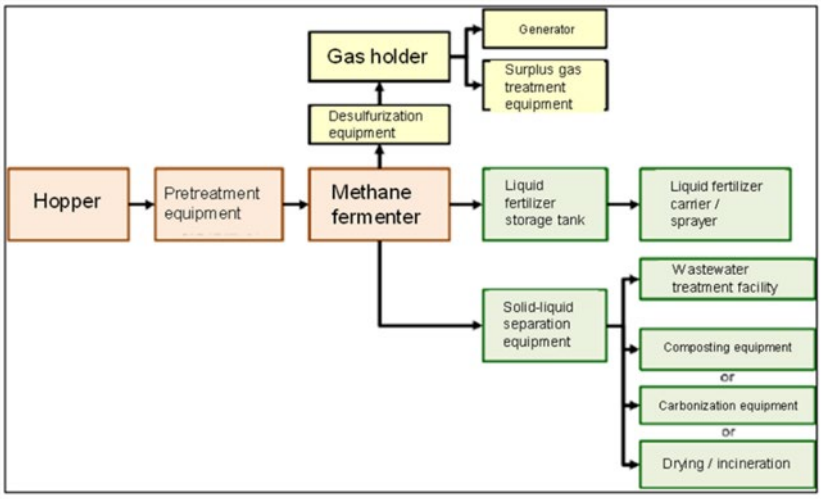


Figure 3-6 Basic structure of the methane fermentation system[14]

Moreover, the type of methane fermentation process varies between discharged water treatment for mainly soluble components and solid waste treatment for mainly solids. Wastewater treatment is classified according to treatment in the methane fermentation tank, such as returning concentrated sludge to the methane fermentation tank (anaerobic contact method, ABR method), using biofilm (anaerobic filter bed method, anaerobic fluidized bed method), or immobilizing bacterial cells (UASB method, EGSB method).[15] On the other hand, solid waste treatment is roughly classified, according to the sludge concentration in the formation tank, into two types: the "wet method" and "dry method." The wet method is divided into a two-phase method, in which treatment is conducted by suspending methane bacteria at a low sludge concentration, and a one-phase method, with two types of medium-temperature fermentation and high-temperature fermentation. On the other hand, the dry method is divided into the horizontal type and the vertical type, both of which are high-temperature fermentation techniques. The following table outlines the UASB method, EGSB method, wet method, and dry method.

Table 3-4 Comparison of methane fermentation technologies[16]

	Wastewater	Solid waste	
Item	UASB method/EGSB method	Wet method	Dry method
Raw material concentration	5 to 8%	2 to 10%	15 to 30%
Treatment overview	Methane bacteria are granulated and fixed and low SS concentration	Methane bacteria are suspended and treated at low sludge	Treated at high sludge concentration using methane bacteria

[14] Japanese Ministry of the Environment "FY2017 Report on Regional Circulation Area and Eco-Town Low Carbon Promotion Project," Okinawa Prefecture, Japan NUS Co., Ltd., p. 101
[15] Edited by Tatsuya Noike (May 2019), "Methane Fermentation", p. 85
[16] NEDO (April 2021), "Part 3: Fundamentals Related to Methane Fermentation Technology." (https://www.nedo.go.jp/content/100932093.pdf)

	wastewater is treated	concentration	
Characteristics	・ High efficiency ・ EGSB method: Heavy-duty operation is possible compared to UASB method (the fluidized bed type UASB method is the EGSB method)	・ Easy operation management ・ Treatment using digestive solution is unnecessary (when a liquid fertilizer is utilized)	・ Treatment of solids is possible ・ Increased gas generation amount per raw material unit weight
Main applications	・ Food wastewater	・ Business/household garbage ・ Food processing residue ・ Livestock manure ・ Sewage sludge	・ Municipal solid waste ・ Solid waste
Implementation record	Large number in Japan (UASB method)	Large number in Japan	Very small number in Japan
Tolerance for non-conforming mix	Small (Liquid waste treatment with low SS concentration)	Small	Large
Wastewater treatment	Aerobic treatment is necessary depending on discharge standards	Necessary (if not treated with liquid fertilizer)	Not necessary (depending on raw material conditions)
Fermenter maintenance	No need due to proper operation management	Necessary on a regular basis	hardly needed
Method of contact between methane bacteria and organic matter	Contact with the flow rate of wastewater	Stirring inside the fermenter	Mix the drawn sludge and raw materials and put it into the fermentation tan

The target raw material in this project is the sludge discharged from the wastewater treatment plant mentioned above. On the other hand, when considering economic efficiency, it is desirable to increase the amount of power generation through methane fermentation gasification by using food waste, etc., with higher fermentation efficiency as the main raw material. Therefore, this project will target biomass resources such as food waste as raw materials for methane fermentation equipment, earn profits from selling electricity, and consider treatment of wastewater treatment plant sludge by mixing wastewater treatment plant sludge as raw materials.

We will discuss the adoption of methane fermentation technology of Aiken Kakoki K.K. The company is located in Ehime Prefecture and conducts methane fermentation using solid waste such as agricultural products at domestic food factories. Also, in Indonesia, Aiken Kakoki conducted a pilot test of methane fermentation using wastewater palm oil factories operated by the Indonesian government (Palm Oil Mill Effluent: POME) and confirmed performance (recovered energy amount, methane concentration) as part of the JICA project in FY 2020. Aiken Kakoki's methane fermentation technology is more competitive than other companies' technologies for stirring, and has a high gas

recovery rate and a track record of stable removal. The technology will be discussed in detail in the next section.

(2) Overview of methane fermentation technology at Aiken Kakoki K.K.

In wastewater treatment by the EGSB method described above, Aiken Kakoki K.K. succeeded in developing a self-contained circulating drainage system that dramatically improves the stability, efficiency, and economic efficiency of wastewater treatment, and does not require any external energy. As a result, this wastewater treatment system is capable of generating profits while treating factory wastewater, and possesses a high advantage as optimal wastewater treatment equipment for emerging countries where effective use of biomass and energy are insufficient. Specifically, the system price and investment recoupment period have been reduced to about two-thirds compared to the conventional EGSB method.[17]. An overview of the system developed by Aiken Kakoki K.K. is shown below.

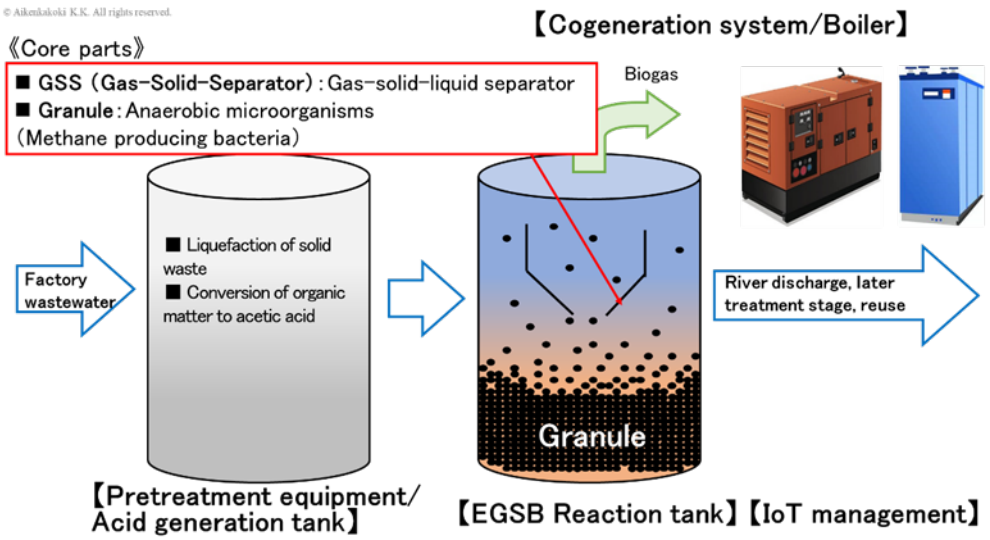


Figure 3-7 Overview of the EGSB system[18]

In the EGSB method, the wastewater treatment capacity and the biogas recovery capacity differ greatly depending on the structure of the three-phase separator (Gas Solid Separator: GSS) in the reaction tank. Although many companies outsource the design of GSS, Aiken Kakoki develops it in house. Therefore, it has accumulated GSS design know-how, and it is possible to design equipment based on the specifications of the entire reaction tank. As a result, Aiken Kakoki has succeeded in increasing the recovery rate of biogas, and it is possible to recoup the investment faster than the

[17] NEDO (November 2021), "Reference Material for NEDO Venture and Emerging Business Matching Meeting" (https://www.nedo.go.jp/content/100939230.pdf)
[18] Material provided by Aiken Kakoki

products of other companies [19]. Additionally, Aiken Kakoki is highly competitive in terms of price because it can handle everything from design to sales to maintenance. After delivering the first unit to a major food factory in 2005, the company has installed a total of 21 units as of 2021. The company's EGSB process results are shown below.

Table 3-5 Installation results of EGSB method at Aiken Kakoki [18]

	水量	原水	処理水	回収エネルギー量		対象排水
	(m3/日)	COD (mg/l)	COD (mg/l)	(Nm3/日)	(kwh/日)	
1	600	5,800	580	1,378	3,740	農産物加工
2	1,000	8,000	1,200	2,992	8,120	製綿洗浄排水
3	650	4,300	430	1,107	2,817	総菜・菓子製造

Aiken Kakoki also possesses experience in energy recovery (methane fermentation by the digestion tank method) equipment using factory residues such as food waste, based on customer needs. By utilizing know-how in areas such as energy efficiency accumulated through wastewater treatment, Aiken Kakoki operates a miniaturized and highly efficient demonstration facility and conducts technical evaluation. The following photograph shows methane fermentation equipment using the digestion tank method.

Methane fermentation equipment using POME at a palm oil mill in Indonesia

Methane fermentation equipment using food residues at a domestic food factory

Figure 3-8 Installed methane fermentation equipment of Aiken Kakoki[18]

Moving forward, Aiken Kakoki will discuss the treatment technology and optimal system design according to the properties of biomass resources as raw materials.

(3) Items to be discussed for installation

When installing a wastewater treatment plant, it is necessary to clearly check and set the inputs

[19] JICA (June 2020) Feasibility Survey for a Project for Treating Highly Concentrated Effluent with Biogas Recovery at Palm Oil Mill in Indonesia: Work Completion Report, Aiken Kakoki K.K., p, 8

and outputs, reflect them in technical discussions for equipment, and verify the feasibility of installing a system. As discussed above, we will discuss requirements for each of the three stages as described below, based on the assumption that other organic waste will be used as fermentation materials in addition to wastewater treatment plant sludge.[20]

- Input (conditions for acceptance of organic waste)

  At the time of installing facilities, acceptance conditions are set by considering the actual conditions, process, and output of wastewater treatment. Such conditions include waste discharge status, waste properties, identification of substances for which treatment is inappropriate, and collection form.

- Process conditions (conditions for setting treatment technology)

  These are specific conditions necessary when designing equipment. These conditions determine the basic performance of equipment that satisfies conditions for input and output, and also follows regulatory standards and emergency response.

- Output (conditions for using recycled resources)

  These are conditions necessary for utilizing the recycled materials and energy (electricity/heat) generated through the treatment. In addition to the shape, properties, and amount required of recycled materials, these conditions include items such as the transportation method to the usage destination, the transportation route, and seasonal variation in the demand amount.

The following table summarizes the specific contents of the three stages listed above.

Table 3-6 Specific contents of requirements for methane fermentation tank installation[21]

Requirement category	Requirement contents	
Input (conditions for acceptance of domestic waste)	Discharge status of waste	Discharge amount and characteristics of wastewater treatment plant sludge and organic materials (daily fluctuations, seasonal fluctuations, discharge form by region) and emission sources (general households, commercial facilities, etc.)
	Properties of waste	【Septic tank sludge】 pH, TSS, BOD, CODcr, NH4-N, T-N, T-P, T-K, VS, C/N ratio, nutrients, N-Hex (or Oil & Grease), etc. 【Organic waste】 Apparent specific density (t/m^3), moisture content (%), pH, TSS, BOD, CODcr, NH4-N, T-N, T-P, T-K, VS, C/N

[20] Supervised by Toru Furuichi, edited by the Organic Waste Recycling Association (OWRA) (March 2006) Biogas Technology and Systems, p. 76

[21] Supervised by Toru Furuichi, edited by the Organic Waste Recycling Association (OWRA) (March 2006) Biogas Technology and Systems, p. 77

		ratio, nutrients Presence or absence of fluctuation in waste quality (seasonal fluctuations, etc.)
	Identification of substances for which treatment is inappropriate	Type, mixing ratio (%), concentration (mg/L)
	Collection form	Collection container/bag type: Bag, bucket/container Number of collection days/delivery days (tons per week), annual delivery plan, etc. Specifications of collection vehicles and vehicles that carry in waste
Process conditions (conditions for setting treatment technology)	Conditions of location scheduled for construction	Distance from the main source and distance and height difference from treated water discharge destination Site area, topography, geology, climatic conditions Legal regulations, surrounding environment, access Conditions for receipt of electricity, telephone, water services, etc.
	Processing capability	Processing capacity (tons per day) Annual working days (days per year) Capacity of receiving and storing equipment (for the maximum receipt amount)
	Operating time by process	Pre-treatment, fermentation equipment, etc. (hours per day)
	Pollution control standards, etc.	Regulatory standards Existence/absence of requested criteria from local residents, etc.
	Pre-treatment	Necessity of pre-treatment equipment and treatment method
	Treatment method	EGSB, UASB, Anaerobic fermentation (methane fermentation: high-temperature method, medium-temperature method) Necessity and quantity of processing auxiliary materials
	Number of treatment equipment series	Single series, multiple series
	Use of treatment products (resources)	Properties, usage method, and usage amount of products (biogas, compost, livestock feed, carbide) Treatment of surplus products
	Disposal of	Method of disposal of substances for which treatment is

	substances for which treatment is inappropriate	inappropriate
	Digested liquid treatment	Use or non-use as liquid fertilizer; discharge destination in the case of discharge Properties of discharged water: BOD, nitrogen concentration, salt concentration
	Electrical instrumentation specifications	Central monitoring control items (type and number of items), field operation items (type and number of items) Contents of automatic operation control for labor-saving
Output (conditions for using septic recycled materials)	Biogas usage	Use of power generation: Power supply destination, power supply method, power supply capacity, power sale (power sale unit price, etc.) Heat utilization: Usage destination, usage conditions, heat supply amount, supply medium (hot water, steam) Direct usage: Supply conditions, degree of purification, supply method, supply amount, supply unit price
	Digested liquid usage (liquid fertilizer usage)	Usage destination conditions: Usage destination, usage form, demand amount, properties, seasonal fluctuations in demand amount, purchase price (paid or free)
	Distribution of recycled materials	Sales channels, transportation routes, transportation methods, etc., for recyclable materials

3.2. Grasping the actual situation for estimating the effects of the project

This project aims to introduce wastewater treatment using a wastewater treatment plant and methane fermentation equipment for organic waste, based on the model of Gorontalo City, where wastewater treatment problems are particularly serious in Gorontalo Province, with a view to spreading it throughout the province in the future.

On the other hand, since it is not realistic to install wastewater treatment plants on a large scale in Gorontalo Province, where the development of sewerage systems is lagging behind, we have the policy of carefully discussing the process for gradually distributing wastewater treatment plants for single or multiple facilities since the last financial year. The same is true for methane fermentation facilities, and we plan to first consider installing such facilities at factories that can stably supply a certain amount of organic waste.

In addition, in consideration of economic efficiency, we set the policy to utilize biomass resources such as food waste as raw materials for methane fermentation facilities and earn profit from the sale of electricity, while disposing of the wastewater treatment plant sludge by mixing it as raw materials, and in FY 2021, we proposed a model plan to combine wastewater treatment using wastewater treatment plants and waste treatment using methane fermentation facilities.

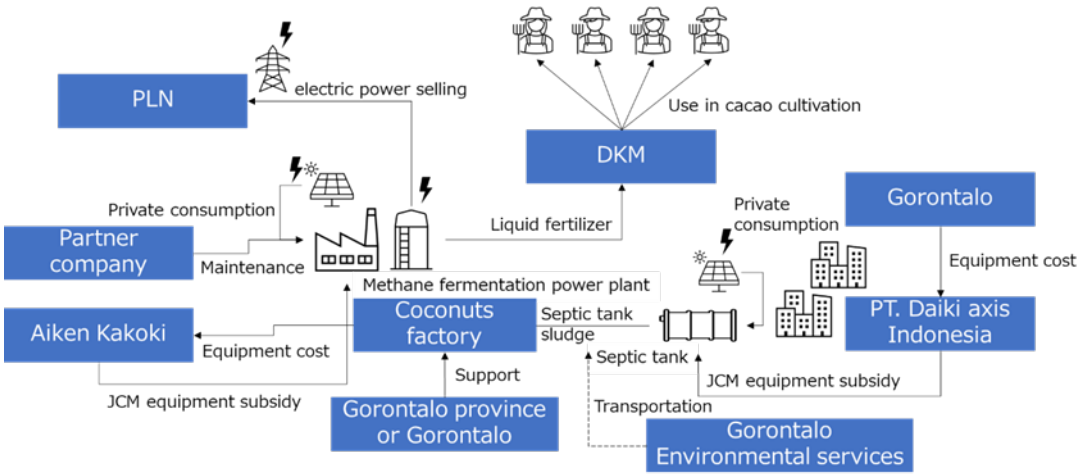


Figure 3-9 Proposed model for the project in FY 2021

In the project in FY 2022, based on the above-mentioned policies, we collected information on potential sites through an exchange of opinions with the Gorontalo provincial government, and examined the possibility of adopting them. In the project in FY 2023, we gathered additional information on potential sites for wastewater treatment plants, and made preparations for installing equipment, such as detailed design and cost estimation, with the aim of installing methane fermentation equipment in coconut processing factories, for which we have been discussing the installation since last fiscal year.

3.2.1. Wastewater treatment plants

(1) **Selection of potential sites**

In considering the installation of wastewater treatment plants, in the last project in FY 2021, BAPPEDA of the Gorontalo Province requested support for a total of eight student dormitories, three in Bone Bolango Regency, two in Gorontalo Regency, and three in Gorontalo City, as facilities with high wastewater treatment needs. Currently, wastewater is processed at each separate facility, but in discussions with BAPPEDA, we were assured of its intention to discuss intensive processing using the Japanese technology in the future. The following is a detailed description provided by BAPPEDA of the Gorontalo Province regarding the student dormitories with high needs for wastewater treatment.

