FY2023 Commissioned Project

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City-to-City Collaboration for Zero-Carbon Society Programme (Feasibility Study on the Decarbonisation of the Cement Industry in West Java Province, Indonesia)
Commissioned Report

March 2024

Institute for Global Environmental Strategies

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1. Purpose and Outline of the Project

1.1. Purpose of the project

The cement industry is the third largest energy consumer and second largest CO2 emitter in the world.[1] In rapidly developing countries, cement is an important industry that builds the foundation for infrastructure development. Therefore, transitioning the cement industry to a sustainable form is an inevitable and important issue for realising a decarbonised society. This study was conducted under a city-to-city partnership between Kitakyushu City and West Java Province, in collaboration with relevant local governments, companies, central government agencies, and other stakeholders in both countries, with the aim of addressing this critical issue and presenting concrete solutions.

1.2. Outline of operations

The approach taken to implement this study was based on the following two concepts.

Concept 1: Reduce CO_2 emissions throughout the supply chain

This study was conducted in West Java Province, Indonesia, to examine the feasibility of decarbonising the cement industry by reducing CO2 emissions throughout the supply chain. Comprehensive and cross-sectoral measures were considered, including reducing CO2 emissions from cement production processes at cement plants, as well as curtailing the use of natural resources such as coal and limestone by promoting the use of waste as an alternative fuel and material for cement. Furthermore, the scope of the study also included the reduction of CO2 emissions from waste emissions sources, collection and transportation, and final disposal sites.

Specifically, the study was divided into four major areas:

(1) Feasibility study on the installation of a power generation system that uses the recovered waste heat in a cement plant and application to the JCM Model Project programme
(2) Feasibility study on a business that converts industrial waste into alternative fuel and material for cement
(3) Feasibility study on a business that converts general waste into alternative fuel for cement and compost
(4) Feasibility study on maximising and optimising the use of alternative fuel and raw material for cement

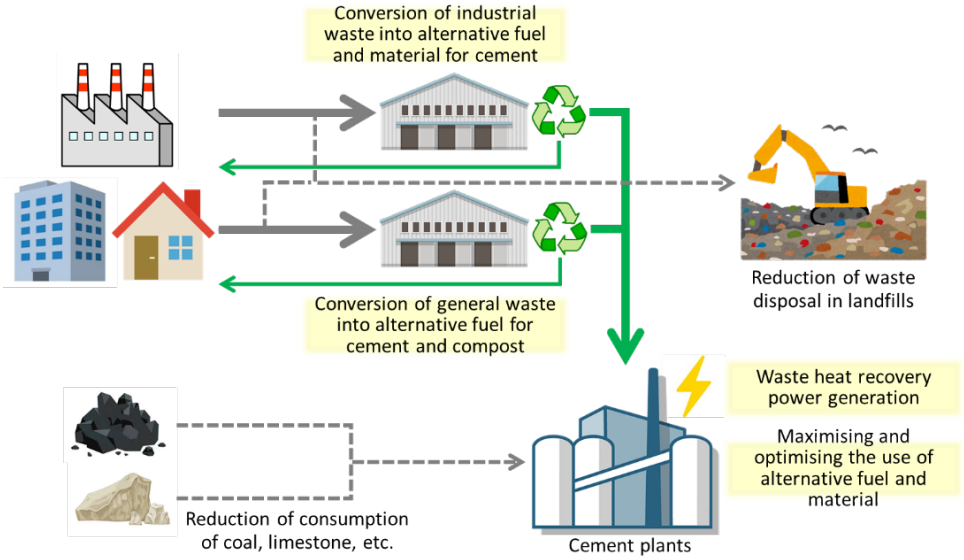


Figure 1.2.1. Conceptual diagram of the project (Source: Prepared by the survey team)

[1] International Energy Agency, "Technology Roadmap - Low-Carbon Transition in the Cement Industry": https://www.iea.org/reports/technology-roadmap-low-carbon-transition-in-the-cement-industry

Concept 2: Regional collaboration approach

In the cement industry, efforts to convert waste into alternative fuel and materials are gaining in popularity around the world for their potential to reduce the consumption of natural resources such as coal and limestone. The Japanese cement industry has achieved a recycling rate of approximately 50%,[2] but efforts in Indonesia are just getting started. Large cement plants consume an enormous amount of coal during the production process, and yet the amount of waste generated by a single municipality may not be sufficient for conversion into alternative fuel that could replace even a portion of that amount, requiring cooperation with multiple municipalities and businesses in the regional collection, transportation and treatment of waste. In Indonesia, cities or regencies manage each municipality's final disposal site and the collection, transportation, and treatment of general waste, while regional final disposal sites are managed by the province. In some cases, the province may also need to intervene and coordinate the collection, transportation, and treatment of waste across municipalities. Therefore, a multi-layer coordination structure between both provinces and cities/regencies is necessary to promote the conversion of general waste into alternative fuel and materials for producing cement at large cement plants.

Waste-to-energy projects are also being planned with support from the Japanese government in two locations in West Java: the Legok Nangka area (six municipalities: Bandung City, Cimahi City, Bandung Regency, West Bandung Regency, Sumedang Regency, and Garut Regency) and the Bekarpur area (three municipalities: Bekasi Regency, Karawang Regency, and Purwakarta Regency).[3] Both projects plan to collect and incinerate general waste over a wide area across multiple cities/regencies. Therefore, considering the scope of these planned projects, a certain level of coordination will be necessary in cases where cement plants will be accepting refuse derived fuel (RDF) produced from general waste, in order to avoid creating a competitive environment for waste within West Java Province. From the perspective of efficient collection and transportation, it is a logical step to treat general waste from adjacent municipalities at the cement plant, while using the waste-to-energy plant to process waste from other municipalities located in that vicinity, thereby reducing CO_2 emissions from collection and transportation and lowering waste management costs. In addition, when waste-to-energy plants are installed in the future, incineration ash generated during the treatment process can be recycled as an alternative material for cement. This particular point will be examined in this study as part of the conversion of industrial waste into alternative fuel and materials. Thus, the action of recycling incineration ash may act as a bridge to integrate these two projects (Figure 1.2.2).

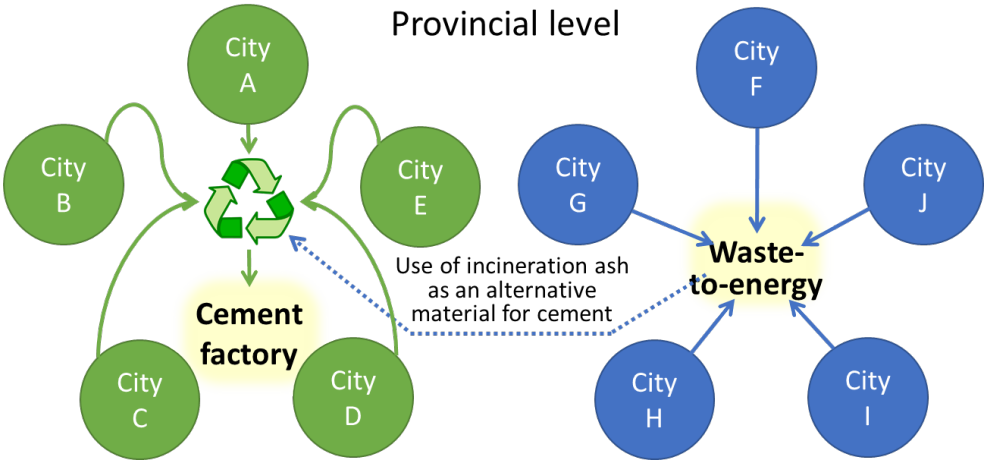


Figure 1.2.2. Conceptual diagram of an existing cement plant and a new waste-to-energy facility that collect general waste from municipalities nearby to improve collection and transportation efficiency and avoid competing for waste (Source: prepared by the study team)

[2] The Cement Association of Japan, Effective utilization of waste and by-products: https://www.jcassoc.or.jp/seisankankyo/seisan01/seisan01a.html

[3] Ministry of Foreign Affairs of Japan, Fact Sheet: Strengthening Japan-Indonesia bilateral cooperation for the next generation: https://www.mofa.go.jp/mofaj/files/100596191.pdf

PT Indocement Tunggal Prakarsa Tbk (ITP), the main local counterpart in this study, has cement plants in Bogor Regency and Cirebon Regency in West Java Province, both of which are located outside the planned waste collection areas in Legok Nangka and Bekarpur areas. Since there are no plans to conduct waste-to-energy projects outside these two areas, there is a need to consider the construction of a treatment facility that can accept a reasonable amount of general waste, rather than simply landfilling waste at final disposal sites in each municipality, where land is limited. The conversion of general waste to RDF being considered in this study only targets areas outside of the planned locations for these waste-to-energy projects.

Figure 1.2.3. Location of ITP's existing cement plants in relation to the planned waste-to-energy project areas in West Java Province (Source: prepared by the survey team based on information available from Wikipedia[4])

1.3. Background

1.3.1. CO2 emissions and decarbonisation in the cement industry

Cement is a fundamental material for social infrastructure such as buildings and bridges, and in a country like Indonesia with a growing population and economy, it is an essential industry for future development. However, a significant amount of energy is consumed during the production process, emitting 0.5-0.6 tCO2 to produce one tonne of cement. In 2019 alone, emissions of 2.4 GtCO from the cement sector accounted for about 26% of the total global CO2 emissions from the industrial sector.[5]

Characteristics of CO2 emissions in the cement industry

In the cement manufacturing process, the main raw material, limestone, is mixed with silica stone, clay, and iron oxide raw materials, which are calcined at temperatures of 1,450°C or higher to produce clinker, the intermediate product of cement. Next, clinker is finely ground and gypsum and mixing

[4] Wikipedia: https://upload.wikimedia.org/wikipedia/commons/8/8b/Map_of_West_Java_with_cities_and_regencies_names.png

[5] IEA: Energy Technology Perspectives 2020: https://www.iea.org/reports/energy-technology-perspectives-2020

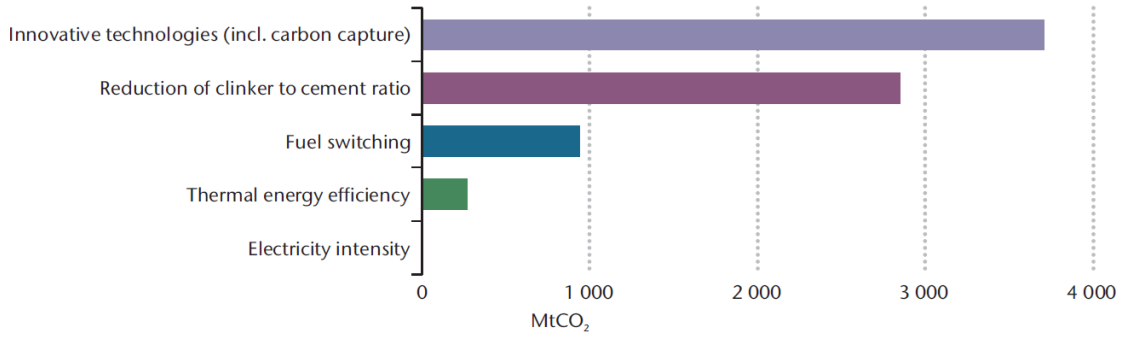
agents are added to produce cement. In the calcination process, the main raw material, limestone (CaCO3), is converted to clinker which has a main component of CaO (CaCO3→Cao+CO2) that releases a large amount of CO2. Approximately 55% of the CO2 emitted during cement production is due to the calcination of limestone and other raw materials. The cement industry is characterised by high emissions of CO2 originating from non-energy sources, and even if energy sources were converted to 100% renewable energy, the challenge remains in the fact that CO2 emissions cannot be reduced completely to zero.[6]

CO2 emission reduction measures in the cement industry

Since most of the CO2 generated by cement plants occurs in the clinker manufacturing process, reducing the clinker ratio in the cement industry would be directly related to reducing CO2 emissions. One way to reduce the clinker ratio is to use waste materials such as ash and sludge as raw material substitutes. Another effective means of reducing CO2 emissions is to replace the large amount of coal used in the clinker firing process with fuels such as biomass and RDF. Furthermore, since the plant consumes a large amount of energy, the introduction of high-efficiency equipment and the effective use of waste heat can also have a significant effect on reducing CO2 emissions.