SMA TERPADU WIRA BHAKTI GORONTALO 	MAN INSAN CINDEKIA GORONTALO 	MA SWASTA HUBULO GORONTALO 
371 students	346 students	467 students
Water source: Tap water, well water	Water source: Well water	Water source: Well water
Waste management: Environmental services in Bone Bolango and incineration	Waste management: Environmental services in Bone Bolango	Waste management: Environmental services in Bone Bolango
Water Sanitation Management: Inflow into irrigation canals	Water Sanitation Management: Inflow into irrigation canals	Water Sanitation Management: Inflow into rivers

MADRASAH ALIYAH AL-ISLAM 	MADRASAH ALIYAH AL-FALAH 
108 students	187 students
Water source: Well water	Water source: Tap water
Waste management: Environmental services in Gorontalo	Waste management: Independently managed
Water Sanitation Management: Inflow into irrigation canals	Water Sanitation Management: Inflow into irrigation canals

PONDOK PESANTREN ALKHAIRAAT	PONDOK PESANTREN AT TANWIR MUHAMMADIYAH	MADRASAH ALIYAH AL-HUDA
		
966 students	172 students	265 students
Water source: Well water	Water source: Tap water	Water source: Well water
Waste management: Incineration and direct disposal	Waste management: Environmental services in Gorontalo city	Waste management: Incineration and direct disposal
Water Sanitation Management: Breaking	Water Sanitation Management: Inflow into irrigation canals	Water Sanitation Management: Inflow into irrigation canals

Figure 3-10 Overview of student dormitories with wastewater treatment needs in Gorontalo Province[2]

In addition, the government of Gorontalo Province has been recognizing the pollution in the Lake Limboto, which is the largest lake in Gorontalo Province, straddling the city of Gorontalo and Gorontalo Regency, as an issue. The Lake Limboto is a symbol of Gorontalo Province, as it plays an important role as a source of income for fishing, flood prevention, water resources and tourism. A total of 23 rivers, 5 large and 18 small, flow into the Lake Limboto.

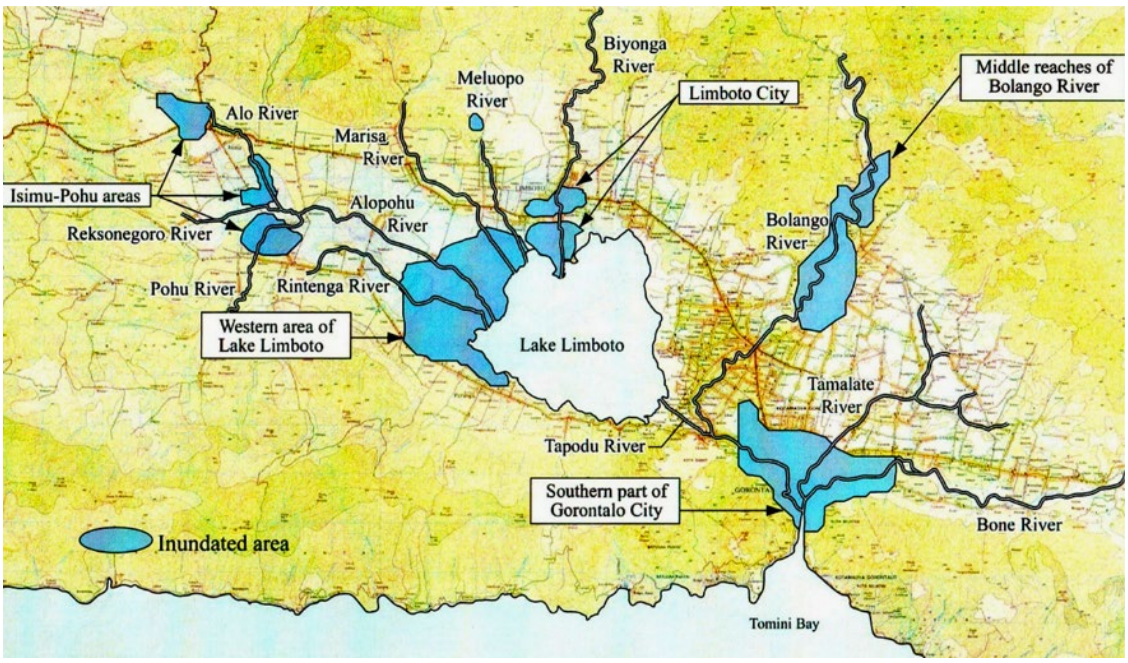


Figure 3-11 The Lake Limboto and rivers flowing into the lake

In recent years, we have seen the emergence of some issues, such as the inflow of sediment due to the loss of forests and the proliferation of water hyacinth due to ecosystem destruction. Through the interviews with the Gorontalo Provincial Department of Public Works, we learned that untreated wastewater from households is flowing into the Lake Limboto, polluting the water, and the aquaculture that has been conducted there, too, pollutes the water. They plan to restrict the aquaculture in the lake as a measure against water pollution.

Inflow of household wastewater

Mass of garbage flows in via the rivers

Overgrowing water hyacinths

Figure 3-12 Environmental issues in the Lake Limboto

According to the Gorontalo Provincial Department of Environment and Forestry, tests of the water quality of the Lake Limboto are conducted every year, and the results show the very high concentration of *E. coli*, and the concentration was apparently particularly high in 2022.

Among the rivers flowing into the Lake Limboto, there are concerns about pollution by domestic wastewater of the Biyonga River, one of the larger rivers that flow in from the north of the lake, as there are many houses in its basin. In the Biyonga River, water quality analysis has been carried out at three points in its basin. While there are locations with high *E. coli* concentrations as in the Lake Limboto, there are also water supply facilities in the basin to utilize the river for drinking water, and we received comments that countermeasures here are a high priority during the meeting with the Gorontalo Provincial Departments of Public Works, River Management, Watershed Management, and Environment and Forestry.

Figure 3-13 Meeting with the Gorontalo Provincial Departments of Public Works, River Management, Watershed Management, Environment and Forestry (January 2023)

In the projects in FY 2022 and FY 2023, we visited the above-mentioned student dormitories and potential sites around the Lake Limboto, etc. The results are shown below.

① Student dormitories

The Boarding school Pondok Pesantren Hubulo is an Islamic boarding school with a total of 424 male and female students, plus teachers and their six families living in them. The female and male dormitories are housed in different buildings, and domestic wastewater and human waste are discharged separately.

In both male and female dormitories, human waste is treated with a conventional septic tank in Indonesia installed underground, and domestic wastewater is collected in one place with a drainage channel, stored in a reservoir, and then discharged into the river.



Figure 3-14 Wastewater treatment in the female dormitory (left: human waste treatment (septic tank); right: domestic drainage channel)

A cafeteria is housed in a building different from those for the male and female dormitories, and does not have proper drainage channels, and all domestic wastewater and human waste are stored in one reservoir, which is emitting a strong stench. When the bottom of one reservoir becomes clogged due to the accumulation of sludge and becomes unable to store any more wastewater, they build a new reservoir in another place. The school staff expressed great concern about this treatment.


Figure 3-15 Wastewater treatment of the cafeteria (left: drainage channel; right: reservoir)

② Areas surrounding the Lake Limboto

After having discussions with the Gorontalo Provincial Departments of Public Works, River Management, Watershed Management, Environment and Forestry, we visited several locations in the Biyonga River basin, especially the areas that are thought to have a particularly high volume of household wastewater, as potential sites for the installation of wastewater treatment plants. In addition to the points where drainage channels run directly into the river from each household, there were points where drainage channels were constructed to some extent, where the channels of surrounding households join together before wastewater flows into the river.

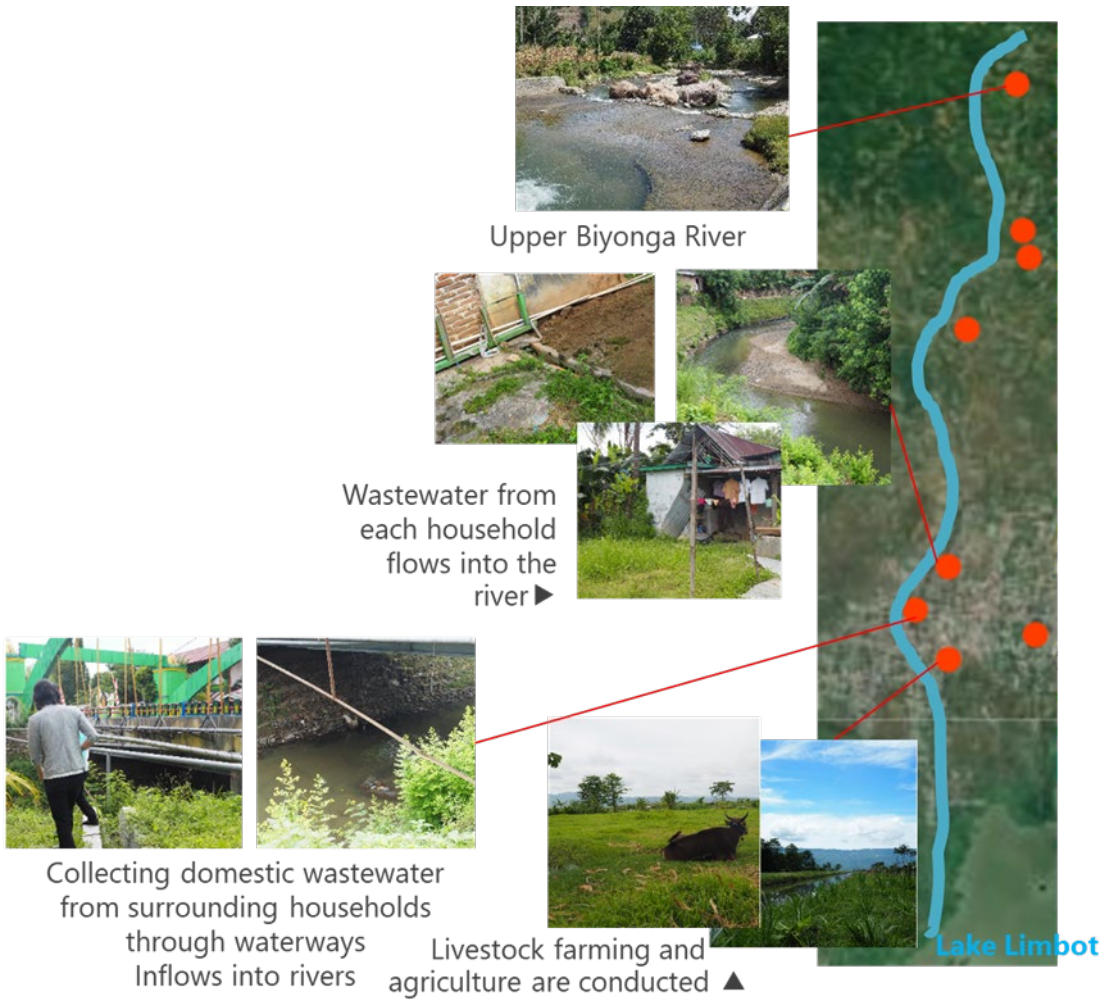


Figure 3-16 Results of the survey on potential sites in the Biyonga River basin

It is assumed that the closer areas to the Lake Limboto, the greater the impact of domestic wastewater on the lake, therefore it would be easier to evaluate the effect of a wastewater treatment plant in those areas. On the other hand, in the vicinity of the Lake Limboto, livestock farming and agricultural activities are conducted in the riverbeds, and it is assumed that the impact of livestock wastewater and agricultural wastewater on the lake is also highly significant.

In selecting sites, it is essential to grasp the true conditions based on data analysis of water quality, but there is no such analysis agency in Gorontalo Province, and currently the samples are sent to Manado or Makassar for analysis. The Gorontalo Provincial Department of Public Works said that it plans to establish a research institute and expects support from Ehime Prefecture and the Ehime University for the installation of water quality analysis equipment, etc.

③ Large-scale facilities

While sites ① and ② are seriously contaminated by domestic wastewater, there are obstacles to the installation of wastewater treatment plants, such as the lack of infrastructure, including underdeveloped pipelines, and the difficulty in showing the improvement effect on the Lake Limboto. Therefore, surveys were carried out on potential sites for the installation of wastewater treatment

plants, including sites where the installation of sewage treatment systems is required by law, systems scheduled to be updated, and large-scale systems scheduled to be newly constructed.

In Gorontalo province, traditional markets are organized in different locations on different days of the week, and untreated wastewater effluents from these markets drain through the surrounding agricultural land into the Lake Limboto.

Figure 3-17 Wastewater discharged from traditional markets

Last year, large central public markets were established in Gorontalo City and Gorontalo Province, with shops moving out of the traditional markets. The wastewater in these public markets is collected in tanks, periodically collected by vacuum trucks, and then discharged into the river. The tanks are made in Indonesia and are managed under the Department of Industry, with microbiological treatment being carried out. Several tanks are installed to separate the wastewater from each shop, toilet, and fish market, and they are collected in separate tanks. Food waste, plastic waste, etc., also flow into the tanks along with wastewater, indicating that there are challenges in sustainable management.

Figure 3-18 Wastewater treatment system at the City Central Market (Pasar Sentral Kota Gorontalo) in Gorontalo City

Figure 3-19 Wastewater treatment equipment at the provincial central market (Pasar Moderen Limboto) in Gorontalo Province

We heard the needs for additional wastewater treatment facilities for the hospital RSUD Dr M. M. Dunda, located in the Gorontalo Province, through BAPPEDA, Gorontalo Province. It is a Class B hospital in Indonesia, with 253 beds. Currently, all wastewater is treated using a single wastewater treatment system, but the hospital is considering installing an additional wastewater treatment system in order to increase the number of beds by 50 and improve the grade of the hospital.

The already installed wastewater treatment system is commonly known as IPAL (Instalasi Pengolahan Air Limbah), which has been installed at hospitals in Indonesia.

Figure 3-20 Wastewater treatment system at RSUD Dr M. M. Dunda

(2) **Understanding the actual situation at potential sites**

On January 26, 2024, Daiki Axis Indonesia visited the student dormitory in (1)① to check the current status of sewage wastewater treatment in the dormitory.

Figure 3-21 Site visit by Daiki Axis Indonesia (January 26, 2023)

According to the company, septic tanks in male and female dormitories are unlikely to be introduced as sites for testing the effects of installing wastewater treatment plants because the

drainage channels are different from those of sewage wastewater, and the layout of the dormitories would require extensive construction work to implement, for example, the combined treatment by wastewater treatment plants together with the sewage wastewater. On the other hand, comments were received on the wastewater from the canteen, stating that the wastewater comes from a single building, which also has toilets and can be treated in combination with sewage wastewater and human effluent using a wastewater treatment plant made by Daiki Axis.

The reservoir has been relocated further since the visit in August 2022, with sanitation issues expected due to its very close proximity to the canteen and wastewater treatment considered as an urgent issue.

We plan to collect information from the student dormitories regarding the volume of wastewater and building layout drawings. Furthermore, after determining the size of wastewater treatment plants that can be installed, piping, etc., we will make another proposal to the student dormitories.

(3) Evaluation of the effects of installation

[CO_2 emission reduction]

As mentioned above, this project is aimed at the province-wide introduction of wastewater treatment facilities with wastewater treatment plants, but at this initial stage, we are considering installing single facilities or area-limited installations. Therefore, we are planning to designate a village located in the basin of the Biyonga River that flows into the Lake Limboto as a demonstration site, and a wastewater treatment plant provided by Daiki Axis Co., Ltd will be installed to treat wastewater. In addition, we explored a model in which the power to run a wastewater treatment plant is supplied by solar power and calculated the CO_2 reduction effect.

We assumed the installation of a large wastewater treatment plant (BJ-30) capable of processing 30 m^3 of water per day in a village with 25 households and an average of 4 people per household. The power consumption of the facility is about 1,000W, and annual power consumption is 6,570 kWh/year, under the assumption that it will operate 24 hours a day, 365 days a year. A model supplying this power with solar panels is being considered. The CO_2 emission coefficient for electricity in Indonesia is 0.533t CO_2/MWh according to the "FY2019-2021 Mechanism for Measures to Reduce Carbon Dioxide Emissions (Equipment Subsidy Projects as part of Joint Crediting Mechanism Fund Support Projects) Appendix 4," and it is possible to reduce CO_2 emissions by about 3.501 tons per year from the 6,570 kWh generated by the above estimate.

In addition, the installation of a wastewater treatment plant is expected to have the effect of reducing greenhouse gases that were previously released into rivers and generated by natural decomposition. For this reduction calculation method, please refer to "5.D.1 Decomposition of domestic wastewater in nature"[22] among the greenhouse gas emission and absorption calculation methods compiled by the Ministry of the Environment. This methodology is based on the 2006 IPCC

[22] Ministry of the Environment, "5.D.1 Decomposition of domestic wastewater in nature" (https://www.env.go.jp/earth/ondanka/ghg-mrv/methodology/material/methodology_5D1_4_2020.pdf)

guideline "Chapter 6 Wastewater treatment and discharge"[23] and methane emissions associated with the natural decomposition of domestic wastewater can be calculated by the following formula.

$$E = EF \times \sum (A_i)$$

E : 生活排水の自然界における分解に伴う CH_4 or N_2O 排出量［kg-CH_4］or［kg-N_2O］
EF : 2006 年 IPCC ガイドラインのデフォルト排出係数［kg-CH_4/kg-BOD］or［kg-N_2O/Kg-N］
A_i : 公共用水域に未処理で排出される生活雑排水・汚泥（種類 i）中の有機物量もしくは窒素量［kg-BOD］or［kg-N］

In accordance with the guidelines, 0.6 [kgCH_4/kg-BOD] is used as the default value for domestic wastewater. The default value of 0.1 for "Sea, river and lake discharge" in "Untreated system" in Table 6.3 of the same guideline is used as the methane conversion coefficient. As a result, the CH_4 emission factor is calculated to be 0.06 [kg-CH_4/kg-BOD]. In addition, the BOD (biochemical oxygen demand) load of domestic wastewater in Japan is 13 g/person/day of human waste and 27 g/person/day of miscellaneous wastewater – a total of 40 g/person/day. When this figure is applied, the CH_4 emission reduction due to the introduction of wastewater treatment plant equipment will be 131.4 kg-CH_4/year, or 3.285 t-CO_2/year when converted into a CO_2 emission reduction (global warming potential of CH_4: 25).

In contrast to the reference CO_2 emissions described above, project CO_2 emissions include emissions from transportation when transporting generated wastewater treatment plant sludge from the wastewater treatment plant to the methane fermentation facility, but since it is difficult to predict this as of now, we have assumed it as ignorable. In other words, it is estimated that a total of 6.786t-CO_2 can be reduced per year.

[Cost-effectiveness]

Regarding the above-mentioned area-limited demonstration project, we intend to use the demonstration budget of the Ministry of the Environment's "Model Project for Improving the Water Environment in Asia" rather than the JCM equipment subsidy program, to install wastewater treatment plants, verify the effects associated with them, and consider systems packaged with solar power generation. On the other hand, when installing wastewater treatment plants in the entire area of the densely populated city of Gorontalo, we are considering the use of the JCM equipment subsidy program for solar power generation facilities related to CO_2 reduction, and this time we estimated the cost-effectiveness of such a project.

The population of the city of Gorontalo is about 200,000, and assuming the installation of the above-mentioned large wastewater treatment plants (BJ-30) that can treat 30 m^3 of water per day, about 1,300 units are expected to be installed. Since the annual power consumption of 1,300 wastewater treatment plants is 2,847,000 kWh, in order to obtain these powers, an installed capacity of 1,625 kW is required, considering that the utilization rate of solar power generation equipment is about 20%. The cost is 150,000 yen per kW when the procurement of Japanese panels is assumed,

[23] 2006 IPCC Guidelines Vol6 Wastewater treatment (https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf)

so the total cost is 243.75 million yen. Since the solar power generation business already has a track record of multiple JCM equipment subsidy programs, the subsidy rate will presumably be 30%. In this case, the subsidy amount would be about 73.12 million yen.

Using the above-mentioned estimated CO_2 emission reduction in wastewater treatment for a total of 100 people, and referring to the "Appended Table of the Ministerial Ordinance on the Durable Years of Depreciable Assets" of the Ministry of Finance, the statutory service life of 17 years for "other equipment other than machinery and devices made mainly of metal" is applied to solar panels, and the statutory useful life of 12 years for "water supply or sewerage industry equipment" is applied to wastewater treatment plants. As a result of estimating the total reduction in emissions during the depreciation period, including the effect of reducing greenhouse gases generated by natural decomposition, a reduction of 42,879t-CO_2 is expected. From the above, the installation of wastewater treatment plants will reduce the cost by 1,705 yen per ton.

3.2.2. Methane fermentation facility

As mentioned above, as a result of the study in the project in FY 2021, we are now planning to examine the other types of organic wastes than wastewater treatment plant sludge as raw materials for methane fermentation facilities. Regarding the needs from Gorontalo Province, our support for the utilization of wastes as an energy source is also eagerly anticipated. Accordingly, we researched the biomass resources that can be used in Gorontalo Province in the project in FY 2021.

As of 2020, the amount of waste generated in Gorontalo Province was 543 tons per day, so an estimated 198,032 tons of waste is generated per year. The amount of waste generated in each municipality of the province and the waste classification of the entire province are shown below.

name	Total amount of waste/day	Total amount of waste/year
Gorontalo	157t	57,408t
Gorontalo city	143t	52,320t
Bone Bolango	67t	24,379t
Pohuwato	64t	23,208t
Boalemo	60t	22,035t
North Gorontalo	51t	18,682t

Household waste	75%	148,524t/year
Organic waste	65%	128,721t/year
Inorganic waste	35%	69,311t/year
Plastic waste	11%	21,783t/year
Office waste	1%	1,980t/year

Figure 3-22 Waste generation and classification in Gorontalo Province[2]

The amount of generated organic waste that can be used as raw materials for methane fermentation facilities is 128,721 tons per year, and in the project in FY 2023, we have been collecting data on companies that produce a large amount of organic waste.

In addition, the 2021 Local Government Work Plan (RKPD) of Gorontalo Province lists the

following industries for each municipality in the province [24].

Table 3-7 Industries in Gorontalo Province

Name of municipality	Industry
Gorontalo Regency	Coconut processing, sugar production, seaweed processing
North Gorontalo Regency	Seashell crafts, fish processing, bamboo crafts, embroidery, palm fibers
Gorontalo City	Food processing, handicrafts, apparel

Of these, coconut processing and sugar production are mentioned as particularly developed industries in Gorontalo Regency and the names of several companies are also mentioned. The fact that sugarcane and coconut are cited as the plantation crops with the highest production in Gorontalo Province suggests the province's strong focus on these crops from both the agricultural and processing industries' perspectives. For this reason, cooperation and support from Gorontalo Province can be expected for the installation of methane fermentation facilities. The outline and location of each plant are shown below.

Figure 3-23 Locations of a coconut processing plant and a sugar factory

The suitability of the generated raw materials is also cited as a reason why the installation of methane fermentation equipment in these factories is highly feasible. Since the wastewater generated when processing coconuts and manufacturing sugar has a high sugar content, which activates

[24] PROVINSI GORONTALO (Sep. 2021) "BAB II GAMBARAN UMUM KONDISI DAERAH" (https://bappeda.gorontaloprov.go.id/institution/file_share/BAB-II_179_637.pdf)

fermentation by microorganisms, generating a large amount of methane gas, hence more electricity can be obtained. In Japan, at the food factories whose operation decreased due to COVID-19, the above-mentioned methane fermentation equipment of Aiken Kakoki K.K. was utilized to generate profits from power generation and selling electricity by treating wastewater with a high sugar content that had been stored, and in some cases, it helps the factories stay afloat while the income from the main business has dropped. Although it is somewhat dependent on the power demand and power grid of Gorontalo Province, the above-mentioned system is certainly worth considering.

In the field survey of last fiscal year's project, we contacted the coconut processing plant mentioned above and proceeded with discussions on the installation of the methane fermentation facility as follows.

(1) **Selection of potential sites**

① Coconut processing plant (PT. Royal COCONUT)

PT. Royal COCONUT was established in 2007 and produces a variety of processed coconut products. The company is headquartered in Jakarta, with offices in Surabaya, factories in North Sulawesi and Gorontalo Provinces, and 66,800 hectares of coconut plantation forest around its factories in Gorontalo Province.

The company's products are also exported mainly to European and Middle Eastern countries. For example, about 50,000 tons of coconut flour was exported to Taiwan, China, the Netherlands, Portland, Africa, Russia, etc. in 2020, and in the six months from January to June 2022, about 3,000,000 tons of products were exported, earning revenues of about 800 million yen.

According to the company, 27% of the amount of coconut processed becomes wastewater, and together with washing water, about 350 to 400 m^3 of wastewater is generated daily.

The current wastewater treatment flow is as follows.

Figure 3-24 Current wastewater treatment flow at PT. Royal COCONUT (created by Aiken Kakoki K.K.)

Wastewater analysis is carried out regularly, but analysis values fluctuate greatly from day to day, and the reason for this is presumed to be that the water sampling analysis is carried out in conditions where there is no control tank, hence the concentration is not uniform. On the other hand, a certain level of COD concentration was detected although concentration level varied, so Aiken Kakoki K.K. said that an energy recovery system utilizing oil-water separation (EGSB) is feasible. The technology proposed by Aiken Kakoki K.K. is shown below.

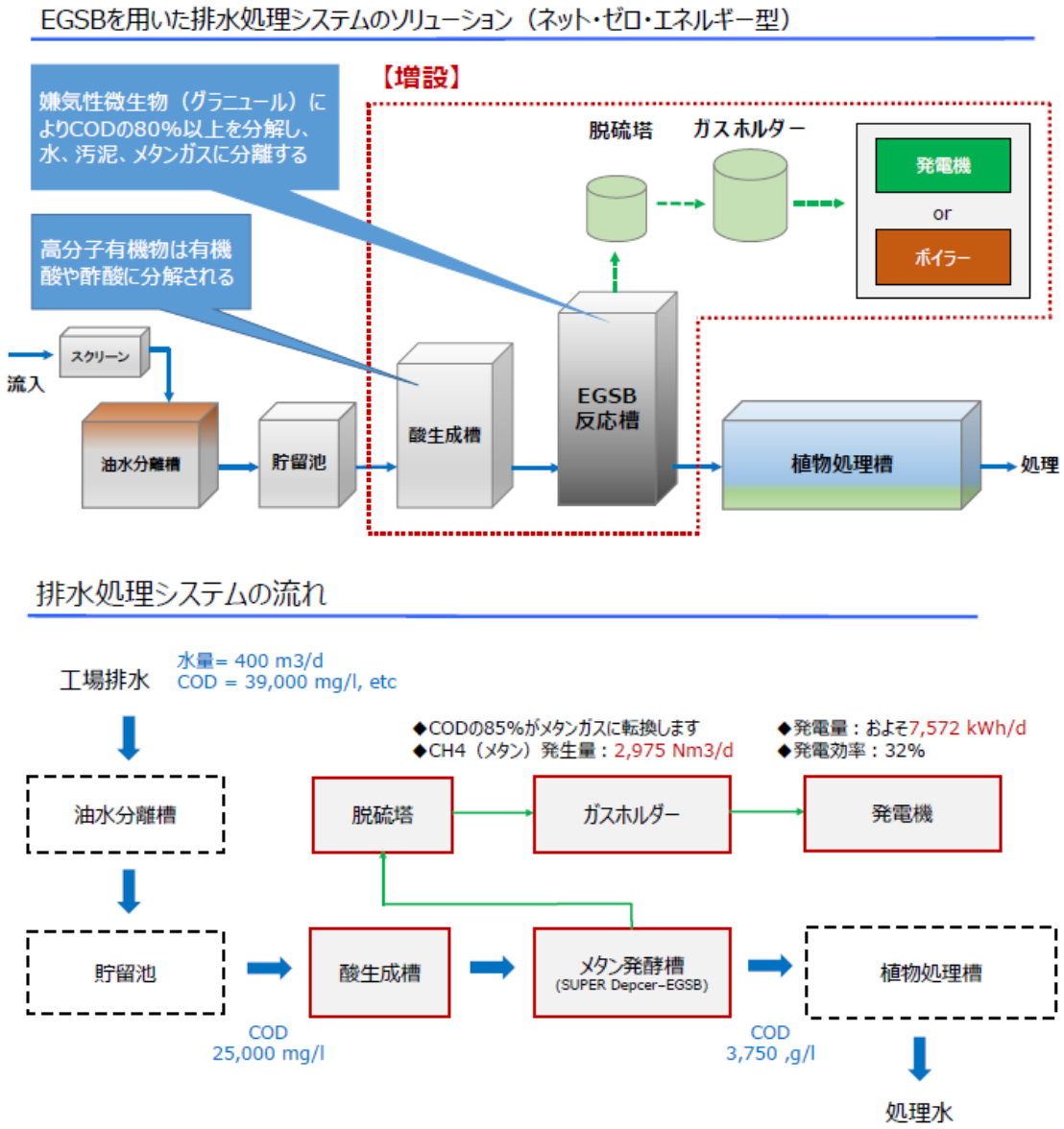


Figure 3-25 System proposed by Aiken Kakoki K.K. to PT. Royal COCONUT (as of January 2023)

② Coconut Processing Plant (PT. Trijaya Tangguh)

PT. Trijaya Tangguh is one of the two largest coconut processing plants in Gorontalo Province along with PT. Royal COCONUT. Founded in 2006, around the same time as PT. Royal COCONUT, the company is headquartered in Surabaya and has a factory in Gorontalo Province. It mainly produces coconut milk and coconut water.

Like PT. Royal COCONUT, the company's products are also exported mainly to European and Middle Eastern countries.

Figure 3-26　PT. Trijaya TANGGUH

About 500 m^3 of wastewater is generated per day, and the monthly electricity bill is about 5 million yen. The current wastewater treatment flow is similar to that of PT. Royal COCONUT and is as follows.

Figure 3-27　Current wastewater treatment flow in PT. Trijaya TANGGUH (created by Aiken Kakoki K.K.)

Wastewater analysis is carried out regularly, but the analysis value fluctuates greatly from day to day as seen at PT. Royal COCONUT, and the reason for this is presumed to be that the water sampling analysis is carried out in conditions where there is no control tank, hence the concentration is not uniform. On the other hand, a certain level of COD concentration has been detected although the concentration level varies, so Aiken Kakoki K.K. has said that an energy recovery system utilizing oil-water separation (EGSB) is feasible.

(2) **Understanding the actual situation at a potential site**

In the previous fiscal year's project, PT. Royal COCONUT expressed a very high interest in wastewater treatment and energy recovery. Therefore, with the aim of first introducing such systems in PT. Royal COCONUT, a detailed assessment of the actual situation was continued in this fiscal year's project.

Figure 3-28 Exchange of opinions with PT. Royal COCONUT (January 2023)

The analysis of wastewater effluents is carried out regularly, and the data were collected in the last fiscal year's project. Since the retention time of wastewater in the treatment tank is approximately one month, the analysis is currently carried out once a month. Through interviews and site visits, it was found that water samples are currently collected and analyzed at two locations, Inlet and Outlet, as shown in the diagram below.

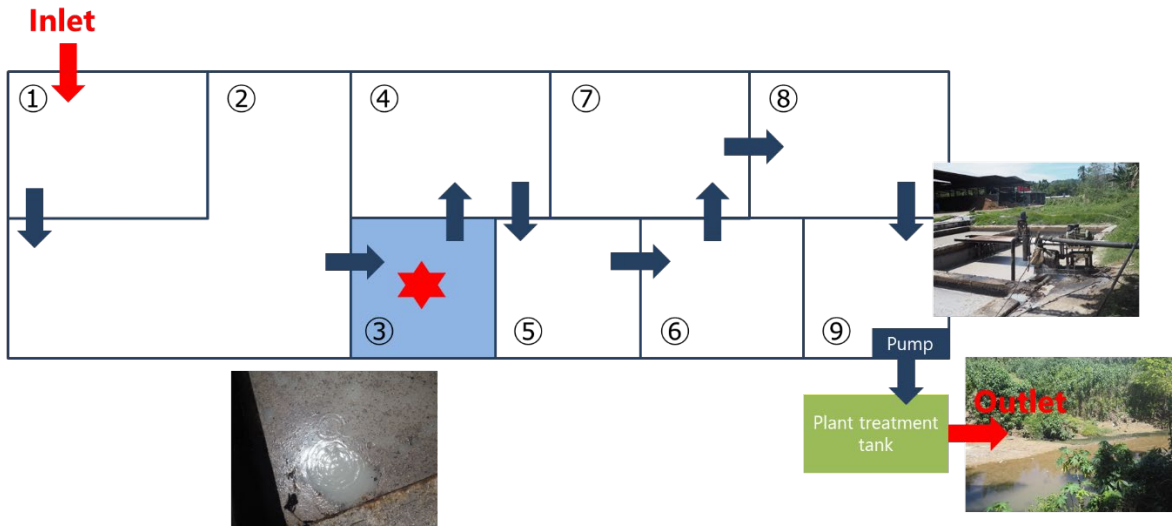


Figure 3-29 Current drainage flows and water sampling points

On the other hand, these analysis data show variations in inspection results, making it difficult to design more detailed systems. For this reason, in this fiscal year's project, in addition to the analysis data from Inlet and Outlet, the water samples were also collected from the areas marked with ★ in the diagram above, where wastewater accumulates. In the proposed system by Aiken Kakoki K.K., the granule bacteria activity drops when the temperature of the wastewater effluents falls below 30°C, hence the temperature of the wastewater effluents was also measured.

In order to determine the concentration variations in the wastewater effluents, water sampling was carried out four times, at different timings, frequencies, sampling providers, and organizations conducting analysis, as summarized below.

Table 3-8 Collection and analysis of wastewater data

Timing	Frequency	Water Sampling Location	Sampled by	Organization Conducting Analysis
June	Once a week: approx.16:00	★	PT. Royal COCONUT	PT. WATER LABORATORY NUSANTARA INDONESIA
August	Three times a day: 10:00/13:00/16:00	★	JANUS	MIURA CO., LTD.
September	Three times a day: 10:00/13:00/16:00	A/B/C	Aiken Kakoki K.K.	Aiken Kakoki K.K.
November	Three times a day: 10:00/13:00/16:00	A/B/C	Aiken Kakoki K.K.	Aiken Kakoki K.K.

Figure 3-30 Water sampling at PT. Royal COCONUT

In methane fermentation, the COD concentration contributes to the amount of energy that can be recovered, making it necessary to understand the COD concentration when designing. The analysis revealed that the COD concentrations varied slightly, but the concentration after retention was found to be approximately 12,000 mg/L. Furthermore, water sampling and analysis by Aiken Kakoki K.K. indicate that the concentration of suspended solids is high in A and B, while the concentration of suspended solids was 1,000 mg/L or less in the sedimentation tank in C. Therefore, it is expected that treatment can be carried out as it is in Aiken Kakoki K.K.'s facilities. In order to keep the price of the system low, it was considered suitable to treat wastewater effluent from C, where the removal of suspended solids does not need to be taken into account. Regarding the water temperature, which contributes to the activity of granule bacteria, the water temperature was kept above about 30°C in

all three water samples taken in the morning, noon, and evening.

Regarding the operation of PT. Royal COCONUT's plant, the company mentioned that the plant operates 24 hours a day, except on Sundays, public holidays, and New Year holidays, with no difference in the volume of wastewater discharged throughout the year. The company primarily produces coconut oil while manufacturing coconut milk in occasional periods as per the orders received. Coconut milk was manufactured at the time of water sampling in August, but there was no significant difference in COD concentrations compared to the other timings. The manufacturing process at PT. Royal COCONUT is as follows.

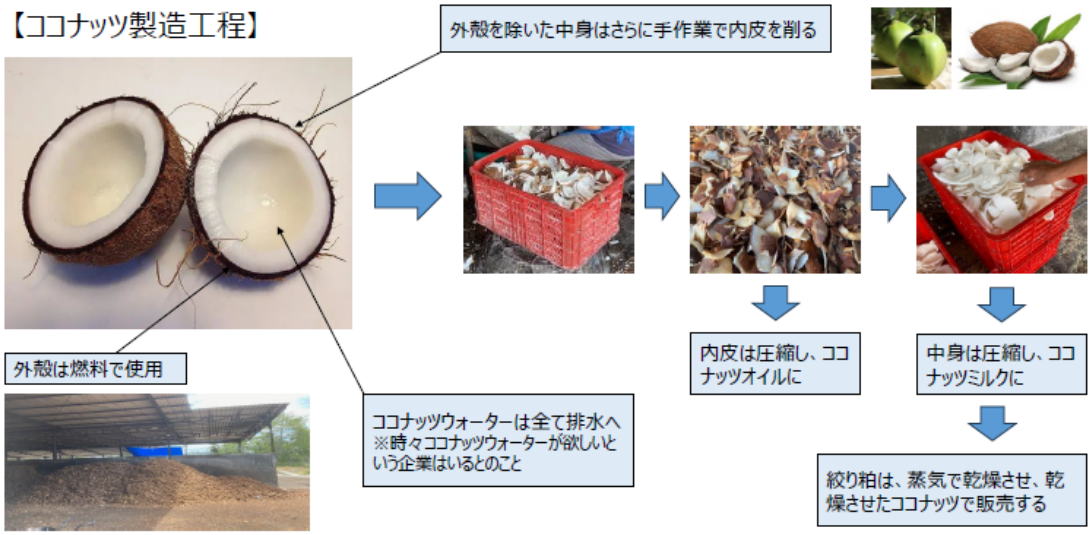


Figure 3-31 Manufacturing process at PT. Royal COCONUT (compiled by Aiken Kakoki K.K.)