According to the IEA report, in order to achieve the 2°C scenario (2DS), which limits temperature increase to 2°C by 2100, direct CO2 emissions from cement production worldwide must be reduced by about 24% (7.7 GtCO2) relative to the RTS[7] by 2050. To achieve this, the roadmap identified four CO_2 emission reduction strategies: (1) innovative technologies such as carbon capture and storage (CCS), (2) reduction of clinker to cement ratio, (3) fuel switching, and (4) thermal energy efficiency (Figure 1.3.1.1).[8]

More time will be needed to put the CCS technologies in (1) into practical use, as they are still in the demonstration stage in Japan[9]. In terms of the other technologies, the role of reducing the clinker to cement ratio in (2) has a particularly important role to play. In this study, the team investigated the feasibility of introducing these technologies to the cement industry in Indonesia, focusing on those that can be put into practical use and would have a significant impact on reducing CO2 emissions, namely, the reduction of clinker to cement ratio through the conversion of industrial waste to alternative fuel and materials (in item (2) above), the conversion of general waste to alternative fuel by RDF (in item (3)), and improving thermal efficiency by generating power through the recovery of waste heat (in item (4)).



Note: Cumulative CO_2 emissions reductions refer to the period from 2020 to 2050 and are based on the low-variability case of the scenarios.

Figure 1.3.1.1. Cumulative global CO2 emission reductions compared to RTS under the 2°C scenario (2DS), which limits temperature increase to 2°C by 2100 (Source: IEA)

[6] The essence of decarbonised management: prospects for decarbonising the cement industry: https://rickysprout.com/cement_industry/#toc1

[7] RTS: International Energy Agency (IEA)'s Reference Technology Scenario by 2050

[8] IEA: Technology roadmap: Low-Carbon Transition in the Cement Industry: https://www.iea.org/reports/technology-roadmap-low-carbon-transition-in-the-cement-industry

[9] NEDO: Carbon recycling in the concrete and cement sector: https://green-innovation.nedo.go.jp/article/co2-concrete/

Cement production trends in Indonesia

Cement production in Indonesia has been growing steadily as demand for infrastructure has increased. The compound annual growth rate (CAGR) reached 6.2% between 2009 and 2019, before demand fell due to the COVID-19 pandemic.[10] Demand started to decline between 2019 and 2020, but has since recovered and is expected to increase through 2025 (Figure 1.3.1.2). Production capacity is large relative to demand and usage in the domestic market, which has led to an excess in capacity. However, the volume of exports is also increasing, aided by rising demand overseas.[11] In Indonesia, the number of cement companies has risen to nearly 20, but more than 60% of the total market share is held by two cement group companies: state-owned PT Semen Indonesia Tbk (SIG) and its group companies, PT Solusi Bangun Indonesia Tbk (SBI; formerly PT Holcim Indonesia Tbk) and ITP. The share of these two group companies is significantly ahead of those ranked third and lower (Figure 1.3.1.3).

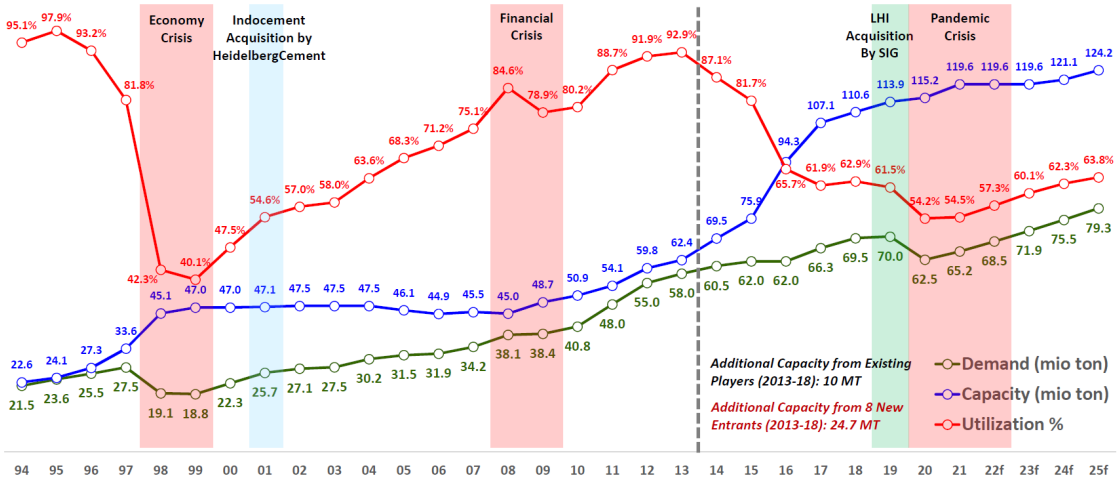


Figure 1.3.1.2. Production capacity, demand, and utilisation of cement in the Indonesian cement industry through 2022 and projections to 2025 (Source: ITP[12])

[10] International Cement Review: Indonesia's face of recovery: https://www.cemnet.com/Articles/story/170972/indonesia-s-face-of-recovery.html

[11] International Cement Review: Indonesia remains gripped by cement overcapacity: https://www.cemnet.com/News/story/175339/indonesia-remains-gripped-by-cement-overcapacity.html

[12] Indocement: Public expose, 25 March 2022: https://www.indocement.co.id/resource/03.%20Investor/3.4%20Paparan%20Publik/2022_25%20March%20Indocement%20Public%20Expose_final.pdf

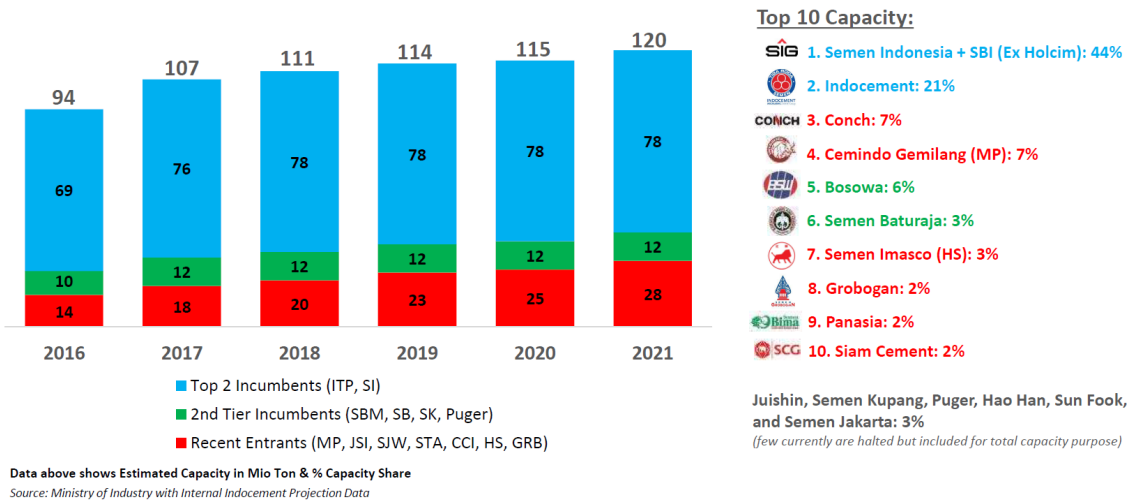


Figure 1.3.1.3. Cement production trends and market share status of cement companies in Indonesia from 2016 to 2021 (Source: ITP)

1.3.2. Related trends in Indonesia

Nationally Determined Contribution (NDC)

In advance of the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2021, the Government of Indonesia submitted an Enhanced Nationally Determined Contribution (ENDC)[13] and a Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050)[14] to the UNFCCC Secretariat, both of which include targets to lower net GHG emissions by 2030 and achieve carbon neutrality on or before 2060.

Under the ENDC, Indonesia aims to reduce GHG emissions by 29% by 2030 relative to business-as-usual (BaU) scenarios without external support (CM1), or by 41% in cases that include international aid (CM2), with 2010 as the base year. The most relevant sectors in this study are the Industrial Processes and Product Use (IPPU) sector, which includes the cement industry, and the waste sector.

In the IPPU sector, the cement industry aims to reduce the clinker ratio from 81% to 65% by 2030 under a BaU scenario with international aid (CM2) by promoting the introduction of alternative raw materials (Figure 1.3.2.1).

In the industrial waste sub-sector, the ENDC outlines the aim to promote the use of sludge and solid industrial waste from wastewater treatment plants (WWTPs) as raw materials and energy (Figure 1.3.2.2).

Under the ENDC for the municipal solid waste sub-sector, Indonesia aims to compost 3.7 million tonnes of waste, increase the number of integrated waste treatment facilities (TPST: Tempat Pengolahan Sampah Terpadu) to 2,857 (with 1,469 facilities equipped with composting functions), and boost the number of 3R type waste treatment facilities (TPS3R: Tempat Pengelolaan Sampah 3R) to 2,018 (with 1,703 facilities equipped with composting functions). Indonesia also aims to process 4.6 million tonnes of waste, either by converting waste to RDF or through waste-to-energy (PLTSa) (Figure 1.3.2.3).

Converting general waste into alternative fuel for cement and compost, which is the goal of this study, is directly related to precisely these three measures, and the study team believes that the implementation of the proposed project will aid in achieving the CM2 target in West Java Province (Figure 1.3.1.3).

[13] Enhanced Nationally Determined Contribution (NDC), Indonesia: https://unfccc.int/sites/default/files/NDC/2022-09/ENDC%20Indonesia.pdf

[14] Long-Term Strategy for Low Carbon and Climate Resilience 2050: LTS-LCCR 2050): https://unfccc.int/sites/default/files/resource/Indonesia_LTS-LCCR_2021.pdf

The ENDC does not contain direct references to power generation at cement plants through the recovery of waste heat, which is the subject of this study. However, this is broadly considered to fall under energy consumption efficiency in the energy sector section of the ENDC, which has an objective of reducing electricity consumption by 15,187 GWh under the CM2 scenario by 2030.