The power consumption at PT. Royal COCONUT was calculated from electricity payment invoices to PLN. According to the company's invoices for August 2023, the monthly power consumption and unit prices can be calculated as follows. Though unit prices differ between peak and off-peak hours, the aggregated power consumption per month was 274,120 kWh and the unit price for electricity was Rp 329,662,386. According to interviews with the company, electricity costs are approximately 3 million yen per month, which is in line with the approximate figure.

Table 3-9 Electricity consumption and unit prices at PT. Royal COCONUT (as of August 2023)

	LWBP (22:00-18:00)	WBP (18:00-22:00)	Sum
Electricity consumption (kWh/month)	201,690	72,430	**274,120 kWh/month**
Unit price (Rp)	1,065.78	1,583.67	-
Sum (Rp)	214,957,168	114,705,218	**329,662,386 Rp**

In addition, interviews were held on future business plans related to the scale of installing wastewater treatment systems. The president of the company has about 30 hectares of unused land, and although he has expressed an interest in expanding the business by adding a factory in the future, he has no concrete plans.

(3) Calculating the effects of system installation

Based on the results of the survey in (2), the benefits of installing the company's patented net-zero-energy wastewater treatment system as an addition to the existing wastewater treatment plant were calculated.

[System installation effects]

The values of PT. Royal Coconut used in the calculation of the system installation effect are given below. The daily power consumption was calculated from the above-mentioned monthly power consumption. Electricity costs were assumed to be 3 million yen.

Table 3-10 Criteria used for calculating system installation effects

Criteria	Value
Plant effluents	400 m^3/day
COD concentration of influent water	12,000 mg/L
Current power consumption	8842.5 kWh/day
Current electricity charge	3 million yen/month

According to the company, the installation of the above-mentioned wastewater treatment system would enable the treatment of PT. Royal COCONUT's highly concentrated wastewater to reduce the COD concentration from 12,000 mg/L to 1,800 mg/L. In addition, 3,634 kWh/day can be generated from 400 m^3 of wastewater per day. The recovered energy can also be used as boiler fuel, but since PT. Royal COCONUT has confirmed that the boiler is fueled by coconut shells, a model where part of the plant's operating electricity is consumed in-house will be considered.

[CO_2 emission reduction]

Currently, as an MRV methodology for anaerobic treatment of organic waste and the use of biogas, we have the MRV methodology (VN_AM004) from the case in Ho Chi Minh City, Vietnam: “Methane Fermentation of Organic Waste and Cogeneration in the Wholesale Market”; however, its target organic waste is solid waste. Therefore, there has been no registered project regarding methane fermentation in wastewater treatment, and it is necessary to develop MRV methodologies for project development.

The low-carbon effect of methane fermentation facilities is derived from the reduction of greenhouse gases that would be generated by natural decomposition if the wastewater containing a large amount of organic matter is released into rivers and other places. For this reduction calculation

method, please refer to "5.D.2 Decomposition of industrial wastewater in nature" of the greenhouse gas emission and absorption calculation methods compiled by the Ministry of the Environment.[25] This methodology conforms to the 2006 IPCC guideline "Chapter 6 Wastewater treatment and discharge23," and methane emissions through the natural decomposition of industrial wastewater can be calculated using the following formula:

$$E = EF \times (A_1 + A_2)$$

E : 産業排水の自然界における分解に伴う CH_4 or N_2O 排出量［kg-CH_4］or［kg-N_2O］
EF : 2006 年 IPCC ガイドラインのデフォルト排出係数［kg-CH_4/kg-BOD］or［kg-N_2O/Kg-N］
A_1 : 産業排水処理施設から公共用水域に直接排出される未処理排水中の有機物量もしくは窒素量［kg-BOD］or［kg-N］
A_2 : 産業排水処理施設から公共用水域に直接排出される処理後排水中の窒素量［kg-N］

Using the default value of methane conversion factor 0.1 for "sea, river and lake discharge" in "untreated system" in Table 6.3 of the guideline, the CH_4 emission factor is calculated to be 0.06 [kg-CH_4/kg-BOD].

In addition, the amount of organic matter or nitrogen in the untreated wastewater discharged directly from an industrial wastewater treatment facility to the public water body (A_1) is set at the default value of 5.5 [kt-BOD] (2018) for the food manufacturing industry; on the other hand, the amount of nitrogen in the treated wastewater discharged directly from an industrial wastewater treatment facility to the public water body (A_2) is assumed to be discharged directly into the public water area untreated in the current case, therefore it is excluded from this calculation. The amount of water discharged at the PT. Royal COCONUT plant is approximately 400 m^3 per day, or 146,000 tons per year. When this figure is applied, the CH_4 emission reduction due to the installation of methane fermentation equipment will be 48,180,000 kg-CH_4/year, which is estimated to amount to a total reduction of 1,204,500t-CO_2/year when converted into CO_2 emission reduction (global warming coefficient of CH_4: 25), and this is the reference emission.

Regarding project emissions, according to interviews with PT. Royal COCONUT, the amount of electricity consumed at the existing plant including wastewater treatment facilities is 8842.5 kWh/day, so annual power consumption is 3,227,512 kWh. When this is multiplied by the power grid emission factor of 0.533 t-CO_2/MWh in Indonesia, we obtain 1,720 t-CO_2/year.

By the power output after the installation of wastewater treatment facilities of Aiken Kakoki K.K. and power consumption, the power that can be supplied to PT. Royal COCONUT and CO_2 emission reduction was calculated.

The total project emissions are the methane suppression effect of diffusion in the atmosphere (1,204,500 t-CO_2/year) + Reduction due to the equipment of Aiken Kakoki, if the statutory service life of 12 years ("water supply or sewerage equipment") is applied, the expected reduction in emissions during the depreciation period is 14,454,000 t-CO_2 or more.

[25] Ministry of the Environment "5.D.2 Decomposition of industrial wastewater in nature" (https://www.env.go.jp/earth/ondanka/ghg-mrv/methodology/material/methodology_5D2_3_2020.pdf)

[Cost-effectiveness]

In the JCM Equipment Subsidy Program, either 50% of the equipment that contributes to the reduction of CO_2 emissions or the estimated emission reduction cost of 4,000 yen/t-CO_2, whichever is lower, is applied for the first project in any given country. The cost for methane fermentation facility is estimated to be below 4,000 yen/t-CO_2. Accordingly, sufficient cost-effectiveness can be expected, when discussing this project as the one subject to the JCM equipment subsidy program.

3.2.3. Other (final disposal site)

Regarding the leachate from final waste disposal sites, we have received a request for assistance from the Gorontalo Provincial Department of Public Works regarding the proposal for treatment technology.

TPA Talmelito, a final disposal site of Gorontalo Province, is located in Gorontalo Regency and receives waste from Gorontalo City (70%), Gorontalo Regency (20%) and Bone Bolango Regency (10%).

Below is the outline of the waste collection flow in Gorontalo Province. Each household pays a collection fee (5,000 rupiah/month) to the primary sorting station (TPS) operated by the Gorontalo Provincial Department of Environment, and TPS collects waste from the fee-paying households. Recyclable plastic, cardboard, and other waste are sorted by TPS, and other waste is transported to the final disposal site. The types of waste sorted by TPS are as follows.

type	Price
PET1 (thick)	4000Rp/kg
PET2	3000Rp/kg
Aqua (plastic bottle of drinking water Aqua)	4000Rp/kg
Splite (green plastic bottle)	3000Rp/kg
AleAle (juice cup)	3000Rp/kg
Ingect (oil container)	3500Rp/kg
Bucket (engine oil container)	3000Rp/kg
PP (rigid plastic)	3000Rp/kg
Sembur (plastic bottle cap)	3000Rp/kg

Figure 3-32 Waste sorted by TPS and their selling prices

On the other hand, there are a certain number of households that do not pay their collection fees, and for households located on the main street including these households, waste left in front of each household is collected by trucks owned by the Gorontalo Provincial Department of Environment and transported directly to the final disposal site.

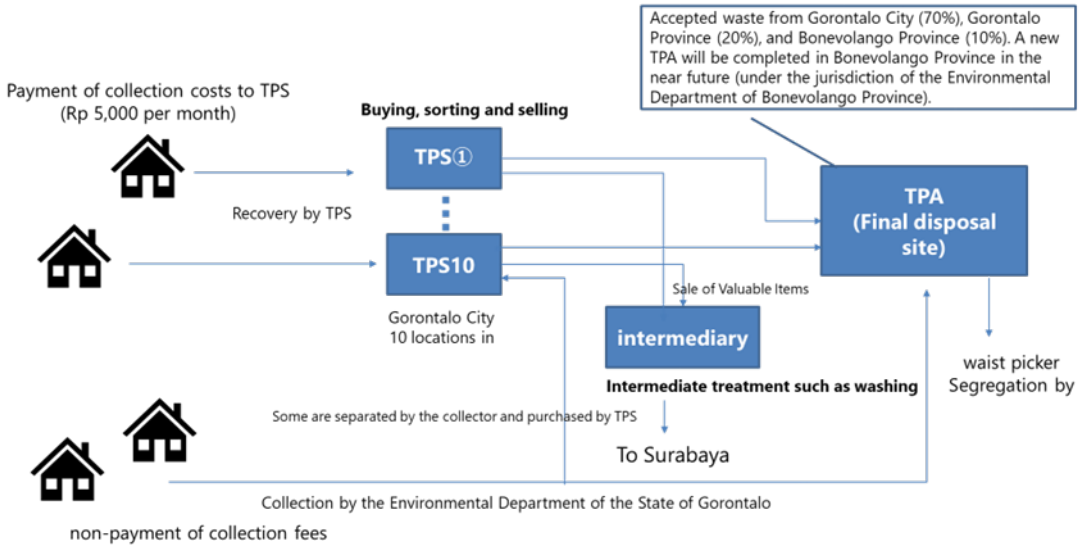


Figure 3-33 Waste collection and treatment flow in Gorontalo Province

According to the Department of Environment and the Department of Public Works of Gorontalo Province, there are many sites that are not functioning due to financial difficulties that emerged only three months after the start due to insufficient fee collection, and it is assumed that there is a lot of uncollected waste outside the above-mentioned system. According to the statistical data from the Gorontalo Provincial Department of Environment, as of 2020, the amount of waste generated in Gorontalo Province was 543 tons per day and the annual amount is estimated to be up to 198,032 tons. The amount of waste generated by municipalities in the province and the waste classification of the province as a whole are shown below.

name	Total amount of waste/day	Total amount of waste/year
Gorontalo	157t	57,408t
Gorontalo city	143t	52,320t
Bone Bolango	67t	24,379t
Pohuwato	64t	23,208t
Boalemo	60t	22,035t
North Gorontalo	51t	18,682t

Household waste	75%	148,524t/year
Organic waste	65%	128,721t/year
Inorganic waste	35%	69,311t/year
Plastic waste	11%	21,783t/year
Office waste	1%	1,980t/year

Figure 3-34 Waste generation and classification in Gorontalo Province2

There are a total of four landfill sites, three of which have already been filled and decommissioned. Currently, only the disposal site shown in pink in the figure below is in use.

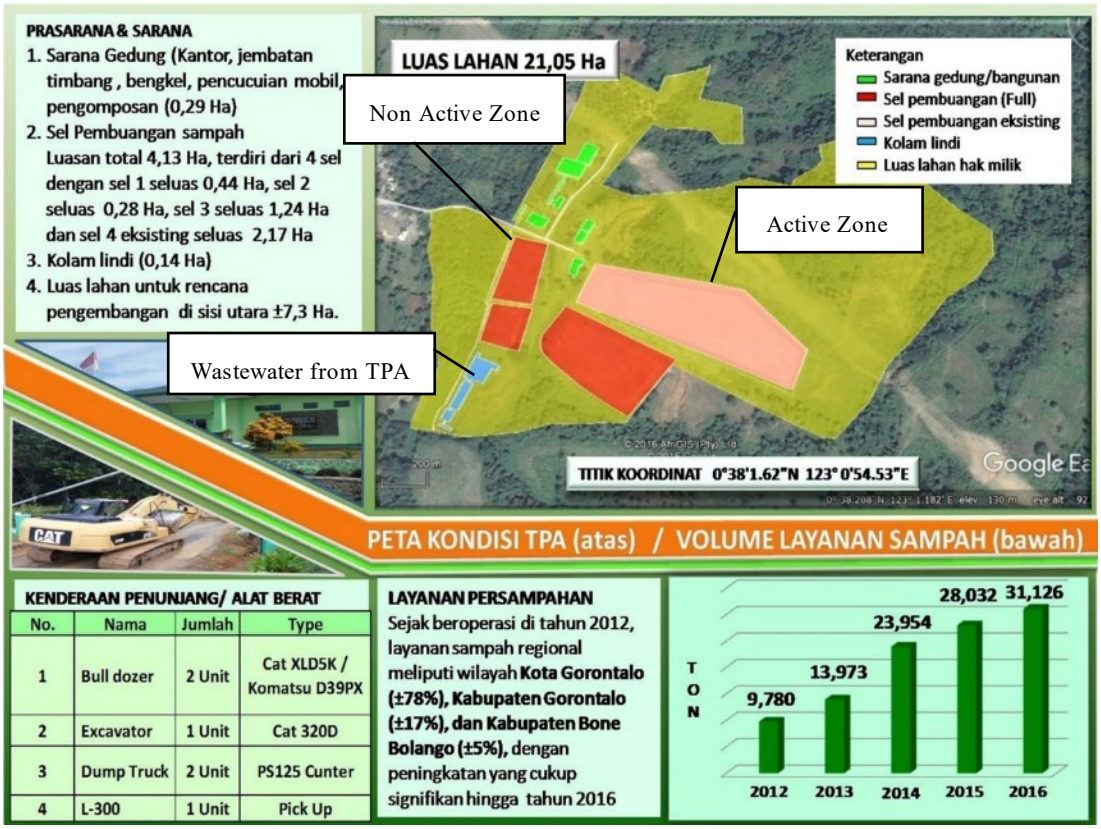


Figure 3-35 Outline of final disposal sites (TPA Talmelito)

The amount of waste transported to the final disposal site is about 100 tons per day, and the landfill areas originally designed to be usable for three years are being filled in less than a year. When we visited there in August 2022, about 80% of the disposal site was full, but by the time we returned in January 2023, the ditches were filled, and the site was almost full. Currently, there are plans to construct a new landfill site with the aim of starting construction in 2025, and the critical situation with the landfill sites is one of the issues at the final disposal site.

At the time of our visit in August 2022

At the time of our visit in January 2023

Figure 3-36 Scenes of the final disposal site

Another major challenge is the leachate from three landfill sites that were decommissioned in

November 2021. According to the Gorontalo Provincial Department of Public Works, the leachate from the final disposal site overflows during rainfall and flows into rivers, causing damage such as the death of livestock in the vicinity, and countermeasures are urgently needed. Currently, they have no treatment system, and the leachate is discharged into the river as it is after aeration only.

Water quality tests are conducted 2 to 3 times a year and they use the same analysis laboratory as PT. Royal COCONUT, so samples are sent to Manado in 24 hours after sample collection. The amount of leachate generated per day is 52 m^3.

Figure 3-37 Current final disposal site leachate treatment flow

On November 10, 2022, Aiken Kakoki K.K. visited the final disposal site and confirmed the quality of leachate and the structure of the treatment tank. As a result, the company concluded that appropriate treatment is possible using the company's technology, and on January 20, 2023, and it proposed a system that could be constructed at the final disposal site.

Figure 3-38 Exchange of opinions between Aiken Kakoki K.K. and the Gorontalo State Public Works Department (January 2023)

According to Aiken Kakoki K.K., two systems with different initial costs, running costs, and operations can be recommended. The first is a technology that separates water and sludge naturally in an installed tank and then performs sand filtration and removal with an activated charcoal. The

second is the membrane separation activated sludge method (MBR system), which is a technology that utilizes installed membranes capable of 1/2,500 mm filtration. Since it is impossible to treat wastewater containing mercury, it is necessary to separate waste items such as electric lights and batteries containing mercury at landfill sites. Accordingly, in the project in FY 2023, we assessed the compatibility of the above-mentioned system and studied leachate analysis data, the actual situation of usage of the final disposal site, etc. for designing the facility.

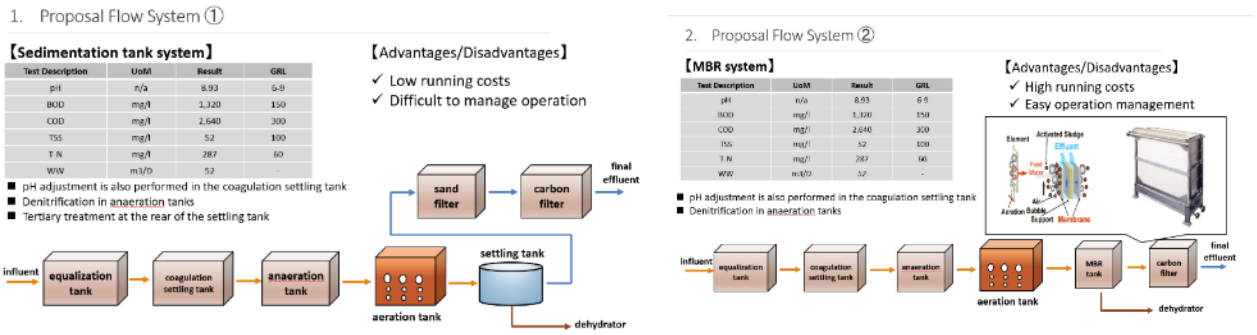


Figure 3-39 Diagrams of the systems proposed by Aiken Kakoki K.K.

(1) Grasping of the actual situation of potential sites

Leachate flows into the treatment tank located in the southern area of the final disposal site, and then it is discharged to a river after the treatment in anaeration and aeration tanks.

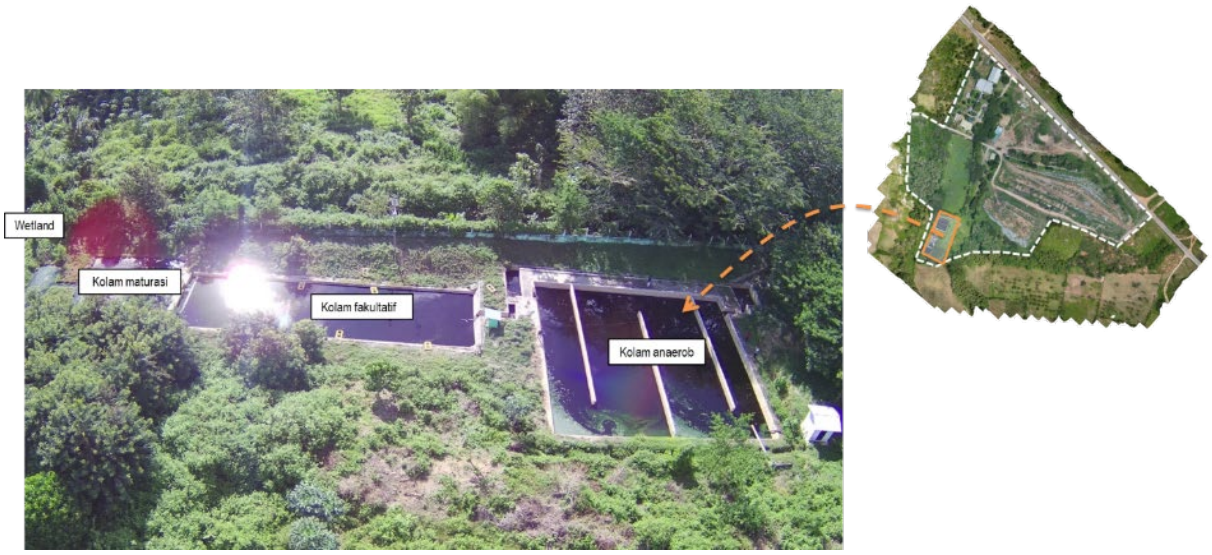


Figure 3-40 Existing leachate treatment facility

The leachate from four (Cells 1 to 4) out of five landfills in the final disposal site is collected and treated. On the other hand, there remain many problems, such as the insufficient depth of the anaeration tank, which leads to the failure to satisfy anaeration conditions, and the breakdown of the aeration system or unstable electricity supply to the aeration tank, so the leachate is discharged to a river without sufficient treatment, destroying the surrounding ecosystem, causing the death of

livestock, etc. A water quality test is conducted regularly at the following five spots, and the test results indicate that all of the BOD, COD, and TSS concentrations exceed the standard values.

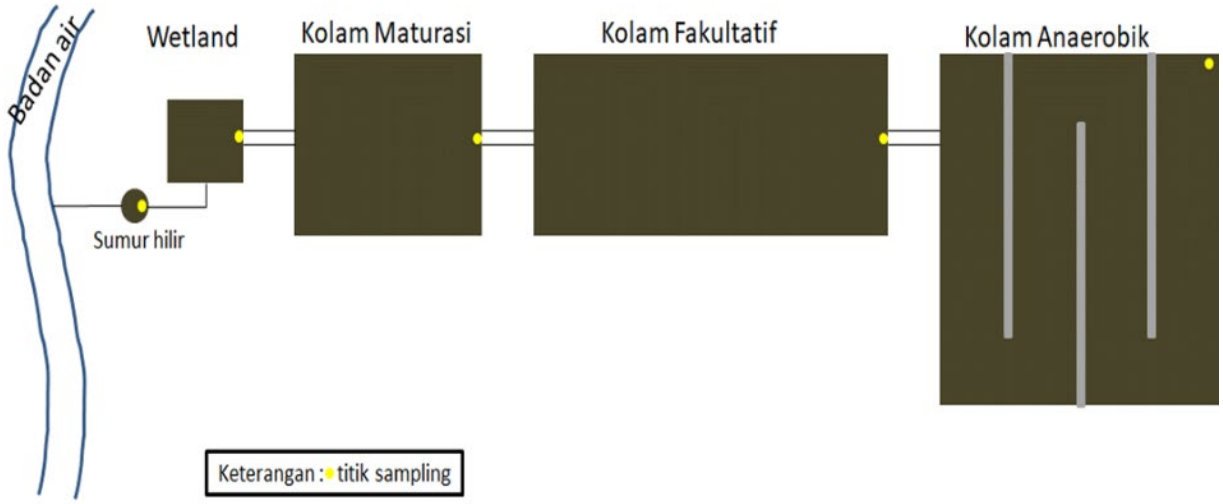


Figure 3-41 Water sampling spot for the test quality test

The water quality standards for leachate are specified in "Regarding the leachate standards for the project and/or activities of the final disposal site" in the Order No. 59 of the Minister of the Environment and Forestry in 2016[26]. The following seven items need to be tested three times a year.

While following the above environmental regulations, we collected the leachate measurement certificates from the Gorontalo Provincial Department of Public Works, and adopted the values in them as design conditions. Mercury, cadmium, etc. are analyzed regularly, but their measurements seldom exceed the reference values, so we decided to design the facility without considering the removal of them.

Table 3-11 Water quality standard values for leachate

Parameter	Kadar Paling Tinggi	
	Nilai	Satuan
pH	6-9	-
BOD	150	mg/L
COD	300	mg/L
TSS	100	mg/L
N Total	60	mg/L
Merkuri	0,005	mg/L
Kadmium	0,1	mg/L

(2) **Estimation of the effects of installation of the facility**

[Effects of installation of the facility]

With reference to the values of the leachate measurement certificates obtained from the Gorontalo Provincial Department of Public Works, we estimated the effects of installation of the wastewater treatment facility of Aiken Kakoki, and the following table shows the comparison with the current

[26] https://peraturan.bpk.go.id/Details/168713/permen-lhk-no-59-tahun-2016#:~:text=Peraturan%20Menteri%20Lingkungan%20Hidup%20Dan%20Kehutanan%20Nomor%2059,Sampah%20T.E.U.%20Indonesia%2C%20Kementerian%20Lingkungan%20Hidup%20dan%20Kehutanan

concentrations in leachate (sampled on May 18, 2023). The measurements indicate that the concentrations in effluent are higher than those in influent. Aiken Kakoki mentioned that the current facility could cause such a situation, and is proposing their facility while taking it into consideration.

Table 3-12 Results of estimation of effects of adoption of the wastewater treatment facility of Aiken Kakoki

Item	Current concentration in influent	Current concentration in effluent	Concentration for the installation of the facility	Unit
pH	7.32	8.09	6-9	-
BOD	155	886	10	mg/L
COD	259	1,450	50	mg/L
TSS	54	80	5	mg/L
N Total	280	355	40	mg/L
Hg	0.00046	0.00030	0.0037	mg/L
Cd	0.0007	0.0005	0.0005	mg/L

[CO_2 emission reduction effect]

The above technology does not lead to the reduction of CO_2 emissions, but we plan to consider the installation of the facility as a zero-emission one by harnessing solar power for the facility. In addition, we plan to discuss equipment for reducing CO_2 emissions while considering the utilization of the JCM equipment subsidy program.

The low-carbon effect of the wastewater treatment facility is to reduce greenhouse gases, which have been emitted through the spontaneous decomposition of the leachate of the final disposal site, which includes a lot of organic substances and is discharged to rivers, etc. On the other hand, there are no cases of research into the emissions of CH_4 and N_2O through the treatment of the leachate of the final disposal site in Japan, and Japan has not specified an original method for estimating emissions. Accordingly, we will estimate CH_4 and N_2O emissions with the default emission factor and calculation method in the IPCC guidelines in 2006. For methods for estimating the reduction, we can refer to "5.D.2.-Industrial wastewater (treatment of the leachate of a final disposal site)"[27] among methods for estimating greenhouse gas emissions and absorption volume summarized by the Ministry of the Environment. For this methodology, we referred to "Chapter 6 Wastewater treatment and discharge" of the IPCC guidelines in 2006."[23] The methane emissions through the decomposition of the leachate of the final disposal site in nature can be estimated with the following equation.

[27] Ministry of the Environment "5.D.2.-Industrial wastewater (treatment of the leachate of a final disposal site)" (https://www.env.go.jp/content/900445998.pdf)

$$E = EF \times A$$

E : 最終処分場浸出液の処理に伴う CH_4 or N_2O 排出量［kg-CH_4］or［kg-N_2O］

EF : 最終処分場浸出液の処理に伴う CH_4 or N_2O 排出係数
［kg-CH_4/kg-BOD］or［kg-N_2O/kg-N］

A : 最終処分場浸出液中の有機物量・窒素量［kg-BOD］or［kg-N］

Using the default value of methane conversion factor 0.8 for "Anaerobic reactor" in "Treated system" in Table 6.3 of the guideline, the CH_4 emission factor is calculated to be 0.48 [kg-CH_4/kg-BOD].

In addition, the amount of organic matter or nitrogen in the leachate of the final disposal site (A) is calculated by multiplying the ratio of organic matter and nitrogen in organic waste transferred to the leachate in the final disposal site (F) by the final disposal amount of general organic and industrial wastes in each fiscal year (W) and the ratio of the leachate of the final disposal site that undergoes biotreatment (T: set at 87.6% taken from the same reference), based on "Survey on the improvement in accuracy of GHG emission factors in the waste field in FY 2009 (MOE Division for Promoting a Recycling Society)." This equation is used for estimating the BOD and TN amounts to be emitted from organic waste after final disposal in the fiscal year under review all at once. It is noteworthy that the estimated amounts differ from the actually treated BOD and TN amounts in the leachate treatment facility.

$$A = F \times W \times T$$

F : 最終処分された有機性廃棄物中の有機分及び窒素分が浸出液中に移行する量の割合
［kg-BOD/t］or［kg-N/t］

W : 有機性廃棄物の直接最終処分及び処理後最終処分量［t（排出ベース）/年］

T : 最終処分場浸出液が生物処理される割合［-］

About 100 tons of waste is transported to the currently used landfill of the final disposal site. With reference to the waste composition data of Gorontalo Province, we can assume that 65% of waste becomes leachate. Accordingly, the amount of leachate in the final disposal site, including decommissioned landfills, can be estimated to be 23,725 tons per year. When this figure is used, the amount A is 3,907 kg-BOD for CH_4, and 5,278 kg-N for N_2O. When these values are put into the above equation for estimating emissions, the reduction of CH_4 emission is 1,875 kg-CH_4/year and the reduction of N_2O emissions is 41 kg-N_2O/year. When these values are converted into the reduction of CO_2 emissions (global warming potential of CH_4: 25, global warming potential of N_2O: 298)[28], it can be estimated that we could reduce emissions by 59,093 t-CO_2/year. This is a reference emission amount.

Regarding project emissions, it is necessary to obtain data on power consumption at existing

[28] Ministry of the Environment (March 2017) "Guidelines for methods for estimating total GHG emissions Ver. 1.0" (https://www.env.go.jp/policy/local_keikaku/data/guideline.pdf)

facilities, because they would be replaced, but we have not obtained detailed data. In addition, the power required for operating the facility of Aiken Kakoki is under study, so we referred to the results of the general evaluation test conducted by Japan Sewage Works Agency for an MBR system to be installed[29] for calculation. The power consumption of the MBR system is 0.46 kWh/m^3. Accordingly, if the volume of treated water is 52 m^3, power consumption is 23.92 kWh/day or 8,730 kWh/year. When multiplied by the Indonesian power grid emission factor 0.533 t-CO_2/MWh, it is 4.6 t-CO_2/year.

Namely, total emission reduction in this project is:

Power consumption of a new wastewater treatment facility (4 t-CO_2/year)－Methane suppression effect of diffusion in the atmosphere (59,093 t-CO_2/year) = －59,089 t-CO_2/year

If the statutory service life of 12 years ("water supply or sewerage equipment") is applied, the expected reduction in emissions during the depreciation period is 709,068 t-CO_2.

[29] https://www.mlit.go.jp/common/000146907.pdf

3.3. Preparation for commercialization and formulation of an installation plan

3.3.1. Wastewater treatment plants

(1) **Challenges toward commercialization**

In Gorontalo Province, the absence of fully developed water and sewage systems means that it takes time to establish a system for gathering wastewater from multiple households at a single location. Therefore, we will first consider a plan to install wastewater treatment plants in standalone facilities or limited areas.

Wastewater treatment plants are public infrastructure, so the installation of them is expected to be based on national and municipal budgets. Sustaining water quality improvements requires education and training on technology implementation, regulation, and facility management.

The results of the surveys in last fiscal year's project indicate that Indonesia introduced new domestic wastewater standards in August 2016 through the Ministry of Environment and Forestry (KLHK) (Decree No. 68 (P.68/Menlhk/Setjen/Kum.1/8/2016)). These standards are stricter than those in Japan, especially for ammonia, requiring advanced treatment including denitrification. On the other hand, the "residences" referred to in the standards primarily denote collective housing such as apartments. Currently, there are no specific standards in place for wastewater from individual standalone houses.

Table 3-13 Domestic wastewater standards in the Ministry of Environment and Forest Decree No. 68 (2016)

Parameters	Units	Maximum allowance*
pH	-	6-9
BOD	mg/L	30
COD	mg/L	100
TSS	mg/L	30
Oil & Grease	mg/L	5
Ammonia	mg/L	10
Total Coliforms	Total/100mL	3,000
Discharge	L/person/day	100

Considering the inability of current standards to encompass wastewater from individual houses, discussions are underway to approach the central government through the Province of Gorontalo regarding the need to revise regulations so that wastewater from individual houses is also covered, based on the verification results of demonstration experiments related to the installation of wastewater treatment plants.

In October 2022, Daiki Axis Indonesia hosted a visit by the Indonesian Ministry of Environment and Forestry, where they toured the company's plant and facilities and gained an understanding of the features of wastewater treatment plants and the company's high technological capabilities. Furthermore, in February 2023, Deputy Minister Aru of the Ministry of Environment and Forestry

and his delegation visited the Daiki-Axis plant in Ehime Prefecture, affirming the technology's compatibility with Indonesia and expressing strong expectations for its implementation in Gorontalo and broader adoption across Indonesia.

Figure 3-42 Inspection at the Daiki Axis Factory (February 27, 2023)

In March, further discussions between the Ministry of Environment and Forestry and Daiki Axis Indonesia led to positive considerations about legal framework enhancements, including the implementation of a certification system for wastewater treatment plants.

Future plans involve presenting recommendations to the central and provincial governments based on the results of demonstration tests comparing the prevalent septic tanks in Indonesia with the new technology.

(2) Implementation structure

As mentioned above, initial efforts focus on demonstrating the effectiveness of the wastewater treatment plants in Gorontalo through demonstration projects. Daiki Axis Indonesia is collaborating with the Ministry of Environment and Forestry, installing wastewater treatment plants at two universities to visually demonstrate their efficacy and promote wastewater treatment systems. The company is considering horizontal development of such activities in the Province of Gorontalo, and the student dormitory mentioned above has been mentioned as one of the candidates. In addition, the company plans to introduce wastewater treatment plants using solar power generation, a model that it has experience with in non-electrified areas. In addition, the student dormitory was built with the support of the Deputy Speaker of the National Assembly, Rahmat Gobel, who has a connection to Gorontalo Province, making it a very symbolic site in terms of environmental education for students and public awareness for local residents.

The project's structure involves the following: As for the demonstration budget, the "Asian Water Environmental Improvement Model Project" by the Ministry of the Environment is being considered as a candidate. The plan is to secure a budget for the feasibility study (F/S), the demonstration project, and the formulation of a commercialization plan.

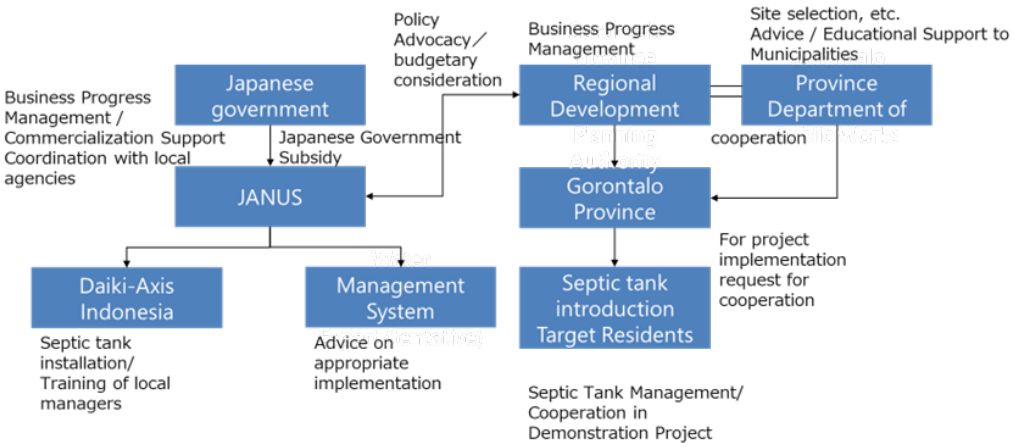


Figure 3-43 Implementation Structure

(3) **Formulation of an introduction plan**

Figure 3-44 Presentation by Daiki Axis Indonesia at BPPW

While adopting the technology, it's essential to also focus on establishing regulations and providing education and training on facility management. Initiatives have begun with discussions with the Gorontalo Provincial Government to promote awareness about wastewater treatment plants. On January 26, 2024, an exchange of opinions was conducted with staff from Gorontalo Province Public Works Bureau's Regional Infrastructure Housing Office (Balai Prasarana Permukiman Wilayah Gorontalo: BPPW), during which Daiki Axis Indonesia shared insights into the differences between the existing Indonesian septic tanks and the new wastewater treatment plants, and the importance of facility management.

Gorontalo Province has plans to install wastewater treatment plants or septic tanks in 3,500 detached houses within the year 2024. This initiative is part of the wastewater treatment plant introduction program by the Ministry of Public Works of the central government of Indonesia. In Gorontalo Province, a budget of 1.5 million yen per case is expected to be allocated. Currently, the plan is to introduce Indonesian-manufactured wastewater treatment plants, but there's potential for considering Daiki Axis wastewater treatment plants if cost reductions can be achieved, for example, using a community plant where multiple households are treated together in a single wastewater treatment plant. Additionally, there was a recommendation to introduce the wastewater treatment plants of Daiki Axis to the person in charge of managing the wastewater treatment plant introduction program of the Ministry of Public Works of the central government of Indonesia.

Moving forward, while conducting the demonstration experiments mentioned in (2), the plan is to use the results of the effectiveness verification to approach both the central government and the Gorontalo Provincial Government. Initially, we will discuss the reflection of Japan's wastewater treatment plant laws and policies in the local ordinances of Gorontalo Province.