SECTOR: IPPU				
No.	**Mitigation Actions**	**2030**		
		BaU	**CM1**	**CM2**
1	**Cement Industry**		GHG emission reduction target is 2.75 Mton CO_2	GHG emission reduction target is 3.25 Mton CO_2
	Increase blended cement by increasing the portion of alternative material for reducing clinker to cement ratio[1]	81% clinker to cement ratio	70% clinker to cement ratio	65% clinker to cement ratio

Figure 1.3.2.1. CO2 emission reduction measures and targets to 2030 for the cement industry under the IPPU sector in Indonesia's ENDC 2022. Areas considered to be relevant to this study are underlined in red (Source: ENDC of Indonesia, 2022)

SUB-SECTOR: INDUSTRIAL WASTE			
	BAU	**CM1**	**CM2**
Management of industrial waste.	No mitigation actions.	Utilisation of WWTP sludge and industrial solid waste through composting, reuse as raw material, use as energy, etc	**Utilisation of WWTP sludge and industrial solid waste through composting, reuse as raw material, use as energy, etc**
		Wastewater treatment in palm oil, pulp & paper, fruits/vegetables & juices processing, and other industries: to implement methane capture & utilisation (biogas).	**Wastewater treatment in palm oil, pulp & paper, fruits/vegetables & juices processing, and other industries: to implement methane capture & utilisation (biogas).**
		The previous target of 3 million ton CO_2-eq is enhanced up to 26 million ton CO_2-eq (equivalent to 1.2 million ton CH_4 recovery)	**The previous target of 18 million ton CO_2-eq is enhanced up to 28 million ton CO_2-eq (equivalent to 1.3 million ton CH_4 recovery)**

Figure 1.3.2.2. CO2 emission reduction measures and targets by 2030 for the industrial waste sub-sector in Indonesia's ENDC 2022 (Source: ENDC of Indonesia, 2022)

2. Waste utilisation by composting and 3R (paper).	No additional activities or enforcement on composting and 3R	Treatment of waste by composting 3.7 million ton MSW and 3R paper to reuse/recycle paper up to 3.7 million ton. The facilities include: - Waste bank 762 unit - TPST 2857 unit (1469 unit is integrated with composting) - TPS3R 3018 (1703 unit is integrated with composting) The target is to eliminate 4.8 million ton CO_2-eq	**Treatment of waste by composting 3.7 million ton MSW and 3R paper to reuse/recycle paper up to 3.7 million ton.** **The facilities include:** - **Waste bank 762 unit** - **TPST 2857 unit (1469 unit is integrated with composting)** - **TPS3R 3018 (1703 unit is integrated with composting)** **The target is to eliminate 4.8 million ton CO_2-eq**
3. PLTSa/RDF (Refuse Derived Fuel) implementation **Note: PLTSa = Pembangkit Listrik Tenaga Sampah**	No effort on waste-to-energy	Utilisation of waste by converting to energy through RDF (in industry) or as renewable energy source in PLTSa; The PLTSa/RDF facilities is to treat 4.6 million ton MSW to avoid 1.9 million ton CO_2-eq	**Utilisation of waste by converting to energy through RDF (in industry) or as renewable energy source in PLTSa;** **The PLTSa/RDF facilities is to treat 4.6 million ton MSW to avoid 1.9 million ton CO_2-eq**

Figure 1.3.1.3. CO2 emission reduction measures and targets by 2030 for the solid waste sub-sector in Indonesia's ENDC 2022 (Source: ENDC of Indonesia, 2022)

30% waste reduction target, 70% marine plastic debris reduction target

The Indonesian government has set the following waste disposal targets: a 30% reduction in household waste and 70% proper disposal by 2025 (Presidential Decree No. 97/2017), and a 70% reduction in marine plastic debris by 2025 (Presidential Decree No. 83/2018). The simultaneous production of RDF and compost, a topic of study under this survey, is expected to contribute to the achievement of these goals because it is a realistic way to dispose of waste plastic, which has no resource value, and is a highly effective option for reducing general waste.

Extended Producer Responsibility (EPR)

In 2019, the Ministry of Environment and Forestry (KLHK) enacted regulations for a waste reduction roadmap by producers (Ministerial Regulation No. 75/2019) (effective from 2020). This was enacted to regulate the application of the Extended Producer Responsibility (EPR) for manufacturers and others (manufacturers, importers, retailers, and the food service industry) to plastic, paper, aluminium cans, glass, and other containers and packaging, and stipulates the development of a roadmap for waste reduction by 2029.

Since a number of Japanese manufacturers have established operations in Indonesia and many of them have experienced problems in complying with said regulations, one of the issues that the Jakarta Japan Club (JJC), a local Japanese Chamber of Commerce in Indonesia, is facing is how to help these companies operate under the EPR. The survey team believes that the simultaneous production of RDF and compost, an area that will be studied in this survey, will be a valuable contribution to the EPR as a realistic recycling method, especially for waste plastics that have no resource value. In fact, in this study, the team identified a case where 70% of the RDF produced is voluntarily counted as the offset portion for EPR (because about 70% of RDF is plastic).

Carbon tax

The Indonesian government had planned to introduce a carbon tax on 1 April 2022 based on Law No. 7/2021 on Harmonisation of Tax Regulations (Harmonisasi Peraturan Perpajakan/HPP), but the

system's introduction has been postponed several times and is currently expected to start in 2025.[15] The carbon tax targets heavy energy consumers, such as thermal power generation, paper, steel, fertiliser, and cement. Therefore, this study, which examines CO2 emission reduction measures in the cement industry, is expected to contribute to the introduction of such measures starting in 2025.

1.3.3. Potential for city-to-city collaboration between Kitakyushu City and West Java Province

Kitakyushu's achievements in city-to-city collaboration with Indonesian cities

Kitakyushu City established a Green Sister City partnership with Surabaya City, East Java Province, and has been engaged in specific collaborations over the past 20 years in the environmental sector under this cooperative agreement. The two cities signed a joint statement on a strategic environmental partnership in March 2011, which was followed by a comprehensive MOU on a Green Sister City partnership in November 2012. The exchange between these two cities started in the 1990s, initially in the fields of human resources development and waste, but has gradually expanded to include the water supply, sewage, and energy sectors. Both cities have participated in this city-to-city collaboration programme between fiscal 2013 and 2015. As a result, the installation of high-efficiency air conditioning equipment in one of the shopping malls was adopted as a JCM Model Project.

In addition, although formal MOUs have not yet been signed, Kitakyushu has a track record of collaboration with Balikpapan City in East Kalimantan Province and Medan City in North Sumatra Province in the field of waste management and environmental education.

City-to-city collaboration with West Java and potential partner cities

West Java has worked with Kitakyushu in the past as a member of the Kitakyushu Initiative Network for a Clean Environment (reorganised in February 2010), but neither party has signed a formal agreement on collaboration.

Kitakyushu selected West Java as a partner for collaboration because two companies in Kitakyushu that are taking part in this survey, Amita Corporation (AMITA) and Nishihara Shoji (which has group company Beetle Engineering (Beetle) participating in this survey), have been studying the feasibility of business development throughout Indonesia using subsidies from the Ministry of the Environment and Kitakyushu City, with West Java identified as the most appropriate location. In order to ensure that business is viable, it would be beneficial to both conduct a detailed feasibility study and obtain support from the Ministry of the Environment and Kitakyushu City in areas that are difficult for private sectors to access and/or coordinate alone, such as discussions with relevant central government ministries and agencies and obtaining permits and approvals. In addition, the transfer of knowledge on general waste management through city-to-city collaboration is expected to bring more depth and stability to the project. For these reasons, both companies requested Kitakyushu City's cooperation, a move that led to the proposals in this study. This can be described as a bottom-up style of city-to-city collaboration led by the private sector.

In addition to West Java Province, Kitakyushu will be expected to collaborate with other municipalities (cities/regencies) within the province. This survey will be used to determine partner municipalities and the kinds of initiatives that Kitakyushu may be able to collaborate on.

[15] JOGMEC, Indonesia: Carbon Tax to be Postponed until 2025 (October 20, 2022): https://coal.jogmec.go.jp/info/docs/221020_13.html

1.4. Method of conducting the survey

1.4.1. Implementation structure

A two-tiered implementation system was established for both Indonesia and Japan, with the private sector partnering up to conduct project development surveys, and the local governments of the two countries collaborating to support institutional development, with the implementation system envisioned to include public-private collaboration as appropriate (Figure 1.4.1.1).

The Institute for Global Environmental Strategies (IGES) served as the lead proponent for this study, and the following stakeholders from both countries participated as collaborating institutions. Letters of Interest (LOI) have been received from all of the partners who will be collaborating on the three-year study.

- International Environmental Strategies Division, Environment Bureau, Kitakyushu City
- Environment Agency, West Java Province
- PT Indocement Tunggal Prakarsa Tbk
- PT Jababeka Tbk
- JFE Engineering Corporation
- Amita Corporation
- Beetle Engineering
- Tokuyama Corporation

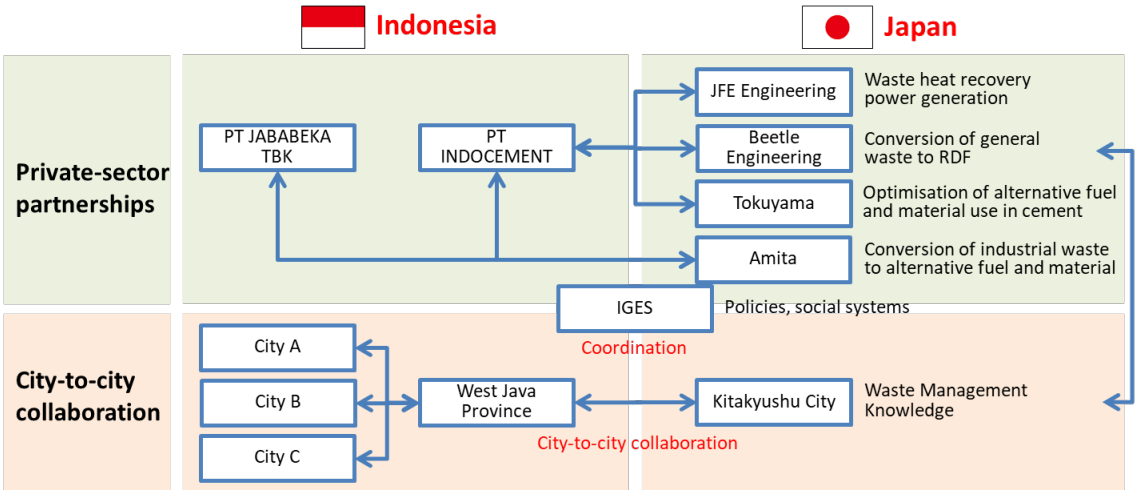


Figure 1.4.1.1. Conceptual diagram of the project implementation structure
(Source: prepared by the survey team)

1.4.2. Survey methods and timeline

The study was conducted mainly through field surveys, with a team formed for each survey theme. During the field survey, the team made full use of its existing network to set up appointments with relevant local organisations, and gathered information through interviews and site visits.