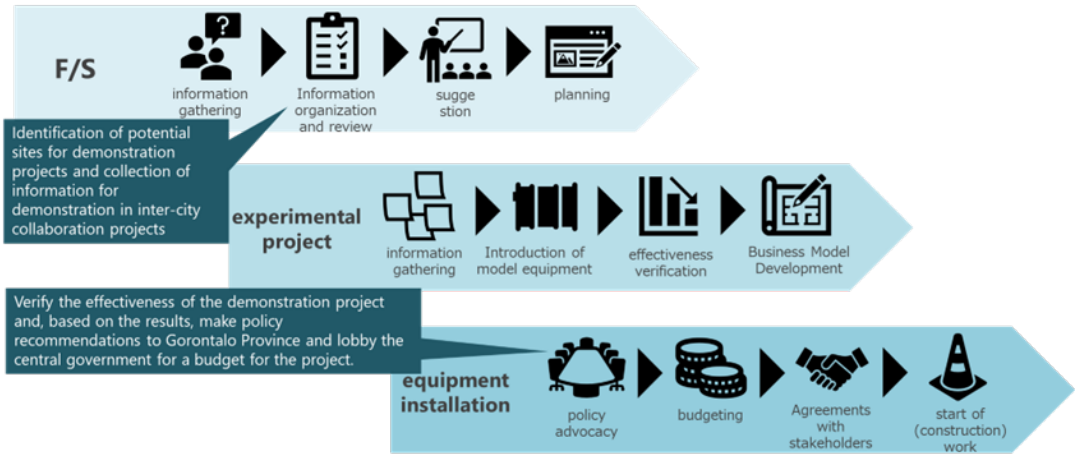


Figure 3-45 Implementation Plan (Sewage treatment plant)

3.3.2. Methane fermentation facility

(1) Facility design

Based on the findings of Section 3.2.2(2) and after discussions with PT. Royal COCONUT, the facility design conditions were established as follows, and the facility was designed.

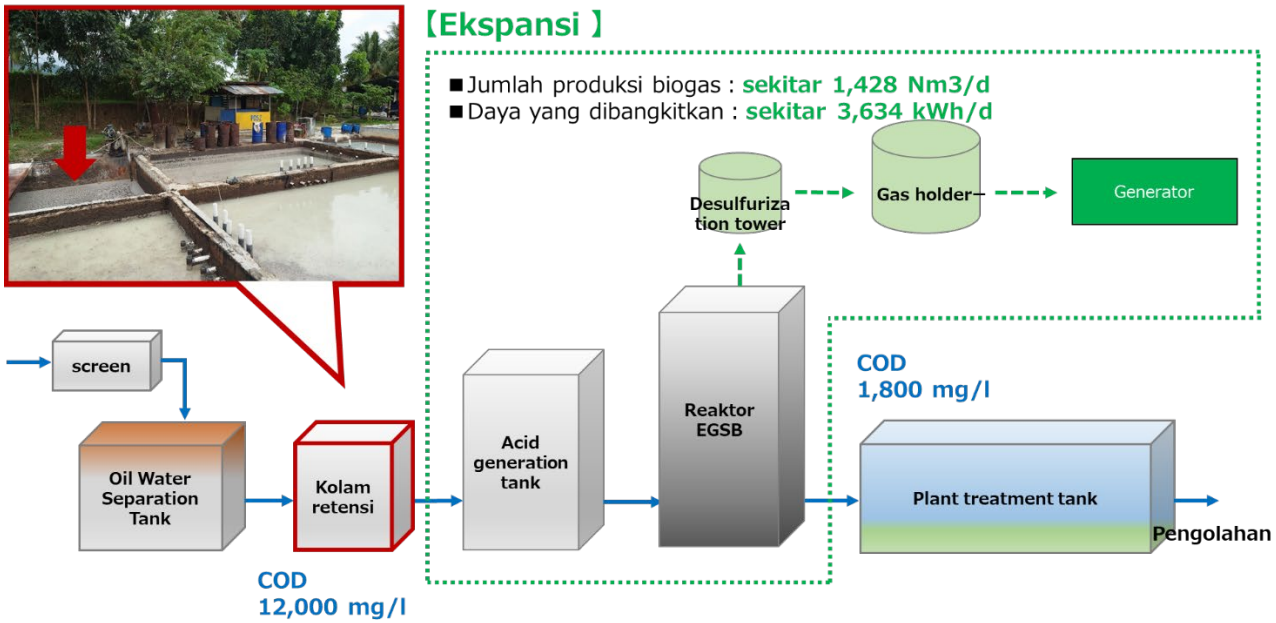


Figure 3-46 Proposed System (designed by Aiken Chemical Engineering)

This information is not open to the public.

Figure 3-47 Design Conditions for the Facility to be Installed at PT. Royal COCONUT (designed by Aiken Chemical Engineering)

For the installation site of the equipment, considering the intentions of the company's president, the plan is to expand the existing facilities at the following locations. Currently, after processing in the existing equipment, the output is connected to a plant tank. The plan is to install additional

equipment proposed by Aiken Chemical Machinery before this connection. The system is designed to reduce the COD (Chemical Oxygen Demand) concentration to 1,800 mg/L using the equipment from Aiken Chemical Machinery, and then to discharge it through biodegradation in the plant tank.

Figure 3-48 Facility Installation Site (Planned)

(2) **Feasibility study**

Based on the data regarding electric power consumption at PT. Royal COCONUT, the installation of Aiken Chemical Machinery's equipment would not generate surplus electric power, hence there would be no sale of electricity to PLN (the state electricity company in Indonesia). Instead, the company would adopt a model where part of the operational power is consumed in-house.

This model is considered as an investment recoupment model due to the reduction in the monthly electricity bills paid to PLN, which currently amount to about 3 million yen. Based on the current power consumption of the company and the power generation from the introduction of Aiken Chemical Machinery's equipment, an annual electricity cost reduction of 925,932,000 Rp is anticipated. The calculated payback period is not open to the public.

This information is not open to the public.

Figure 3-49 Investment Recovery Model Based on Current Estimates

(3) **Proposed implementation structure**

Regarding the implementation system, even if half of the equipment costs can be subsidized through the JCM Equipment Subsidy Program, a crucial point is determining who will bear the initial investment.

An implementation structure proposal, in case PT. Royal COCONUT bears the initial investment, is presented below. However, in this scenario, PT. Royal COCONUT would need to undertake various procedures and responsibilities related to the power generation business, which could lead to potential challenges during implementation. Therefore, another implementation structure proposal was also considered, where the initial investment is borne by the Gorontalo Province Regional Development Corporation (Badan Usaha Milik Daerah, hereafter referred to as BUMD). BUMD is a state-owned enterprise responsible for regional infrastructure and power projects, and there is an intention from the Gorontalo Provincial Government to revitalize BUMD's activities going forward. In this scenario, BUMD would bear the initial investment, and as the power generator, it would undertake the recovery of its investment. PT. Royal COCONUT would purchase electricity from BUMD, meaning they would still incur electricity costs. However, this model allows them to benefit from wastewater treatment services at no cost.

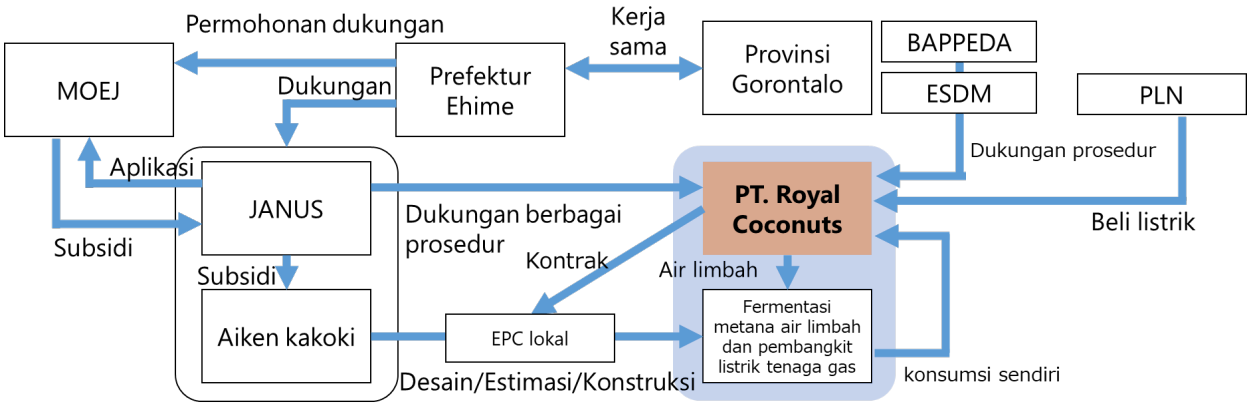


Figure 3-50 Roles of Stakeholders and Budget Flow (PT. Royal COCONUT's Initial Investment)

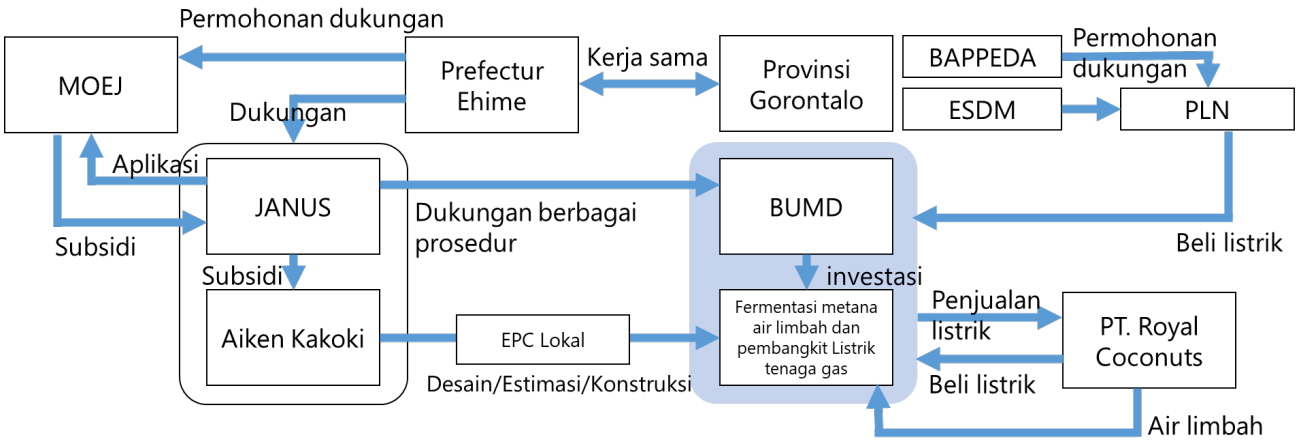


Figure 3-51 Roles of Stakeholders and Budget Flow (BUMD's Initial Investment)

Regarding the design system in (1) and (2), introduction effects, and implementation structure, a proposal was made to PT. Royal Coconuts during the visit in January 2024. While the company is compelled to address complaints from local residents about the wastewater and has future plans for factory expansion, they indicated that decision-making would require time. Therefore, while continuing to consider the installation of equipment at PT. Royal Coconuts, it is also planned to proceed with the consideration of equipment installation at other potential sites such as coconut processing factories and sugar factories suggested by the Gorontalo Provincial Government.

(4) **Formulation of an introduction plan**

As mentioned above, through this project, we have been exploring detailed designs for wastewater treatment equipment by Aiken Chemical Machinery, feasible systems, and possible implementation structures, targeting wastewater from coconut processing factories, which are a major product of Gorontalo Province. As candidates for coconut processing factories of the same scale other than PT. Royal Coconuts, PT. Trijaya Tangh etc., are mentioned in 3.2.2 (1) ②. While continuing the approach to PT. Royal Coconuts, the plan is to also simultaneously proceed with lateral deployment utilizing the knowledge gained so far. Additionally, since there are multiple sugar factories, the plan is to also target wastewater containing a large amount of organic matter suitable for Aiken Chemical Machinery's energy recovery technology and continue to consider its feasibility for introduction.

Currently, in Gorontalo Province, short-term (2025-2030) and long-term (2025-2040) development plans related to the primary industry are being formulated. Discussions will continue with the Gorontalo Province Government regarding the inclusion of Aiken Chemical Machinery's equipment installation from the perspectives of effective utilization of biomass and CO_2 reduction.

3.3.3. Other considerations (final disposal sites)

(1) **Facility design**

Based on the collection of information about leachate measurement certificates and water quality standards, as well as discussions with the Gorontalo Province Public Works Bureau regarding the design conditions for wastewater treatment facilities, the equipment design was carried out by Aiken Chemical Machinery. The Membrane Bioreactor (MBR) system proposed by the company is detailed below.

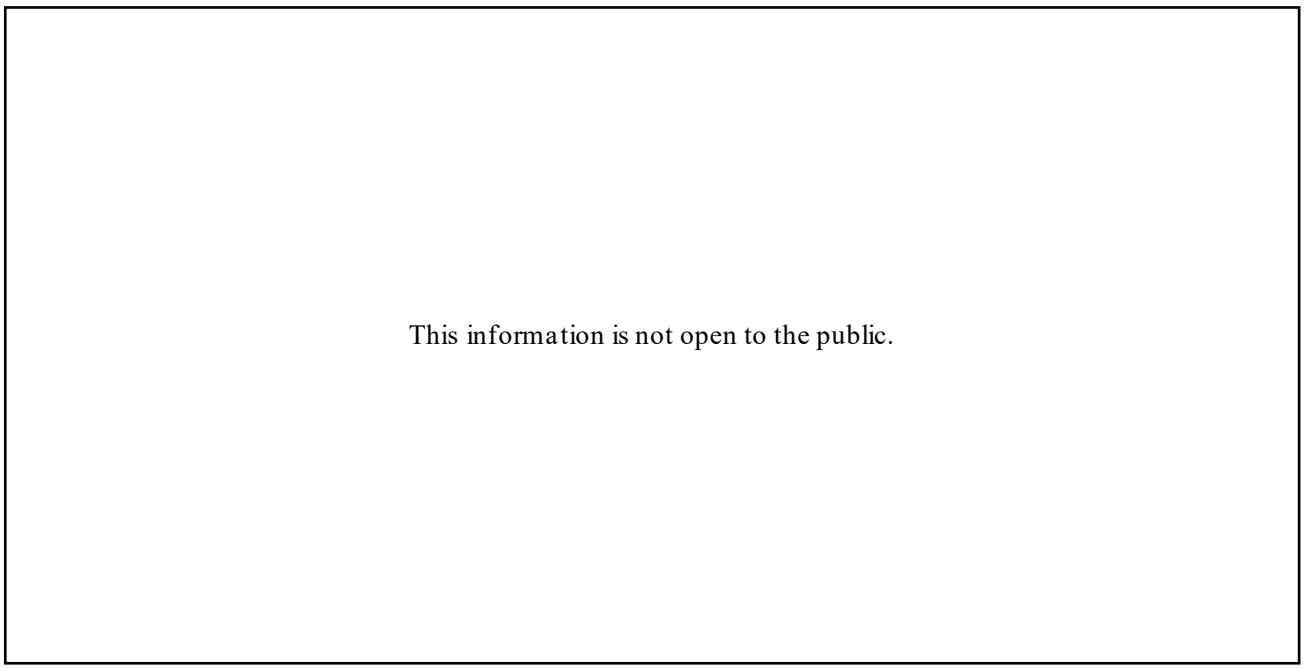


Figure 3-52 Aiken Chemical Machinery's proposed Membrane Bioreactor (MBR) system

(2) **Feasibility study**

The Gorontalo Province Public Works Bureau is considering a budget of 5 billion Rp annually for the introduction of wastewater treatment facilities.

Following discussions in January 2024, it was clarified that a budget of this scale could be requested annually. Hence, a phased equipment introduction plan has been agreed upon with the Gorontalo Province Government.

Furthermore, the Gorontalo Province Government indicated that June is the time for budget application and reallocation for the next year. A schedule considering the aforementioned plan and budget application timing is outlined below.

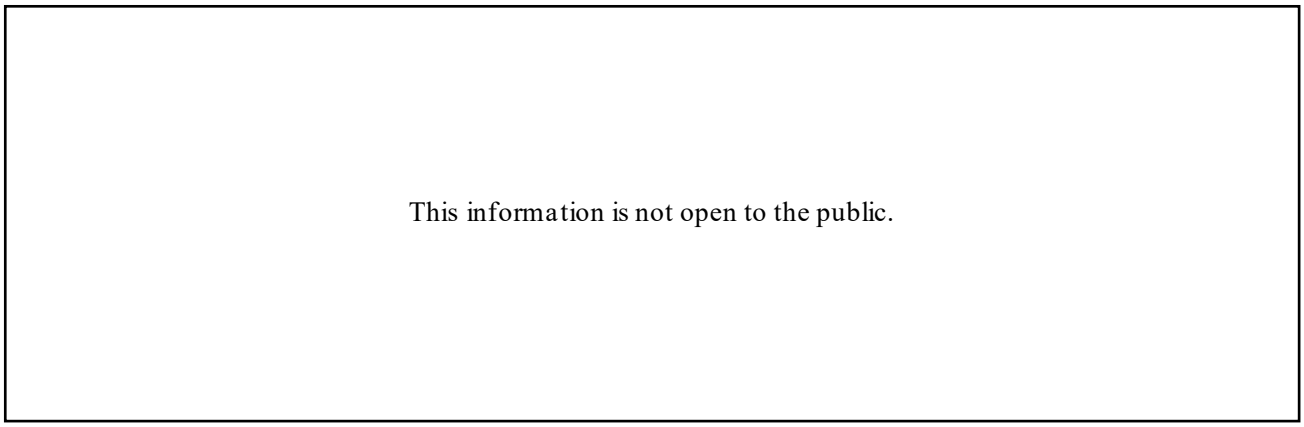


Figure 3-53 Proposed Schedule for Installation of Final Disposal Site's Leachate Treatment System

(3) **Implementation structure**

As a business implementation structure, the following is assumed.

According to the Gorontalo Province Public Works Bureau, the Memorandum of Understanding (MoU) signing for the urban collaboration project between Ehime Prefecture and Gorontalo

Province, and the associated Action Plan include a section on the consideration of introducing technology for the treatment of leachate from final disposal sites. Moreover, due to the adverse environmental impact caused by the leachate, it is an urgent issue for Gorontalo Province. Based on this, comments have been received that it would be possible to propose adding the cost of equipment introduction for this project within the budget plan for 2024.

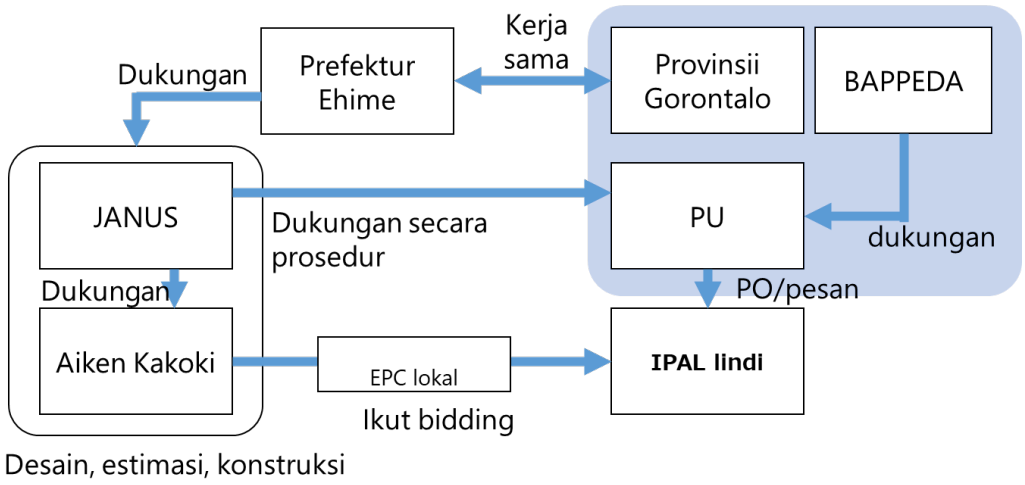


Figure 3-54 Proposed Implementation Structure

Furthermore, the head of the Gorontalo Province Public Works Bureau has mentioned a direct request to the Governor of Gorontalo Province for budget allocation. The construction will go through public bidding, with Aiken Chemical Machinery's local partner, an EPC contractor with a track record in Gorontalo Province, expected to participate. The Gorontalo Province Government is also considering prioritizing the selection of this contractor for equipment procurement through nominated competitive bidding.