In parallel with the field survey, secondary information was collected and organized from the Internet and other sources, and information was exchanged with relevant organisations in Indonesia through e-mail, WhatsApp-style communication and coordination, and meetings via Zoom. The results of these surveys were compiled, evaluated, and discussed.

A workshop was held with local stakeholders on 8 September 2023 at ITP's cement plant in Citeureup district (Bogor Regency, West Java Province), bringing together ITP, the main local counterpart, and four Japanese companies participating in the survey (see 3.1. Workshop with Local Team). This workshop was positioned as a kick-off meeting for the study, where the plans, issues, and direction of the study were discussed in terms of the introduction of a power generation system that

uses recovered waste heat and the conversion of waste into alternative fuels and materials for cement production (both industrial waste and general waste).

The schedule for the fiscal 2023 study (actual Gantt chart) is shown in Table 1.4.2.1.

Table 1 .4.2.1 Fiscal 2023 survey schedule (actual Gantt chart)

Activities	2023					2024	
	8	9	10	11	12	1	2
Survey on introducing waste heat recovery power generation equipment							
On-site survey of the target cement plant	■	■	■				
Data collection, design			■	■	■	■	■
Power generation amount, GHG emission reduction, cost effectiveness estimation					■	■	■
Coordination with clients, data updates							■
Survey on turning industrial waste into raw material and fuel for cement							
Market research	■	■	■	■			
Permit investigation		■	■	■	■	■	
Platformer survey			■	■	■	■	■
Discussions with partner companies for JV	■	■	■	■	■	■	■
Survey on turning general waste into raw material and fuel for cement							
RDF production facilities survey		■		■		■	
RDF demand survey		■		■		■	
Scoping survey, coordination with target project stakeholders				■	■	■	■
Research on maximizing and optimizing the use of raw materials and fuel for cement							
On-site survey of alternative material and fuel conversion		■					
Technical exchange, follow-up						■	
Holding meetings, reports/presentations, etc.							
Workshop with stakeholders		■					
Progress report meetings	■			■			■
Presentations at related meetings, coordination, etc.							■
Meeting with JICA local office, etc.						■	
Commissioned report							■

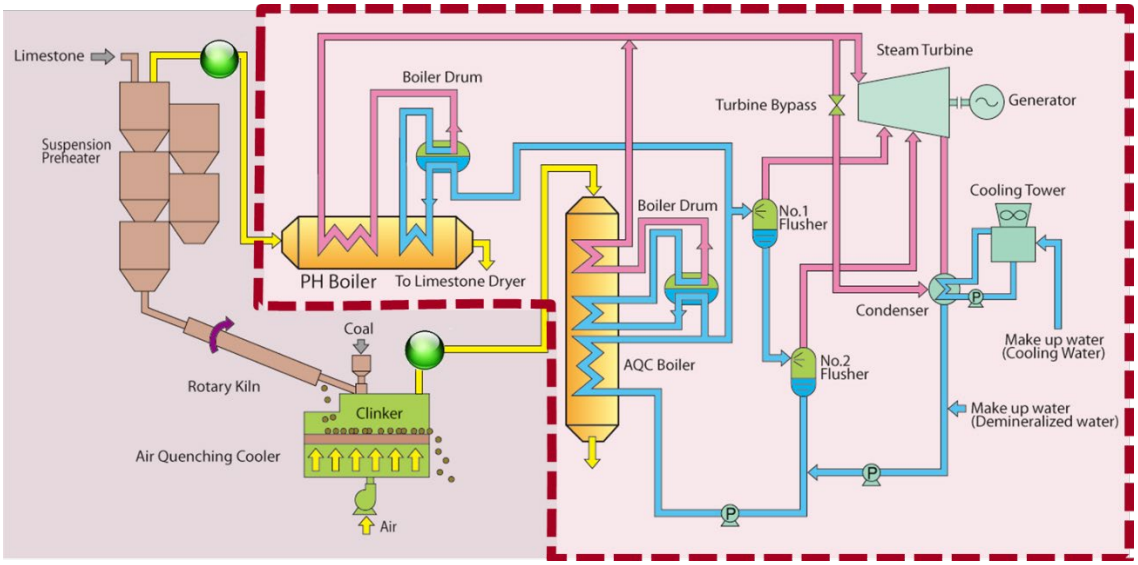
2.1. Survey on waste heat recovery system

2.1.1. Onsite survey

2.1.1.1. Survey background and objectives

The cement industry in Indonesia is expected to continue to increase its production due to robust demand for cement in construction projects such as housing, commercial facilities, and various infrastructure developments, driven by rapid urbanisation and population growth. Indonesian cement companies such as PT. Semen Indonesia and PT. Indocement Tunggal Prakasa are actively engaged in entrepreneurial activities to meet this demand. In addition, the Indonesian government is pushing for greener production and operations in the cement industry, prompting companies and plants to consider adopting the latest production and environmental technologies.

Waste Heat Recovery (WHR), which is categorised as an energy saving and environmental protection technology, is widely used not only in the cement industry but also in industries that require large amounts of heat in the production process. In the cement manufacturing process, a significant amount of heat is generated during the calcination, grinding and blending of raw materials. Previously unused high-temperature waste heat can be recovered and, through the production of steam and electricity using boilers, it is possible to improve energy efficiency, reduce greenhouse gas emissions and achieve economic benefits.



Schematic is indicative. Orientation of boiler may be changed to suit individual client requirements

Figure 2.1.1.1.1. Example of diagram of WHR facilities at a cement plant

JFE Engineering Corporation (JFE) has numerous records of introducing WHR facilities for factories in Japan, Taiwan, China, the Philippines, and other locations since the 1980s. JFE has also been proposing the introduction of WHR facilities in the Indonesian cement industry, and as of 2023, they have two successful introductions in the country as follows:

1) PT Semen Indonesia, Padang factory (formerly PT Semen Padang)
- Introduced under NEDO Model Project Program in 2009
- Power generation capacity: 8.5 MW
- Completion: November 2011

2) PT Semen Indonesia, Tuban factory

- Introduced under the Ministry of the Environment's JCM Model Project in 2014
- Power generation capacity: 28 MW
- Completion: June 2018

Indocement, which has shown strong interest in introducing WHR facilities at its own plants, has been directly consulting with JFE Engineering prior to this survey. They have also shown keen interest in the JCM Model Project Program at the Semen Indonesia's Tuban plant and are already engaged in discussions with JFE Engineering regarding information exchange and concrete facility introductions related to JCM. Based on these preliminary discussions, this survey aims to further progress specific discussions between JFE Engineering and Indocement, with the goal of introducing the company's second WHR facility in Indonesia through the JCM Program, by leveraging various activities.

Figure 2.1.1.1.2. Overview of the Tuban factory, PT Semen Indonesia

2.1.1.2. Survey subjects and methods

PT Indocement, headquartered in Jakarta, Indonesia, has a production capacity of approximately 25 million tons per year, distributed across 13 lines in three factories: the Citeureup plant in Bogor, West Java (10 lines), the Cirebon plant in West Java (2 lines), and the Tarjun plant in Kota Baru, South Kalimantan (1 line). Since 2001, the company has been a subsidiary of Heidelberg Materials, a global cement major based in Germany, alongside Holcim and Cemex.

As of 2023, WHR facilities have not been introduced in any of the lines at these factories. Prior to the start of this survey, JFE Engineering had received numerous enquiries regarding the implementation of WHR at the Tarjun plant in South Kalimantan.

Prior to the start of this FS, discussions were held between Indocement and JFE, regarding the implementation of WHR at the target plant. These discussions resulted in a clear understanding on the part of Indocement's senior executives of the benefits of implementing WHR at the Citeureup plant and other related plants, the impact of the JCM Model Project Program, and the smooth progress of

this project under the city-to-city cooperation between Kitakyushu City and West Java Province. As a result of these discussions and deliberations, it was decided to proceed with the introduction of WHR facility at the Citeureup plant in West Java as part of this project. It was also decided that Mr Kevin J. Chandra, the company's Senior Sourcing Manager for Alternative Fuel & Alternative Material (AFAM), would be the point of contact for various conditions and information.

As of 2023, JFE Engineering's subsidiary JFE Engineering India Private Limited (JFE Engineering India) is responsible for everything from business development to EPC of new WHR plants. As such, this FS was mainly carried out by JFE Engineering India, with support from JFE Engineering HQ and the Jakarta office.

JFE Engineering India is one of JFE's large subsidiaries, based in Pune in the western Indian state of Maharashtra, and employs more than 100 Indian engineers. JFE Engineering Corporation, Japan acquired the design and engineering division of Transparent Energy Systems Private Limited (TESPL) in 2014, which is the market leader in the design and construction of WHR plants for cement factories in India, and is actively developing its activities as a global engineering center for JFE Engineering's waste-to-energy plants, biomass power plants, WHR plants and others. In the waste-to-energy project in Bac Ninh Province, Vietnam, which was implemented as a JCM model project by the Ministry of Environment of Japan and celebrated its completion in January 2024, the company is in charge of the design work and equipment procurement for the WtE plant.

The cement industry consists of large plants with various specialized production facilities, and it is common for each company to have its own in-house departments for design, construction, and installation of the various plants.

As a result of discussions, Indocement and JFE Engineering India have agreed to share their roles in the FS (Feasibility Study) for the installation of a WHR (Waste Heat Recovery) facility in the Citeureup factory as follows: JFE Engineering India will handle the engineering and cost estimation work of the WHR equipment, while the installation of the equipment, related civil works, cost estimation of the entire WHR equipment, as well as the review and decision on the introduction of the equipment based on the estimation results, will be carried out by the client, Indocement. The final decision on whether to implement the JCM (Joint Crediting Mechanism) model project will be made by Indocement after verifying the cost-effectiveness of the project along with the results of the construction and civil engineering cost estimation to be carried out by Indocement.