July 2022 August 2023 November 2023

Figure 3-55 Exchange of Opinions with Gorontalo Province Public Works Bureau

4. Field of sustainable forest utilization by cocoa cultivation

In Gorontalo Province, rapid deforestation is progressing due to reclamation by excessive slash-and-burn farming in areas other than those suitable for cultivation, in parallel with the growth of agricultural GDP. The results of analysis of the LANDSAT images taken in 1991, 2000, and 2010 indicate deforestation at an annual rate of 0.68% (from 2000). As indicated by the brown areas in the following photographs, it can be confirmed that deforestation expanded from 2010 to 2018. According to the Gorontalo Province Regional Action Plan (RAD), the current deforestation rate is about 13,216 ha per year. This accounts for 1.6% of the total forest area (826,000 ha), and the rate of decrease is increasing. There is concern over the possibility that deforestation will not only decrease CO_2 absorption, but also reduce the water holding capacity of forests, which will cause landslides and frequent floods in urban areas.

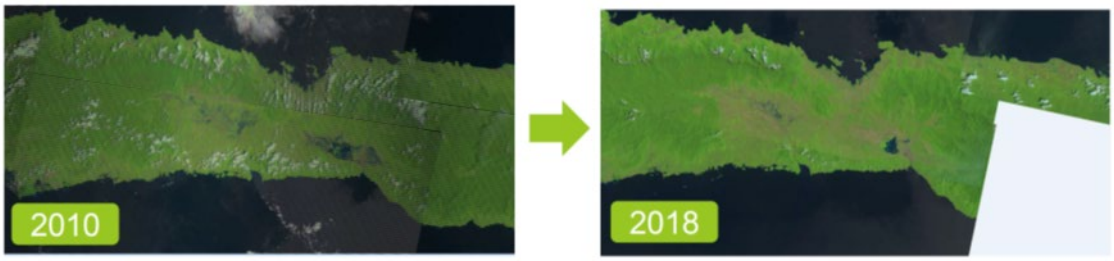


Figure 4-1 Satellite images showing the shrinkage of forest

Kanematsu Corporation, a co-operator of this program, has been promoting cacao cultivation in the western region of Boalemo Regency since 2011. This cacao cultivation is an alternative to corn cultivation, which is a type of slash-and-burn agriculture. Through these activities to suppress the expansion of agricultural land through slash-and-burn agriculture and to conserve forests, Kanematsu Corporation has been involved in the REDD+ project aimed at establishing sustainable agriculture by forming bilateral credits and earning revenue from the sales.

This project aims to expand the REDD+ business implemented by Kanematsu Corporation throughout all of Gorontalo Province. In FY 2021, we conducted a survey on policies and plans in Gorontalo Province, Indonesia, which is the basis of forest conservation, and selected candidate areas for REDD+ projects. In the project in FY 2022, we continued activities for grasping the actual situation of the decrease and deterioration of forests and land usage in candidate areas in Gorontalo, Boalemo, and Pohuwato Regencies, and supported neighboring communities in sustainable cacao agriculture without deforestation in cooperation with the local Gobel Group. In addition, we discussed business plans with BAPPEDA in Gorontalo Province and the governments of the regencies in target areas, to enlist their cooperation and win their understanding of our project. In this fiscal year, we will continue discussions on business plans and expected effects with relevant sections of local governments, and pursue methods for the government of Gorontalo Province to join the project of “sustainable use of forests” proactively.

The following sections show the items discussed this fiscal year and the results.

4.1. Trends in Indonesia related to emissions trading

The Indonesian Government revised its NDC in September 2022 and aims to reduce greenhouse gas emissions by 31.89% without international support and 43.20% with international support by 2030.

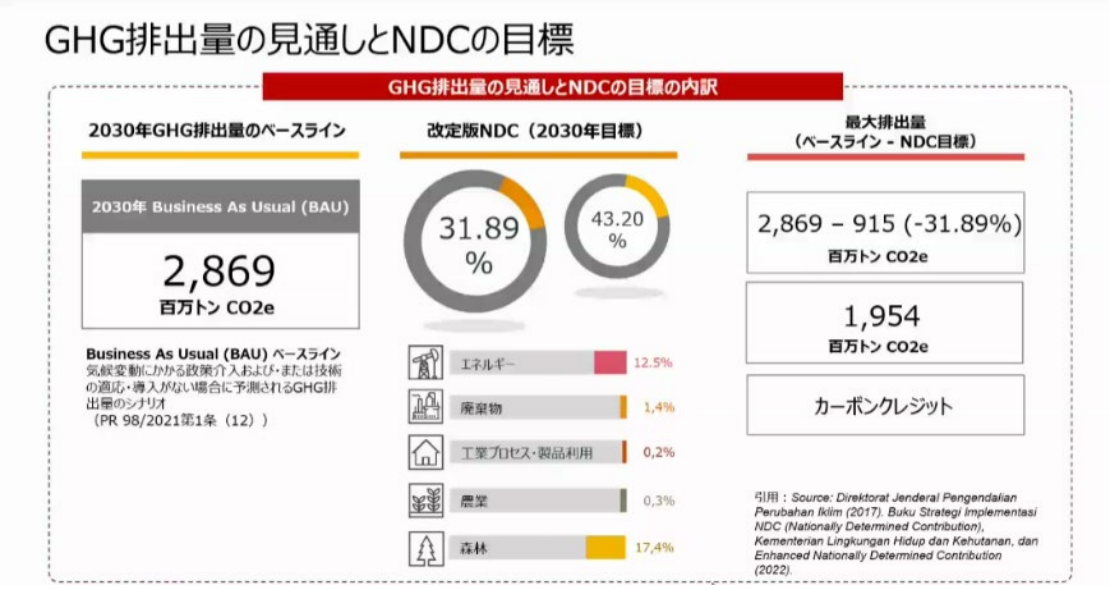


Figure 4-2 NDC Targets of Indonesia [30]

The Ministry of Environment and Forestry Ordinance No. 21 of 2022, which is based on the NDC, is a pivotal law for understanding carbon pricing in Indonesia. The framework of the ministries responsible for carbon pricing is as follows.

[30] Excerpt from the reference material for an online seminar on the Japanese-Indonesian emissions trading market organized by the JETRO Jakarta office of the Japan External Trade Organization (JETRO) on January 15, 2024.

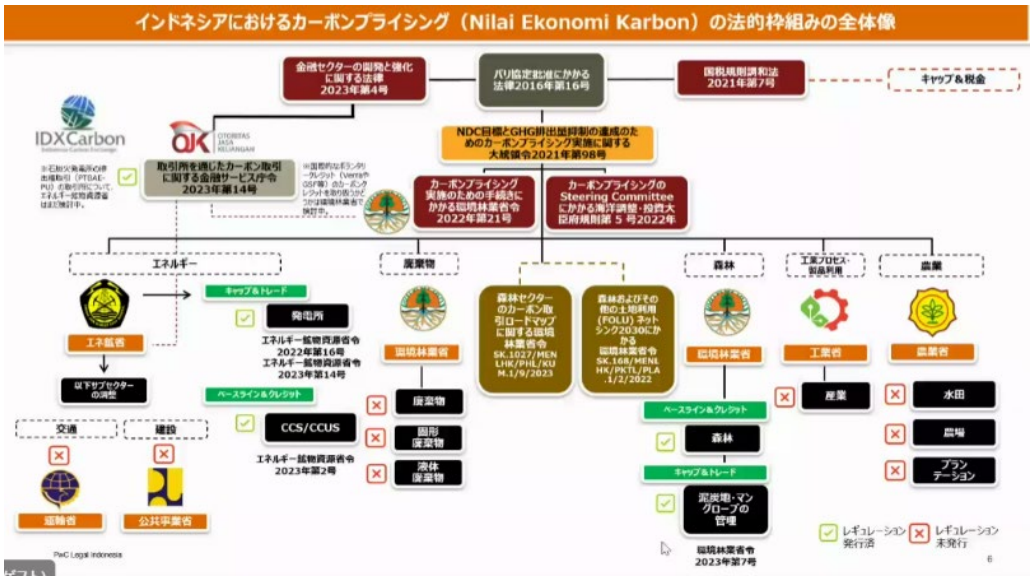


Figure 4-3 Ministries responsible to the Central Government of Indonesia for carbon pricing[30]

In February 2023, the Ministry of Energy and Mineral Resources announced the launch of a trading scheme for greenhouse gas emissions, initially for power plants fueled by coal. In particular, it was mandatory for 99 power plants fueled by coal with a generating capacity of 100 MW or more connected to the PLN grid to participate in emissions trading.

Furthermore, on September 26, 2023, a carbon emissions trading market (IDXCarbon) was established on the Indonesia Stock Exchange. In addition to the market for power generation fueled by coal (compliance market), there is a market where companies voluntarily engage in emissions trading (voluntary market). Although there were many trading activities on the first day of IDX Carbon, the number of trading companies has since declined. User registration on IDX Carbon is currently limited to legal entities located in Indonesia. At present, 46 companies are registered, including many Japanese companies.

Figure 4-4 President Joko announcing the launch of an emissions trading market (September 26, 2023)

In addition, the Ministry of Environment and Forestry Ordinance No. 21 of 2022 relating to emissions trading was issued in October 2023, but no operational details have been published. While there is a view that the Indonesian government is cautious about international trade in order to achieve its own NDC, a contradiction occurs that the market will not be active if trade does not take place. With the assumption that regulations on international trading will come into force by the end of 2024, operators will need to wait for the publication of guidelines on approval systems and procedures, including how to set baselines for estimating CO_2 reductions, whether carbon credits can be transferred to overseas markets, and the allocation of credits between local governments and operators.

Currently, projects related to carbon credits can only be formulated in the sectors shown in the diagram below. In the forest sector, which is expected to be the sector with the largest reductions in Indonesia, only four methodologies have been defined.

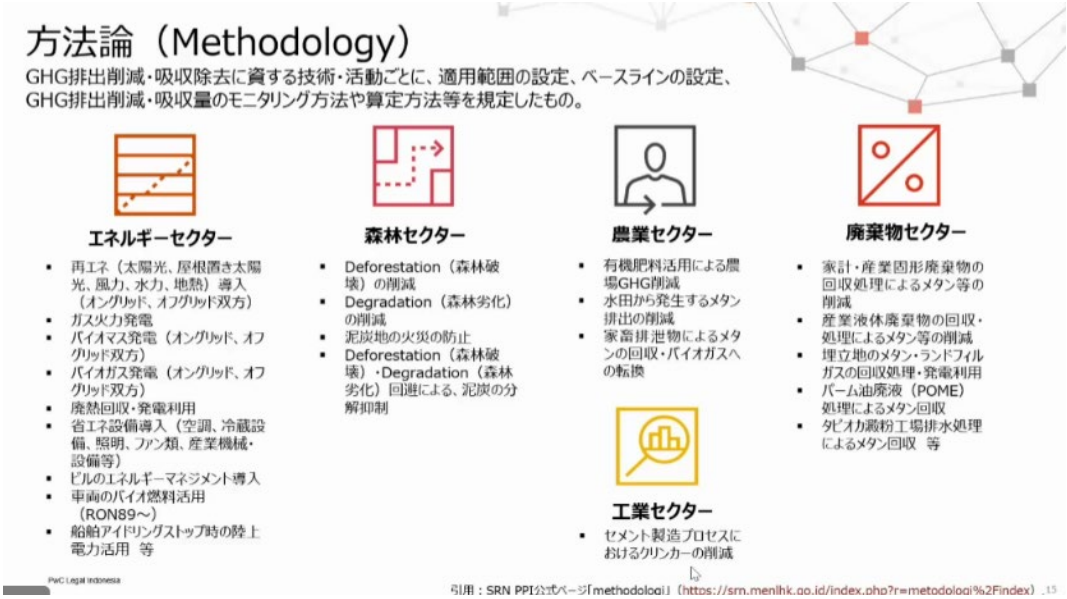


Figure 4-5 Areas for which carbon credit composition-related methodologies have been developed [30]

Regarding the future policy of the Indonesian Government on emissions trading in REDD+ projects, the above-mentioned Ministry of Environment and Forestry Ordinance No. 21 of 2022 and Ministry of Environment and Forestry Ordinance No. 7 of 2023 need to be closely monitored.

4.2. Extraction of potential sites and estimation of project effects

4.2.1. Extraction of potential sites

In last fiscal year's project, we grasped the deforestation and degradation situation in Gorontalo Province and then selected candidate areas for the REDD+ project. These areas are watershed areas, which included areas where the forest coverage rate was 70% or higher as of 2018 and areas where deforestation has not progressed. Potential sites are shown in the right figure.

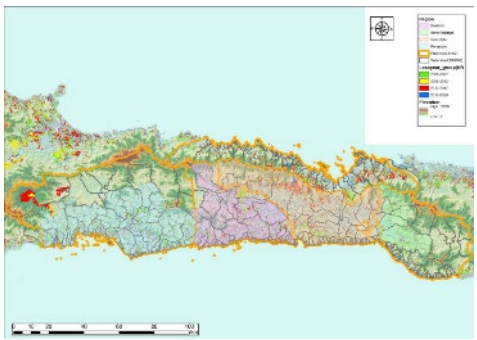


Figure 4-6 Target areas of the REDD+ project, including watershed areas in Gorontalo Province

We formulated a business plan for promoting the REDD+ project this fiscal year. In the business plan, we first extracted the deforested area for each year and each period from the past forest data and summarized the forest coverage changes from 2008 to 2017. Like in last fiscal year's project, we visited the sites to confirm the forest utilization conditions and excluded hotspots such as areas with oil palm plantation development in northern Pohuwato and timber concessions in northern Gorontalo from the potential sites.

The location and area of deforestation that occurred during the baseline period (2008-2017) are as follows.

Figure 4.1-2: Deforestation Area/Map of period 2008-2012 in Gorontalo Province

Table 4.1-2: Area of historical deforestation

Year	Area of deforestation (ha)
2008	1,011
2009	5,602
2010	845
2011	1,700
2012	1,382
2013	1,392
2014	2,805
2015	5,819
2016	4,012
2017	3,731
Average deforestation/year (2013-2017)	3,552

Figure 4-7 Deforestation map (2008-2012) (left) and deforestation area (ha) (2008-2017) (right)

4.2.2. Estimation of the project's effect

This project aims to expand the outcomes of the REDD+ project Kanematsu Corporation has implemented in Boalemo Province. In the project in FY 2021, we found that significant deforestation had occurred in the Pohwato, Boalemo, and Gorontalo regencies, located in the western part of Gorontalo province. Thus, we have selected them as our target areas. The estimated amount of GHG emission reduction for these sites and the estimated project cost are shown below.

[Estimated amount of GHG emission reduction (absorption)]

Using the above-mentioned GHG emission reduction amount for the fiscal year 2017 as a baseline, we estimated the emission reduction amount in this project.

The avoidable GHG emission amount was estimated with the following equation. The project concept is to set the purchase price of cacao beans in the project so that the cacao agriculture will become more profitable than the corn agriculture, with the aim of keeping the area of fields burnt by corn farmers from increasing further.

$$ER = RE - (PE + DE)$$

$$ER_{credit} = ER * (1 - df)$$

ER	Emissions reductions [tCO_2/yr]
DE	Displacement of emissions [tCO_2/yr]
ER_{credit}	Emissions reductions to be credited [tCO_2/yr]
df	Discount factor

The forest area in Gorontalo Province was 767,022 ha in 2000. However, a survey revealed that the area decreased by 58,995 ha between 2000 and 2011.

For emissions in the case where the project was not implemented (reference emission level: RE), please refer to the Gorontalo Province Greenhouse Gas Emission Reduction Plan (RAD-GRK) prepared by the Indonesian Ministry of Environment and Forestry and the Gorontalo Provincial Government. Specifically, we use the business as usual value of GHG emissions in the state's forestry sector. Since the annual GHG emissions of the forest sector in Gorontalo Province is 1,078,347t-CO_2, the reference emission level (RE) of Boalemo Province is 123,600t-CO_2. Based on the calculation of the amount of GHG emissions avoided due to changes in the forest area within the

scope of the project from the land cover classification map data, the amount of emissions reduced (ER) is 120,214 t-CO_2 as the deforestation of the area almost stopped from FY 2016 to FY 2017.

Assuming that the above results in Boalemo Province will be achieved in the three prefectures in Gorontalo Province on the same scale, the amount of emissions that could be reduced by applying the project is estimated to be 360,642t-CO_2/year.

[Cost]

In terms of the implementation of the REDD+ project mentioned above, the project has an annual operating cost of 80 million yen, of which 40 million yen is covered by the budget of Boalemo Regency and 40 million yen by subsidies from the Ministry of the Environment. A two-year demonstration project was implemented.

This project assumes that the duration of the REDD+ project is four years, including the period of the city-to-city collaboration project, and expects to conduct a survey of the same scale as the above-mentioned demonstration project in each of the three regencies of Gorontalo province. In this case, about 200 million yen is estimated to be necessary for the project cost per year. We plan to proceed with commercialization upon winning the understanding about Gorontalo Province and the cities/prefectures' budgetary measures from the perspective of the CO_2 emissions reduction initiatives and sustainable farming,

[Expectations for improvement of farmers' livelihoods through the implementation of the project]

The area of corn fields in Gorontalo Province is about 63,450 ha, and its annual production is 320 tons. Since there are 45,896 farming households, farmland area per household is 1.38 ha, and yield is 4.9 t/ha. Assuming that the selling price is 4,200 Rp/kg, the sales from one harvest will be 28,400,400 Rp.

Figure 4-8 Regions where corn and cacao farming coexist

On the other hand, the farmland area for cocoa farming is about 1,674 ha, and its yield is 0.19 t/ha. Under the assumption that farmland area per household is 1.38 ha and its selling price is 33,000 Rp/kg, annual sales are estimated to be 8,652,600 Rp. With a target of 0.40 t/ha, which is close to Indonesia's average cocoa yield of 0.47 t/ha, annual sales will be 18,216,000 Rp.