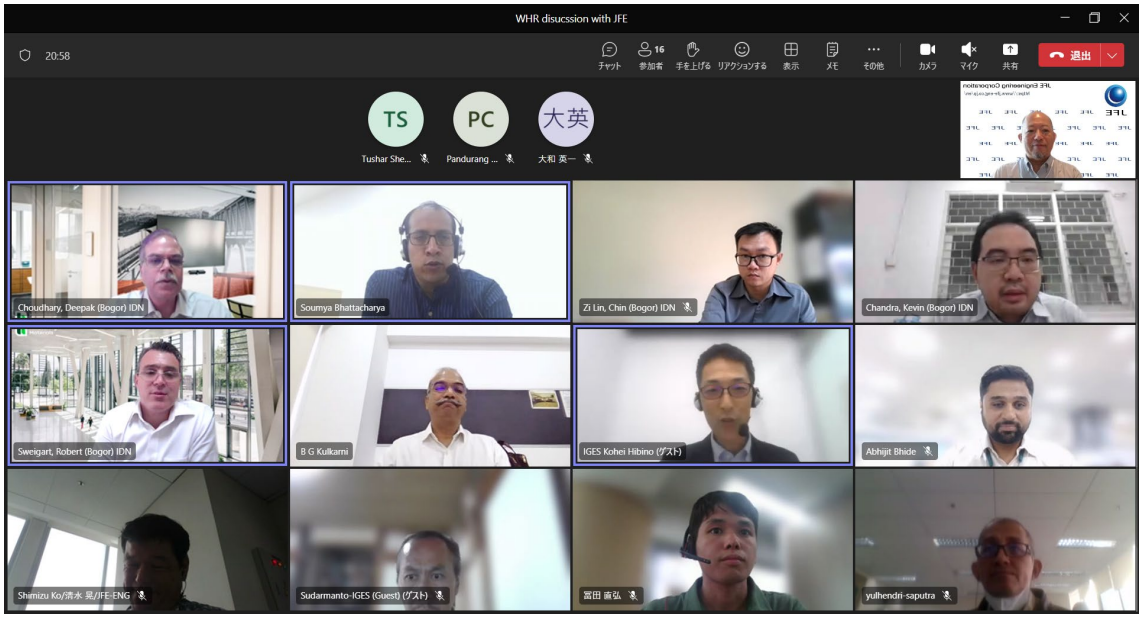


Figure 2.1.1.2.1. Online meeting with Indocement

2.1.1.3. Survey outcomes

Following several online meetings between JFE Engineering Group and Indocement, a kick-off meeting and site visit for this FS was conducted at Indocement's Citeureup plant on 8 September 2023. The content of the discussions and other information related to the WHR are as follows.

Participants JFE Engineering:

- (India) Mr Abhijit Bhide (Sales), Mr Tushar Shelake (Engineering)
- (Jakarta) Mr Shimizu Ko and Mr Yulhendri Saputra (Sales)

Main discussions/agreements:

(1) Targets for WHR implementation

- Target kilns: 3 kilns (P8, P11 and P14)
- Waste heat recovery units: 1 P8 preheater boiler, 2 P11 preheater boilers, 2 P14 preheater boilers, 1 AQC boiler, common steam turbine, air cooled condenser.

(2) Scoping of studies and investigations

- JFE Engineering will perform the FS for the WHR equipment only.
- The FS for the whole project including civil works, installation works, OPEX etc. will be carried out by Indocement and its contents will be shared with the study team and JFE Engineering.

(3) FS implementation schedule

- Engineering work of WHR equipment by JFE Engineering: 3 months (as soon as the necessary data is received from Indian Cement).
- Estimation of construction costs etc. by Indocement: 1 month
- Overall FS by Indocement: 1 month

Figure 2.1.1.3.1. Onsite survey

Based on the agreement, JFE Engineering India received various data and information from Indocement and conducted design considerations. As a result, the proposal for the specification of the WHR equipment was made. It should be noted that this proposal was created in English to serve as material for the consideration of WHR introduction within Indocement, and the Japanese rendition is provisional. Additionally, certain content is omitted due to non-disclosure agreements with Indocement.

Target facilities	P8　preheater boiler 1 P11　preheater boiler 2 P14　preheater boiler 2・AQC boiler 1 Common Steam Turbine and Air-Cooled condenser
Power generation capacity	Gross Power Output at generator terminal (A)　28.5 MWe Auxiliary Power Consumption (B)　2.0 MWe Net Power Output (A-B)　26.5 MWe
Expected GHG reduction	155,752t CO2/year (average)
Implementation schedule	Approx.. 24 months
Cost estimation (only for the scope by JFE Engineering)	※not-disclosed CFR Port of Tanjung Priok, Indonesia (Reference Incoterms 2022).

The expected greenhouse gas (GHG) emission reduction was calculated as follows. It should be noted that certain conditions are to be determined at the end of this project, and the implementation of the JCM (Joint Crediting Mechanism) facility support project is also undecided, and thus it is treated as a reference estimate.

1) Reference emissions

In the WHR facility, power generation is carried out from waste heat to cover the power consumption of the WHR facility itself (electricity from the grid is used for boiler ancillaries such as circulation pumps, which are part of the waste heat facility), and the remaining net power can be used as an alternative to grid electricity. Therefore, the net alternative power quantity is calculated using the following method.

EGy ＝ EGGEN － EGAUX

EGy ＝ The quantity of net electricity generation by the WHR system which replaced grid electricity import (MWh/y)
EGGEN,y ＝ The quantity of gross electricity generation by the WHR system (MWh/y)
EGAUX,y ＝ The quantity of electricity consumption by the WHR system (MWh/y)

In the case of the pre-existing WHR at the Semen Indonesia Tuban factory by JFE Engineering, the calculation accounts for the variation in effective power generation between the rainy and dry seasons, attributable to the heat demand for raw material drying during the rainy season. However, information regarding the operation during the rainy and dry seasons at the Indocement Citeureup factory has not been provided by the company as of the end of this feasibility study (FS). Consequently, the calculation was conducted without taking into consideration the difference between the rainy and dry seasons. Additionally, as an agreement has not been reached regarding the setting of the WHR facility operating rate, a provisional rate of 85%, similar to the pre-existing case, was utilized.

	A	B	C	D	E=A*B*C*D
Quantity of electricity generation	Generation capacity (MW)	Operating day/year	Time (hrs/day)	Operating Rate	Electricity (MWh)
Full year	28.5	365	24	0.85	212,211
Electricity consumption by WHR system	2.0	365	24	1	17,520
Quantity of net electricity replaced grid electricity import					194,691

In this FS, JFE utilize the CO2 emission factor of 0.800 tCO2e/MW from Indonesia Jamali Case 2 (which involves the substitution of both grid electricity and on-site self-generation) in Appendix 2-1 of the Financing Programme for JCM Model Projects in FY2023.

Therefore, reference emissions are calculated as follows:

Reference emissions (REy)＝EGy×EFgrid
＝194,691 MWh/y × 0.800 tCO2e/MWh
≒ 155,752 tCO2e/year

2) Project emissions

Project emissions are not assumed in the methodology as the WHR system utilizes only waste heat and does not utilize fossil fuels as heat source to generate steam for power generation.

Therefore, the following formula is used to express the project emissions:

PEy ＝ 0

3) Calculation of emissions reductions
Emission reductions are calculated as the difference between the reference emissions and project emissions, as follows:

ERy＝ REy – PEy ≒ 155,752 tCO2e/year

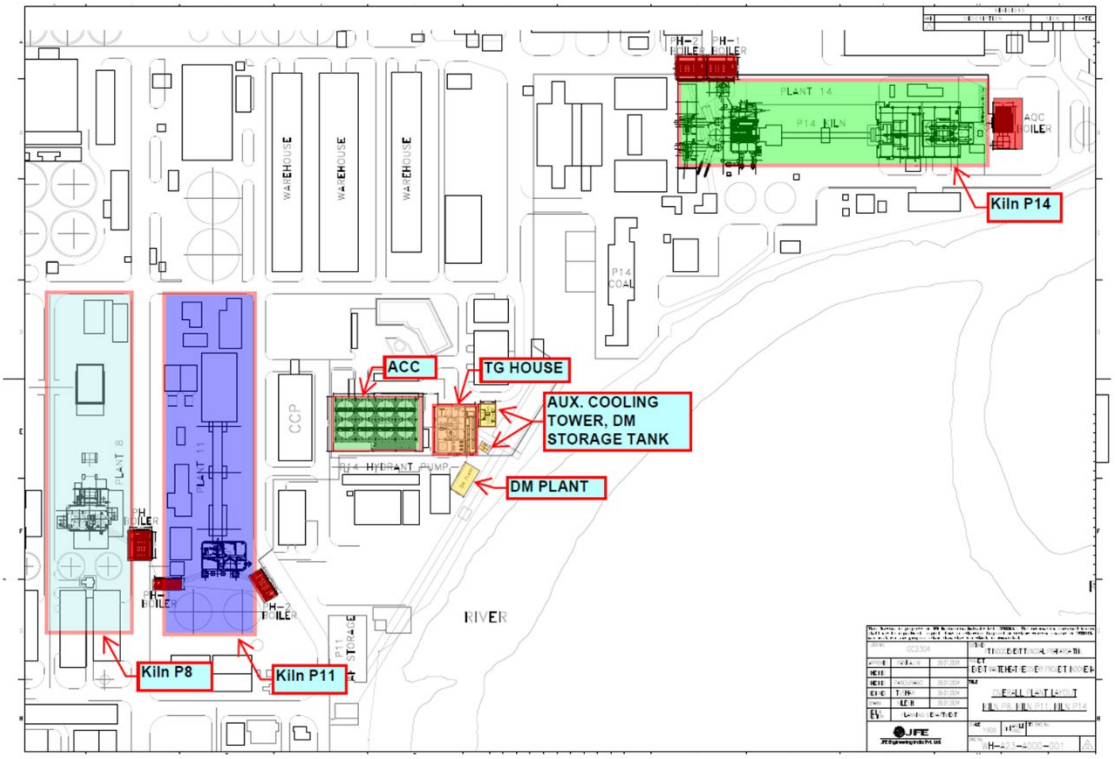


Figure 2.1.1.3.2. Overall layout

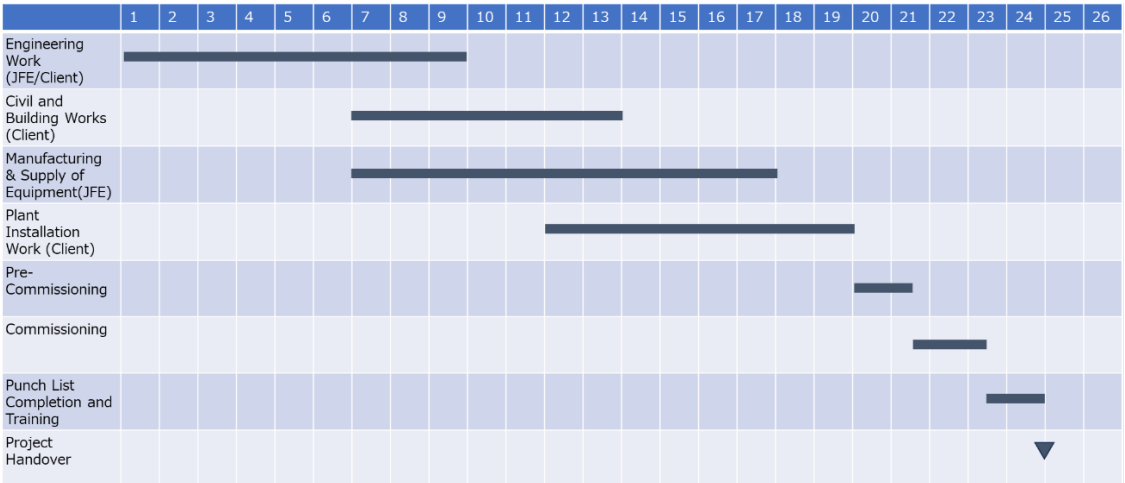


Figure 2.1.1.3.3. Project schedule

2.1.2. Preparation for application for the JCM Model Project

After conducting multiple discussions with Indocement and using the case of the pre-existing WHR project for the Semen Indonesia Tuban plant in Indonesia as a reference, JFE was able to gain a certain level of understanding regarding the JCM scheme and JCM model project, considering the potential implementation of the WHR facility for Indocement under the JCM program.

Both Indocement and JFE confirmed that the adoption is determined after submitting the "Project Idea Note (PIN) for the JCM Project" to the Japan-Indonesia JCM Joint Committee during the evaluation of JCM model project from FY2023, and that there is a possibility of an extended review period due to the additional process. JFE also explained the potential misalignment of the WHR facility investment plan and the institutional decision-making process at Indocement, and the resulting concerns. Therefore, it was agreed to periodically share the internal review status from Indocement and, based on this, to engage in extensive discussions with relevant parties in Japan.

On the other hand, Indocement demonstrated strong interest in the handling of JCM credits. The main discussions were as follows:

1) Issuance of JCM credits in JCM projects in Indonesia

The survey team explained that the procedures for issuing credits in JCM projects in Indonesia, not limited to the WHR project at the Semen Indonesia Tuban plant, have been delayed. Various negotiations and procedures related to the credits are conducted by the joint committee between the two countries. It was also explained that JFE Engineering, as the project implementer, cannot directly participate in the credit issuance process and that the specific circumstances of the Tuban plant project are confidential.

2) Handling of JCM credits by private companies

Indocement inquired about whether they, as a result of bilateral negotiations, can use the credits acquired in Indonesia for market trading. The survey team explained that under the current system, the credits cannot be used for market trading. Furthermore, it was clarified that the details of operation for the so-called “private sector handled JCM”, even in FY2023, have not been finalized, and it is not a subsidy for project costs like the facility support project. It was also explained that it is uncertain whether the credits can be used for market trading. There was also a comment from Indocement's executives urging to avoid confusion regarding JCM, and an agreement was reached to focus on considerations related to JCM only in the context of the JCM facility support project, without considering private JCM for the time being.

Due to the delayed start of this FS, the review and estimation work for the content identified within the overall facility investment, scoped by Indocement, is scheduled to be conducted after the completion date of this FS. Additionally, as further understanding from the senior management of Indocement is required regarding the JCM credits, it has been decided that both companies will continue to engage in ongoing discussions for the consideration and preparation of the application for the JCM model project for the Citeureup plant's WHR facility, even after the completion date of this year's FS.

2.2. Survey on converting industrial waste into raw materials and fuel for cement

2.2.1. Onsite survey

2.2.1.1. Survey background and objectives

As the manufacturing industry in Japan downsizes and companies relocate their operations overseas, industrial waste is on the decline. Amita is actively considering expanding its operations overseas as countries institute stricter waste disposal laws, creating a growing need for recycling.

Amita accepts a wide range of waste generated by the manufacturing industry for analysis and uses its proprietary "blending" technology to turn industrial waste into usable alternative raw materials and fuel for cement production plants. Amita has analysis data and simulation experience for more than 4,000 types of waste developed over more than four decades of engagement in the recycling business in Japan which the company uses to resolve issues of instability in terms of the composition, properties, and amount and timing of waste generated, that, when properly blended, can be processed into stable quantities of quality, alternative raw fuel. In 2017, Amita successfully developed and launched a similar business in Malaysia, where it recycles more than 40,000 tonnes of waste annually (developed into a business following a feasibility study under the Ministry of the Environment's "Project for Overseas Expansion of Japanese Waste Management and Recycling Industries").

There are five types of raw materials for cement: limestone, clay, silica, iron oxide materials and gypsum. Producing one tonne (1,000 kg) of cement requires 1,100 kg of limestone, 200 kg of clay, and 100 to 200 kg of other materials. Approximately 120 million tonnes of cement is produced annually in Indonesia, which, if all these materials were produced from natural resources, would require 132 million tonnes of limestone, 24 million tonnes of clay, and 12 to 24 million tonnes of other materials. Therefore, it is likely that with the use of a large amount and variety of waste and byproducts generated in manufacturing processes, and secondary residue generated by off-site recovery operators as alternative raw materials, this project can help reduce the use of natural resources in the production of cement. By the same token, the alternative fuel produced can also help reduce the amount of coal used as fuel in the cement calcination process and effectively contribute to reducing CO_2 emissions.

Indonesia is currently the focus of attention as the world's second largest source of marine plastic litter after China. Plastics, however, are not Indonesia's only issues with waste. In fact, household waste is still transported directly to final disposal sites where it is openly dumped, and the illegal disposal of hazardous industrial waste (category B3) can also be observed. In this project, research was conducted on the potential of developing a new type of business with the aim of contributing to the proper treatment and recycling of B3 waste through the recycling of waste in the cement industry. On 14 August 2020, the Ministry of Environment and Forestry enacted Ministerial Regulation 2020-16 on the "Strategic Plan of the Ministry of Environment and Forestry for 2020-2024". This regulation stipulates the regulatory policies of the Ministry of Environment and Forestry for the five-year period from 2020 to 2024. With the inclusion of a number of new regulations and revisions related to the management of hazardous and toxic materials (B3), it is expected to act as a way to tighten penalties for improper disposal and promote recycling. Indonesia also announced its commitment to achieving carbon neutrality by 2060 with the release of its "Long-Term Strategy for Low Carbon and Climate Resilience 2050" in July 2021, which is certain to increase the country's efforts to reduce CO_2 emissions.

Amita has collaborated with Kitakyushu City on this project since being commissioned by the city on projects to support local small- and medium-sized enterprises (SMEs) in developing environmental businesses in Asia (2020), as well as the development of local sustainable environmental businesses in Kitakyushu (2021). This fiscal year, Amita conducted a survey to review the project with the aim of reaching consensus before the start of the project with a focus on discussions with ITP as a potential partner.

Germany's Heidelberg Materials, ITP's parent company, is a global enterprise that is dedicated to decarbonisation and low-carbon development, with a goal of reducing CO_2 emissions by approximately 50% from 1990 levels by 2030. ITP itself has already achieved a 17% co-firing rate for alternative fuels (rice husks, waste plastics), and is aiming to reach a 43% co-firing ratio by 2030, a progressive goal within the cement industry. Amita has positioned ITP as the company's foremost partner in achieving its business goals in Indonesia, and has engaged in this survey with the goal of implementing a joint feasibility study and reaching consensus between the two companies at the executive management level.

At the G20 Business Summit (B20) held in November 2022, Indonesia announced its aim for Jababeka Industrial Estate to become the first industrial park in Southeast Asia to achieve carbon neutrality by 2050. Amita looks to promote an exchange of ideas with a view to collaboration as this is entirely in line with this project. Jababeka Industrial Estate is also a member of the World Economic Forum's (WEF) Net Zero Cluster, and is the first industrial park in Southeast Asia, out of 11 industrial parks around the world, to announce its intention to go net zero. This project aims to support Jababeka Industrial Estate in its commitment to achieve carbon neutrality through the conversion of sludge from treated wastewater and other B3 waste generated by companies in the park into raw fuel for cement and by examining the potential of new projects with other tenants.

This survey examines the feasibility of applying the Malaysian business model to West Java Province, targeting industrial waste (sludge, incinerated ash, slag, waste catalysts, other) generated from the Jababeka Industrial Estate and other business operators. Amita is already engaged in substantial discussions with Indocement, Jababeka and others to realise the development of this into a business, an indication that the potential for commercialisation is quite high. While production facilities for alternative fuel do not qualify for the JCM Model Projects programme because they are indirectly related to the reduction of energy-derived CO_2 emissions, this is expected to result in the development of a B-to-B relationship because investments can be recovered through low-interest loans even without subsidies.

2.2.1.2. Survey subjects and methods

This fiscal year, the survey team visited Indonesia three times to engage in discussions with partners, collect information on waste and cement, and exchange views on the formulation of policies and guidelines in the country. Information was also collected online and over the telephone.

[Field survey schedule]
Three times (as follows):
- 6 to 8 September 2023
- 13 to 17 November 2023
- 22 to 25 January 2024

[Amita Corporation]
Three persons (as follows):
- Amita Holdings Co., Ltd.: SATO Hiroyuki
- Amita Corporation: YAMATO Eiichi
- Amita Corporation: TOMITA Naohiro

[Details]
Details on the field survey can be found in Table 2.2.1.2.1.

Table 2.2.1.2.1. Outlines of the field survey

Organisations	Objectives
ITP	・Discussions on collaboration ・Discussions on leasing land ・Site visits ・Interviews on current issues ・Exchange of ideas on solutions to issues
Salim Group	・Discussions on collaboration ・Discussions on leasing land
PT. Jababeka Infrastruktur (Jababeka)	・Discussions on collaboration ・Exchange of ideas on the creation of new business ・Interviews on wastewater treatment
PT. Prasadha Pamunah Limbah Industri (PPLi)	・Discussions on collaboration ・Interviews on current issues ・Site visits
PT. Wastec International (WASTEC)	・Discussions on collaboration ・Interviews on current issues
PT. Cemindo Gemilang	・Discussions on collaboration ・Interviews on current issues
The Ministry of Environment and Forestry (KLHK)	・Exchange of ideas on waste problems in Indonesia ・Exchange of ideas on the formulation of guidelines ・Exchange of ideas on obtaining business licenses and permits
The Indonesia Cement Association	・Exchange of ideas on social issues around cement ・Exchange of ideas on the development of guidelines

2.2.1.3. Survey outcomes

2.2.1.3.1. Survey on industrial waste and hazardous waste resources

Indonesia classifies waste into three categories: B3 waste from business activities, non-B3 waste, and household waste. B3 waste is listed in Appendix IX of Government Regulation No. 22 of 2021 on Environmental Protection and Management, while business waste that is not covered is classified as non-B3 waste. There are more than 300 codes for B3 waste, which are classified by two methods: hazardous and source. Hazardous waste is divided into two categories: Category 1, which includes waste that has an immediate harmful effect on human health and the natural environment, and Category 2, which includes waste that has no immediate effect, but has indirect, or long-term harmful effects. In terms of source, waste is divided into three categories, i.e., waste from specified sources (industrial processes), waste from unspecified sources (secondary processes, such as cleaning), and waste left unattended or leaked. Business operators that handle B3 waste must apply for and obtain a permit for all waste codes covered. This project looks at B3 waste from the perspective of profitability.

Since the project includes plans to recycle cement, it targets most B3 waste due to the characteristics of the wide range of waste to be recycled, with the exception of medical or other waste with high heavy metal content.

A recent development worthy of note is that 10 types of waste have been removed from the B3 waste category (Steel Slag, Nickel Slag, Mill scale, EAF Dust, PS Ball, Spent Bleaching Earth <3%, Sand Foundry, &FABA from Coal-powered plant with chain grate stoker, pulverized coal (PC), Circulating Fluidized Bed (CFB) technologies).