The estimation with currently available data shows that corn forming would yield larger annual sales, but we plan to keep assessing how much the revenues of cacao farmers in Gorontalo Province could be increased while conducting comparison with the price trend in the global cacao market and cacao beans grown in Africa, where there is the problem of child labor, and improving added value in the project.

4.3. Organizing information and negotiating for building a project implementation system

Since FY 2022, we have been holding discussions on the project plan with BAPPEDA in Gorontalo Province and the governments of respective regencies, where the project target areas are located, to gain their understanding of the project.

Figure 4-9 Exchanging opinions with Gorontalo Province Development Planning Department and DKM (July 2022)

In addition, in collaboration with DKM, which is a local counterpart private company, we engage in educational activities for cacao farmers and supporting the purchase of cacao beans through a new value chain aimed at improving the livelihoods of poor farmers, and discussions regarding expanding the project further. This fiscal year, we proceeded with the finalizing of our project plan and the establishment of a system for promoting forest conservation in the long term, while discussing measures for forest patrol to prevent unnecessary deforestation after the project. The details will be described in the following section.

Figure 4-10 Visits to a cacao farmer (left) and a cacao plantation (right) (January 2023)

4.4. Review of systems for monitoring changes in forests and forest patrolling methods

In this fiscal year's project, methods (systems) for monitoring changes in forests and forest patrols were studied as a means of contributing to forest conservation activities, while taking into account the current forest management know-how possessed by the government of the Province of Gorontalo.

Forest monitoring is carried out regularly by the Ministry of Environment and Forestry of the Indonesian central government using satellite images. Each provincial government also shares information with the central government to keep track of the changes in forests. As for forest patrols, the central government has taken the lead in organizing them, but according to interviews with various agencies, they do not seem to be effective in forest conservation.

Furthermore, based on interviews with communities living in mountainous areas affected by deforestation, current information on changes in forests has not been shared. The lack of incentives for forest conservation activities is considered to be the reason for the continuous illegal deforestation in the area, hence it is essential to first promote community understanding on the

importance of forest conservation and share the incentives that can be gained by curbing deforestation.

Kanematsu Corporation assumes carbon credits from JCM and other REDD projects as the source of the incentive and is currently reviewing the business plan to obtain certification for the project. However, if it is difficult to convert the credits through JCM, it will consider using the global VCS Standard, which is highly versatile, or the SRN Standard, which is unique to Indonesia.

The company is currently reviewing the above-mentioned VCS Standard and SRN Standard to obtain official documents. Based on an overview of both standards, it intends to make a proposal to the Province of Gorontalo how to proceed with the "sustainable use of forests." In addition to summarizing the forest monitoring methodologies likely to be mentioned in the official documents, the company intends to understand the difficulties in making JCM methodologies approved in Indonesia and review the next steps in the development process.

5. City-to-city collaborative activities

5.1. Overview of city-to-city collaborative activities

This fiscal year, four field surveys were conducted from August 12th to 18th, November 6th to 9th, November 21st to 25th, 2023, and January 25th to 27th, 2024. In addition, Ehime Prefecture officials accompanied the entire trip, and during the trip from November 6th to 9th, the Deputy Governor Tanaka of Ehime Prefecture visited Gorontalo Province. It was a great achievement that Mr. Tanaka had a meeting with the Vice Minister of Gorontalo Province and promoted technology from companies in the prefecture.

Additionally, this fiscal year, cooperation began targeting the primary industry, the main industry in Gorontalo Province, from which we received requests for support at the beginning of the project. This project is based on Ehime Prefecture's policy with a view to establishing a sister-city relationship with Gorontalo Province, following the MoU on Environmental Cooperation concluded in January last year, and a survey was started using Ehime Prefecture's supplementary budget.

Like last fiscal year, we have used web tools such as remote meetings and emails, and face-to-face meetings in Gorontalo to make the survey contents and activities understood by local stakeholders while endeavoring to gather information and conduct discussions in cooperation with local counterparts such as BAPPEDA of the Gorontalo provincial government and Gorontalo University. The main activities are summarized below.

Table 5-1 Overview of city-to-city collaborative activities

Date	Activity	Participants
July 14, 2023	Kickoff meeting	Ministry of the Environment, Japan NUS Co., Ltd., Ehime Prefecture, Aiken Kakoki K. K., Daiki Axis Indonesia, Kanematsu Corporation
July 18, 2023	Discussions on the division of responsibility for this fiscal year's survey	Aiken Kakoki K. K., Japan NUS Co., Ltd.
July 20, 2023	Discussions among Aiken Kakoki K. K., BAPPEDA of Gorontalo Province, and PU regarding the installation of leachate treatment equipment at the final disposal site	Aiken Kakoki K. K., Japan NUS Co., Ltd., BAPPEDA of Gorontalo Province, PU
July 21, 2023	Discussions on forest monitoring methods	Kanematsu Corporation, Japan NUS Co., Ltd.
July 26, 2023	Discussion regarding the travel to the site in August	Ehime Prefecture, BAPPEDA of Gorontalo Province, Japan NUS Co., Ltd.
August 12-18, 2023	Field survey	Ehime Prefecture, Japan NUS Co., Ltd.
August 18, 2023	Business trip report and future activity discussion	Aiken Kakoki K. K., Japan NUS Co., Ltd.
September 5, 2023	Business trip report and future activity discussion	Ehime Prefecture, Japan NUS Co., Ltd.
September 14, 2023	Discussing the division of responsibility for this fiscal year's	Kanematsu Corporation, Japan NUS Co., Ltd.

	survey	
September 26, 2023	Discussion regarding the travel to the site in November	Ehime Prefecture, BAPPEDA of Gorontalo Province, Japan NUS Co., Ltd.
September 26, 2023	Business trip report and future activity discussion	Aiken Kakoki K. K., Japan NUS Co., Ltd.
October 2, 2023	Discussing the division of responsibility for this fiscal year's survey	Daiki Axis Indonesia, Ehime Prefecture, Japan NUS Co., Ltd.
October 6, 2023	Discussions on the introduction of methane fermentation equipment with Aiken Kakoki K. K.	Aiken Kakoki K. K., Japan NUS Co., Ltd.
October 19, 2023	Ministry of the Environment Interim report meeting	Ministry of the Environment, Japan NUS Co., Ltd., Ehime Prefecture, Aiken Kakoki K. K., Daiki Axis Indonesia, Kanematsu Corporation
October 31, 2023	Discussion regarding the travel to the site in November	Ehime Prefecture, BAPPEDA of Gorontalo Province, Japan NUS Co., Ltd.
November 6-9, 2023	Field survey	Ehime Prefecture, Aiken Kakoki K. K., Japan NUS Co., Ltd.
November 21-25, 2023	Field survey	Ehime Prefecture, Japan NUS Co., Ltd.
December 6, 2023	Discussion on the installation of equipment in Ainun Hospital	BAPPEDA of Gorontalo Province, Ainun Hospital, Ehime Prefecture, Japan NUS Co., Ltd.
January 9, 2024	Discussion regarding the travel to the site in January	Ehime Prefecture, BAPPEDA of Gorontalo Province, Japan NUS Co., Ltd.
January 11, 2024	Discussion regarding the travel to the site in January	Aiken Kakoki K. K., Japan NUS Co., Ltd.
January 13, 2024	Progress report to Ehime University regarding the city-to-city collaborative project	Ehime University, Japan NUS Co., Ltd.
January 14, 2024	Discussion regarding the travel to the site in January	Daiki Axis Indonesia, Ehime Prefecture、Japan NUS Co., Ltd.
January 25-27, 2024	Field survey	Ehime Prefecture, Daiki Axis Indonesia, Aiken Kakoki K. K., Japan NUS Co., Ltd.
February, 2024	Ministry of the Environment Final Report	Ministry of the Environment, Ehime Prefecture, Japan NUS Co., Ltd.

5.2. Field survey

As mentioned above, we conducted four field surveys this year. The locations visited in each survey are as follows.

Table 5-2 Travel itinerary from August 12 to 18

Day	Time	Plan
13th (Sun)	7:25	Departure from Matsuyama Airport ＜NH582＞
	8:55	Arrival at Haneda Airport
	10:20	Departure from Haneda Airport ＜NH855＞

	16:00	Arrival at Soekarno-Hatta International Airport
	lodging	-
14th (Mon)	7:05	Departure from Soekarno-Hatta International Airport ＜GA644＞
	11:10	Arrival at Jalaluddin Airport
	9:00 - 12:00	Meeting ESDM and PLN
	13:00 - 16:00	Meeting TPA Talumelito, Dinas PU
	lodging	ASTON Gorontalo Hotel&Villas
15th (Tue)	09:00 – 12:00	Bappeda Meeting (participant: Agriculture departement, Fisheries departement, environmental and forestry Departement)
	13:00 – 14:00	Courtesy visit to the Acting Governor
	14:00 – 17:00	Visit to royal coconut
		ASTON Gorontalo Hotel&Villas
16th (Wed)	09:00 – 12:00	Visit to fishing enterprises
	13:00 – 15:00	Visit to Agricultural enterprises
	lodging	ASTON Gorontalo Hotel&Villas
17th (Thu) **national holiday**	14:20	Departure from Jalaluddin Airport ＜GA643＞
	18:10	Arrival at Soekarno-Hatta International Airport
	lodging	-

Table 5-3 Travel itinerary from November 7 to 9

Date	Time	Plan
7th (Tue)	7:35	Departure from Soekarno-Hatta International Airport ＜GA642＞
	13:35	Arrival at Jalaluddin Airport
	15:30	Courtesy visit to Acting Gorontalo Governor Ismail Pakaya
		Welcome reception
	Lodging	ASTON Gorontalo Hotel & Villas
8th (Wed)	9:30	Final waste disposal site (regarding the installation of leachate treatment equipment from Aiken Kakoki K. K.)
	13:00	Visit to Royal coconut (regarding the installation of wastewater treatment/energy recovery equipment from Aiken Kakoki K. K.)
	15:00	Tuna export company (discussions with partners in the fisheries field)
	Lodging	ASTON Gorontalo Hotel & Villas
9th (Thu)	7:00	Departure from Hotel
	8:40	Departure from Jalaluddin Airport ＜ID6243＞
	10:35	Arrival at Soekarno-Hatta International Airport

Table 5-4 Travel itinerary from November 21 to 25

Date	Time	Destination
21st (Tue)	14:00-16:00	Organic farming group (large scale)
22nd (Wed)	8:00-12:00	Rice mill (large scale)
	13:00-16:00	Citrus farms
23rd (Thu)	9:00-11:00	Agricultural group/rice mill (medium scale)
	11:00-12:00	Peanut and pumpkin farms
	13:35	Banana chip processing plant
	PM	Istana Buah (fruit store)
		Cold storage warehouse GUDANG BEKU TERINTEGRASI (UNIT PENGOLAHAN IKAN) PROVINSI GORONTALO
24th (Fri)	7:00-9:00	Auction market ／Cold storage warehouse／ TPI Tenda/UD. CAHAYA MANDIRI (ice factory)
	9:30-10:30	Tuna fishing village Tanjung Kramat
	14:00	Tuna processing plant/export business CV. Baris Anugerah
25th (Sat)	AM	Central Public Market/Mall Supermarket Hypermart Gorontalo

Table 5-5 Travel itinerary from January 25 to 27

Day	Time	Plan/Aiken	Plan/Daiki Axis
25th (Thu)	7:35	Departure from Soekarno-Hatta International Airport ＜GA642＞	
	13:35	Arrival at Jalaluddin Airport	
	15:00	DLHK Provinsi Gorontalo MTG	Hotel Checkin
	17:30	BAPPEDA MTG	
	lodging	ASTON Gorontalo Hotel& Villas	
26th (Fri)	10:00	Meeting TPA Talumelito,Dinas PU	Meeting with Provinsi Gorontalo PUPR BPPW
	13:30	Visit to Royal coconut	Meeting with Kabupaten Bone Bolango PUPR
	16:00	DLHK Kabupaten Gorontalo MTG	Visit to Pondok Pesantren Hubulo
	lodging	ASTON Gorontalo Hotel & Villas	
27th (Sat)		Departure from Hotel	
	AM	Visit to Ainun Hospital	
	14:20	Departure from Jalaluddin Airport ＜ID6243＞	
	18:05	Arrival at Soekarno-Hatta International Airport	

As the contents of individual discussions and surveys are described in the related sections of this report, here we will introduce the discussion with the Gorontalo provincial government, which was held when the Deputy Governor Tanaka made a courtesy visit to the Acting Gorontalo governor in November.

The Deputy Governor Tanaka of Ehime Prefecture was scheduled to visit the Acting Governor Ismail Pakaya on November 7, 2023. However, the Acting Governor was unfortunately not feeling well, and discussions were held instead with Mr. Budiyanto, Acting Regional Director (top administrative staff). At the beginning, Mr. Budiyanto gave a welcome speech and introduced Gorontalo Province, while explaining its main policies and industries. This was followed by the Vice Governor Tanaka's speech and a brief description of the city-to-city collaboration project. Mr. Budiyanto expressed his gratitude because various projects are progressing based on the MoU concluded in January 2023 and commented that the provincial government would continue to provide support. The chairperson of the Gorontalo Provincial Council also attended the meeting, and expressed his gratitude for the various forms of support provided by Ehime Prefecture, and hopes that the Gorontalo Provincial Government will make the most of its collaboration with Ehime Prefecture. He also mentioned that he expects policy transfers by Ehime Prefecture as the project progresses.

Figure 5-1 Scene of the vice-governor Tanaka of Ehime Prefecture visiting the Province of Gorontalo

6. Summary

6.1. Results of this fiscal year's city-to-city collaboration project

Due to the subsiding of the COVID-19 impact, we were able to go to the field to conduct a field survey four times this fiscal year. Like in the previous fiscal year, we successfully conducted interviews and obtained the information and data necessary for examination through frequent remote meetings, e-mails, and other online communication tools. In addition, through the conclusion of an MoU between Ehime Prefecture and Gorontalo Province regarding environmental cooperation, the project became more meaningful. The vice-governor Tanaka of Ehime Prefecture visited Gorontalo Province, enhancing the province's awareness of Ehime Prefecture's policy for cooperation with Gorontalo Province and cementing the cooperation between the two municipalities.

In this fiscal year, which is the third year of the project, we were able to discuss details and share the recognition of issues to be dealt with before commercialization with local governments and related people, while looking ahead to cooperation based on the firm relationship between Ehime Prefecture and Gorontalo Province.

Table 6-1 Summary of results of the city-to-city collaboration project for this fiscal year

Project candidate		Results
Local water infrastructure development	Wastewater treatment plants	・ Selection and on-site assessment of candidate sites for the installation of Wastewater treatment plants ・ Holding of seminars on Wastewater treatment plants for Gorontalo Province Public Works Bureau (BPPW) ・ Agreements with the province and regencies regarding steps for installation
	Methane fermentation facility	・ Collection of data on waste water from coconut processing factories and power consumption there ・ Discussions on detailed design, business potential evaluation, and proposals for an implementation structure for installing equipment in coconut processing factories ・ Marketing by the vice-governor of Ehime Prefecture at a coconut processing factory
	Other	・ Detailed design of equipment for treating the leachate at the final disposal site, and discussions on the implementation system ・ Production of plans for incorporating this project into the budget of the local government, and consensus formation
Sustainable forest utilization		・ Discussions on forest monitoring methods, and grasping of current monitoring methods ・ Discussions on sustainable monitoring methods with the governments of Gorontalo Province and regencies
Support for formulation of decarbonization policies		・ Grasping of needs of local governments regarding the formulation of decarbonization policies ・ Follow-up of the status of formulation of provincial development plans
Other		・ The vice-governor of Ehime Prefecture visited the Province of Gorontalo (Nov. 2023). ・ Start of the cooperative project with the Province of Gorontalo in the industries of agriculture and fisheries based on the original budget of Ehime Prefecture (Nov. 2023). ・ Participated in the city-to-city collaboration seminar on behalf of the regional commissioner of the Province of Gorontalo, and visited related sites in Ehime Prefecture (Feb. 2024).

6.2. Policy for activities from the next fiscal year

This fiscal year is the third year of the 3-year project, but we have not yet applied for the JCM equipment subsidy. On the other hand, Ehime Prefecture and the Province of Gorontalo have been cementing their relationship year by year. As there are some possible transactions that may lead to business through continued discussions under the framework of the city-to-city collaboration project, including the installation of methane fermentation equipment, the Province of Gorontalo is strongly demanding the continuance of this project. Ehime Prefecture, too, hopes to continue the cooperation while looking ahead to the sister-city affiliation with the Province of Gorontalo, following the memorandum regarding environmental cooperation signed in January 2023, based on the policy for overseas business operation of enterprises in the prefecture and business creation. In addition, as an city-to-city cooperation project, we plan to give suggestions about decarbonization measures and plans of Ehime Prefecture, to address concrete issues about decarbonization in the Province of Gorontalo, which were grasped through this project. The consultation with "Environment/zero-carbon promotion section" established in Ehime Prefecture in this fiscal year is ongoing, so Ehime Prefecture and the Province of Gorontalo are expected to issue a declaration for decarbonization together. In the Phase 2 project, we will invite related staff from the Province of Gorontalo to Ehime Prefecture, and have an opportunity to introduce the status of Ehime Prefecture and the technologies of enterprises in the prefecture.

Considering the outcomes of the 3-year project, we would like to finish this report by indicating assumed future activities in the following table and figure.

Table 6-2 Proposals for activities in the Phase 2 project

Theme	Proposed activities in the Phase 2 project
Wastewater treatment plants	・ To propose policies for plans for adopting Wastewater treatment plants in the Province of Gorontalo, while trying to link it with the demonstration project
Methane fermentation equipment	・ To apply it to the industrial waste water (from coconut processing and sugar production) in the Province of Gorontalo based on the project of PT. Royal Coconuts, while trying to link it with the JCM equipment subsidy program
Forest management	・ To complete the REDD+ project in the Province of Gorontalo
Green hospitals*	・ The government of Gorontalo has requested the provision of technologies. ・ To support comprehensive infrastructure development with the technologies of enterprises in Ehime Prefecture, by introducing waste water treatment equipment and renewable energy to hospitals with the green hospital scheme
Low-carbon fishing boats*	・ To seek needs through surveys with the original budget of Ehime Prefecture ・ To realize low-carbon fishing boats by replacing their

	engines, and improve the boats ・ To help increase fishermen's income
Spread of decarbonization initiatives from Ehime Prefecture	・ To discuss the diffusion of the decarbonization plan in the prefecture, in cooperation with the environment/zero-carbon promotion section

*New theme

Figure 6-1 Envisioned Phase 2 Project theme