The total amount of B3 waste generated in Indonesia is estimated to be about 77 million tonnes/year, with both the amount generated and treated on the rise. Although it has been argued that aggregated data is more accurate with the requirement for digital manifests since 2020, there is some concern that data may be counted twice between paper and electronic manifests, so care must be taken when confirming recent figures as well. Figures also include the amount of waste generated at mining sites and disposed and treated on site, although these are not considered to be within the scope of the project at this time, especially since this waste will not be outsourced for processing. Amita has estimated that the current amount of B3 waste generated by the manufacturing industry in Indonesia is 2.5 million tonnes/year, based on their own interviews and industrial data, and believes that this figure represents the market size for waste throughout Indonesia that could be targeted for a JV.

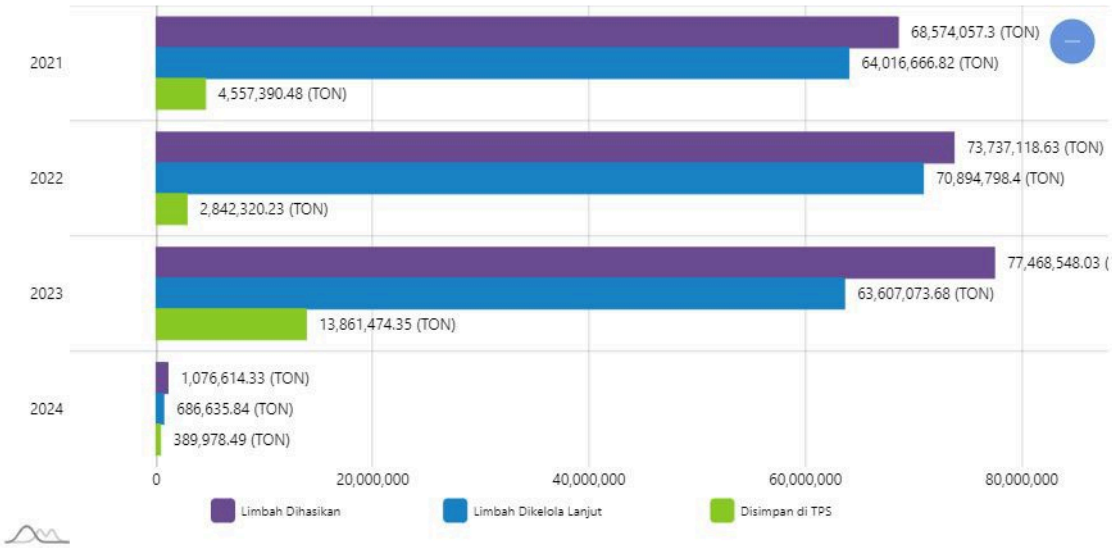


Figure 2.2.1.3.1. Solid waste generation (B3) in Indonesia
(Source: KLHK HP[16])

The project has narrowed its focus to West Java Province and surrounding areas, as Amita is also looking ahead to delivering waste to ITP's Citeureup plant in Bogor Regency (West Java Province). During a survey on the size of the market, data from BPS-Statistics Indonesia confirmed that about half of the country's manufacturing industries are located in the Special Capital Region of Jakarta, West Java Province, and Banten Province. The team was also able to confirm that a number of manufacturing companies, mostly in the automotive industry, have plants in areas between Bekasi and Karawang, with many chemical factories in operation in Cilegon. As shown in Figures 2.2.1.3.2 and 2.2.1.3.3, most Japanese companies in Indonesia are involved in the automotive sector and are also

[16] KLHK website: https://pslb3.menlhk.go.id/dashboard/pengelolaanLimbahB3 (Accessed 18 January 2024)

located in the Special Capital Region of Jakarta and West Java Province. Therefore, this region can be considered to have the largest market potential in terms of the volume of waste generated.

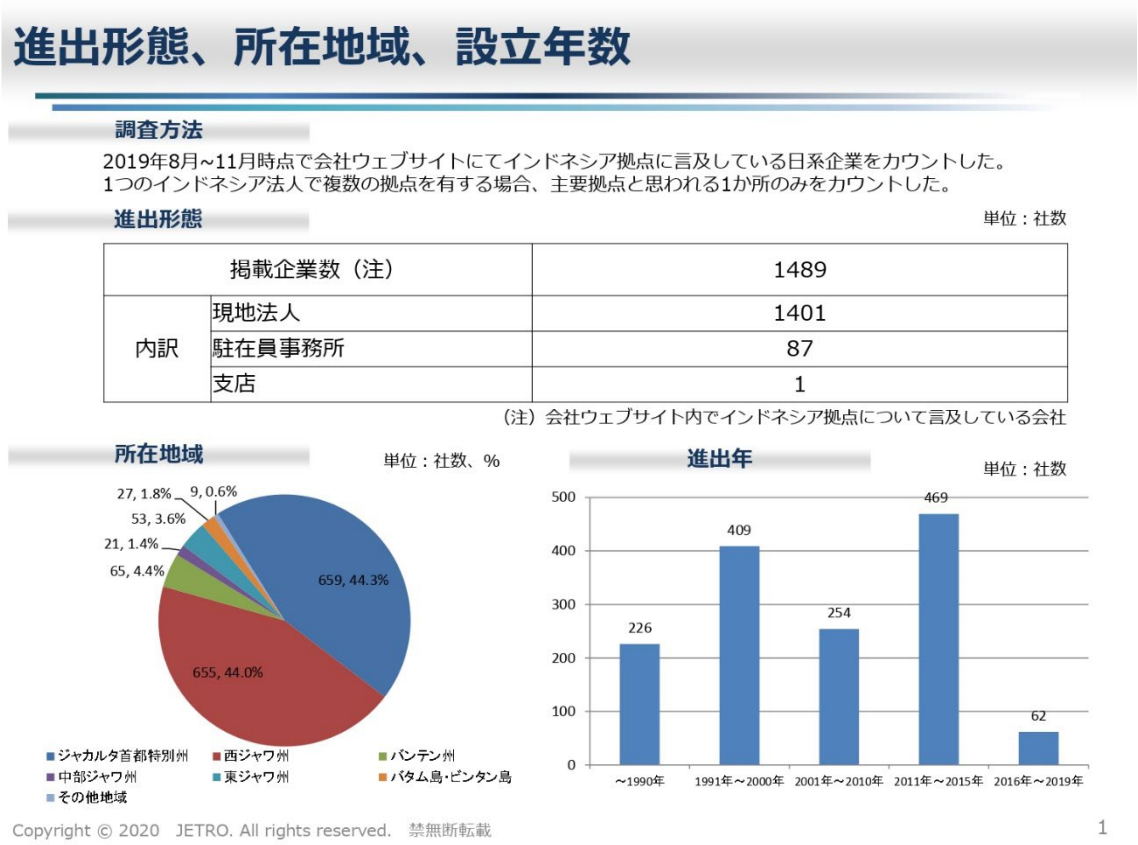


Figure 2.2.1.3.2. Location of Japanese companies in Indonesia
(Source: JETRO[17])

[17] JETRO Jakarta Office, “List of Japanese companies in Indonesia”, January 2020.

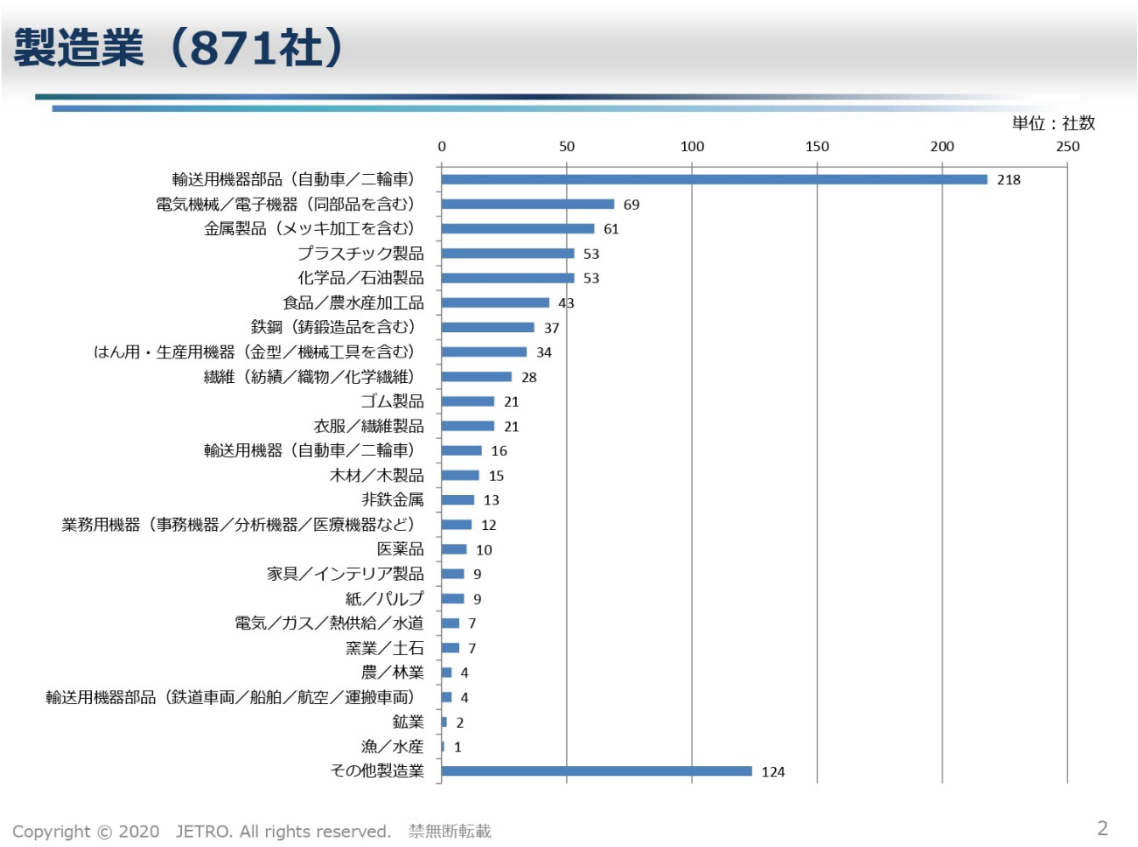


Figure 2.2.1.3.3. Breakdown of Japanese companies in Indonesia by industry (Source: JETRO[18])

The team conducted on-site surveys of waste generators to collect information on the volume and type of waste generated, contractors used to treat waste, processing unit prices, and current issues in terms of treatment, in order to gain an understanding of the needs of these business operators. The companies visited during these surveys expressed a strong need to reduce costs, information and training on proper disposal, and improving recycling rates, and indicated a desire to take part in this project. Below are a few specific examples. As shown in Table 2.2.1.3.1, the team also confirmed that waste generated by each company was as expected prior to the start of the survey.

- Household goods manufacturer: Current costs for disposal are too high and they would be happy to outsource disposal to a contractor that could guarantee proper disposal at lower costs.
- Chemical plant: The company has a zero-landfill waste target and would like to consider proposals for recycling.
- Automobile parts factory: The staff in charge of the environment feels that it is important to recycle and would like to outsource this if possible to use resources more effectively.

[18] JETRO Jakarta Office, “List of Japanese companies in Indonesia”, January 2020.

Table 2.2.1.3.1. Results from on-site surveys

Company and waste type	Quantity generated/month
Foreign corporations (other than Japanese companies)	**120.9 t/month**
Company A	**10.0 t/month**
Waste A	10.0 t/month
Company B	**20.0 t/month**
Waste B	20.0 t/month
Company C	**12.0 t/month**
Waste C	12.0 t/month
Company D	**45.0 t/month**
Waste B	45.0 t/month
Company E	**3.9 t/month**
Waste D	0.6 t/month
Waste E	3.0 t/month
Waste F	0.3 t/month
Company F	**30.0 t/month**
Waste G	30.0 t/month
Japanese companies	**1,315.2 t/month**
Company G	**1.6 t/month**
Waste D	0.8 t/month
Waste H	0.8 t/month
Company H	**45.0 t/month**
Waste I	30.0 t/month
Waste J	7.0 t/month
Waste K	2.0 t/month
Waste L	1.0 t/month
Waste M	5.0 t/month
Company I	**0.1 t/month**
Waste G	0.1 t/month
Company J	**0.1 t/month**
Waste D	0.0 t/month
Waste E	0.1 t/month
Waste N	0.0 t/month
Company K	**70.0 t/month**
Waste O	25.0 t/month
Waste P	20.0 t/month
Waste G	25.0 t/month
Company L	**20.0 t/month**
Waste B	20.0 t/month
Company M	**12.0 t/month**
Waste B	12.0 t/month
Company N	**15.0 t/month**
Waste Q	15.0 t/month
Company O	**546.0 t/month**
Waste R	8.0 t/month
Waste S	500.0 t/month
Waste T	8.0 t/month
Waste G	30.0 t/month

Company P	**24.0 t/month**
Waste U	4.0 t/month
Waste V	20.0 t/month
Company Q	**3.7 t/month**
Waste E	3.7 t/month
Waste W	0.0 t/month
Company R	**0.0 t/month**
Waste X	0.0 t/month
Waste Y	0.0 t/month
Company S	**0.1 t/month**
Waste Z	0.1 t/month
Company T	**20.0 t/month**
Waste AA	9.0 t/month
Waste AB	4.0 t/month
Waste AC	7.0 t/month
Company U	**7.6 t/month**
Waste X	0.3 t/month
Waste AD	7.0 t/month
Waste AE	0.3 t/month
Company V	**60.0 t/month**
Waste AF	60.0 t/month
Company W	**52.0 t/month**
Waste O	7.0 t/month
Waste AG	35.0 t/month
Waste G	10.0 t/month
Company X	**20.0 t/month**
Waste G	20.0 t/month
Company Y	**12.0 t/month**
Waste G	12.0 t/month
Company Z	**400.0 t/month**
Waste B	400.0 t/month
Company AA	**6.0 t/month**
Waste AH	6.0 t/month
Local companies	**109.0 t/month**
Company AB	**1.0 t/month**
Waste AI	1.0 t/month
Company AC	**0.0 t/month**
Waste B	0.0 t/month
Waste AJ	0.0 t/month
Waste G	0.0 t/month
Company AD	**5.0 t/month**
Waste G	5.0 t/month
Company AE	**75.0 t/month**
Waste AK	75.0 t/month
Company AF	**10.0 t/month**
Waste C	10.0 t/month
Company AG	**10.0 t/month**
Waste V	10.0 t/month
Company AH	**4.0 t/month**
Waste I	4.0 t/month
Company AI	**4.0 t/month**
Waste AL	4.0 t/month
Total	**1,545.1 t/month**

2.2.1.3.2. Survey on demand for hazardous waste as fuel to produce cement

The Joko Widodo administration has adopted a national policy of improving the financial content, revenue and profitability of state-owned companies, as well as a strategy to merge cement companies that play an essential role in the expansion of infrastructure projects. This has resulted in several local companies becoming part of the Semen Indonesia Group (SIG). After the takeover of formerly British-owned Blue Circle Cement in Aceh by the French, Lafarge and Swiss-owned Holcim, which had factories in West and Central Java provinces, merged to form Lafarge-Holcim, with Holderfen of the Netherlands as its primary shareholder. State-owned PT Semen Indonesia Industri Bangunan (SIIB) acquired Lafarge-Holcim in 2019, renaming it PT Solusi Bangun Indonesia (SBI). Taiheiyo Cement (TCC) subsequently acquired a 15% stake in SIIB. Prior to 2019, the private companies of ITP, Semen Indonesia and SBI (formerly known as Holcim-Lafarge) accounted for more than half of sales nationwide. The merger between SIIB and SBI in 2019 created an enormous state-owned cement group with market shares of 35.5% for SIG (Semen Indonesia Group) and 25.5% for ITP.

Founded in 1975 in Citeureup (West Java Province), ITP celebrated its 45th anniversary in 2020. The company has an annual production capacity of 500,000 tonnes/year, later merging with six other companies in its current form. ITP increased its manufacturing capacity to 7.7 million tonnes over a decade and was listed on the Jakarta Stock Exchange in 1989. The company acquired a factory in Central Java in 1991, and Germany's Heidelberg became the main shareholder following the Asian financial crisis in 1997 and 1998. With the acquisition of Semen Grobogan in December 2023, ITP's performance has been growing at a steady pace. Production at its Citeureup plant is one of the largest in the world.

The growth rate of demand for cement in Indonesia is currently negative, with a rate of -4.4% in 2022 compared to that in 2021. Lower consumer purchasing power due to higher inflation (5.51% year on year in December 2022, mainly driven by higher fuel prices) has slowed demand (especially in the retail market) since the second quarter of 2022. However, long-term demand is trending upward, with demand for cement in 2023 projected to be 3% higher than in 2022. Although the overall rate of operation of cement plants in Indonesia has been around 60%, it is expected to be 55% in 2023.

In comparison to Japan's current level of demand for cement which has fallen below 40 million tonnes per year since the market contracted, annual demand for cement in Indonesia is approximately 65 million tonnes. Add to this the fact that the cement industry is still in its growth phase, it is clear that cement recycling is an important sector.

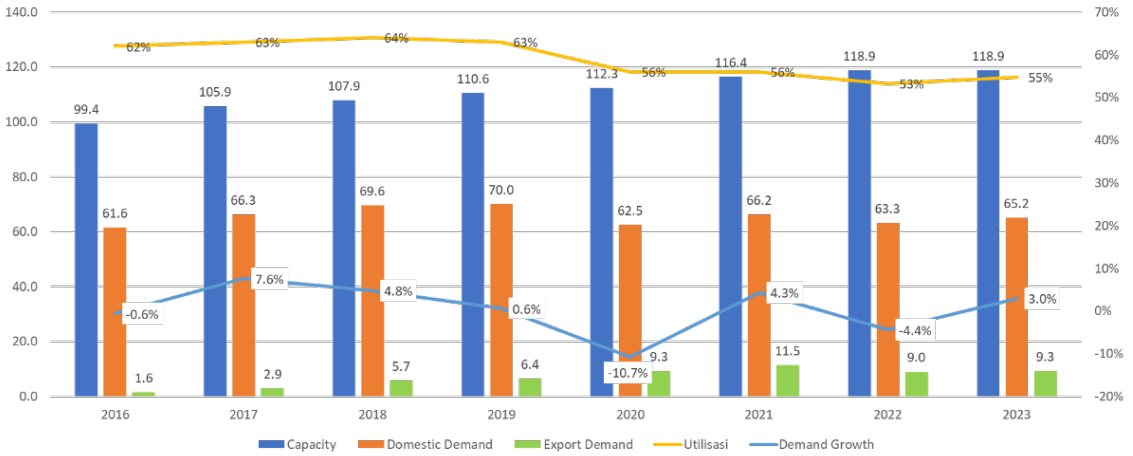


Figure 2.2.1.3.4. Generation of B3 waste in Indonesia
(Source: Indonesia Cement Association[19])

19 Indonesia Cement Association, "Readiness of Decarbonization in the Cement Industry in Indonesia: Issue and Challenge"

The cement industry's impact on decarbonisation is extremely significant. A source-by-source comparison chart of global CO_2 emissions by industry in Figure 2.2.1.3.5 shows that the cement industry contributes about 7% of total CO_2 emissions. In the same fashion, the cement industry in Indonesia accounts for 10% of total CO_2 emissions from industries. Furthermore, if cement manufacturing processes are broken down into several phases, from the procurement of raw materials to production and shipment, it is apparent that 7% of CO_2 emissions are generated from quarries where raw materials are procured and 85% is generated in the cement calcination process flow. In other words, the production and supply of alternative materials for limestone and clay, and alternative fuel for coal can help reduce these CO_2 emissions.

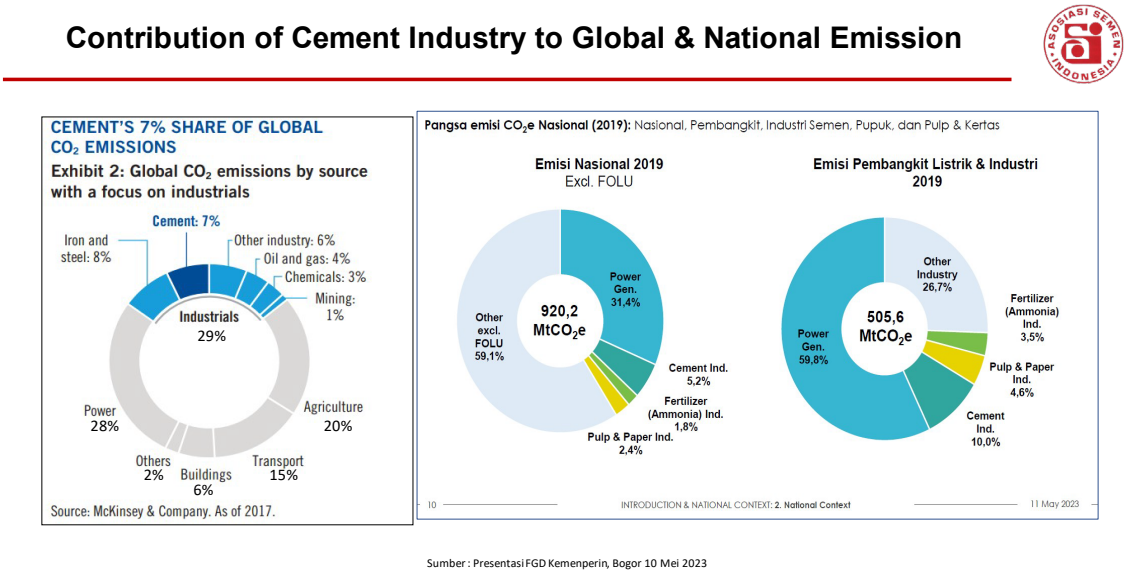


Figure 2.2.1.3.5. Percentage of CO_2 emissions from the cement industry (Source: Indonesia Cement Association[20])

[20] Indonesia Cement Association, "Readiness of Decarbonization in the Cement Industry in Indonesia: Issue and Challenge"

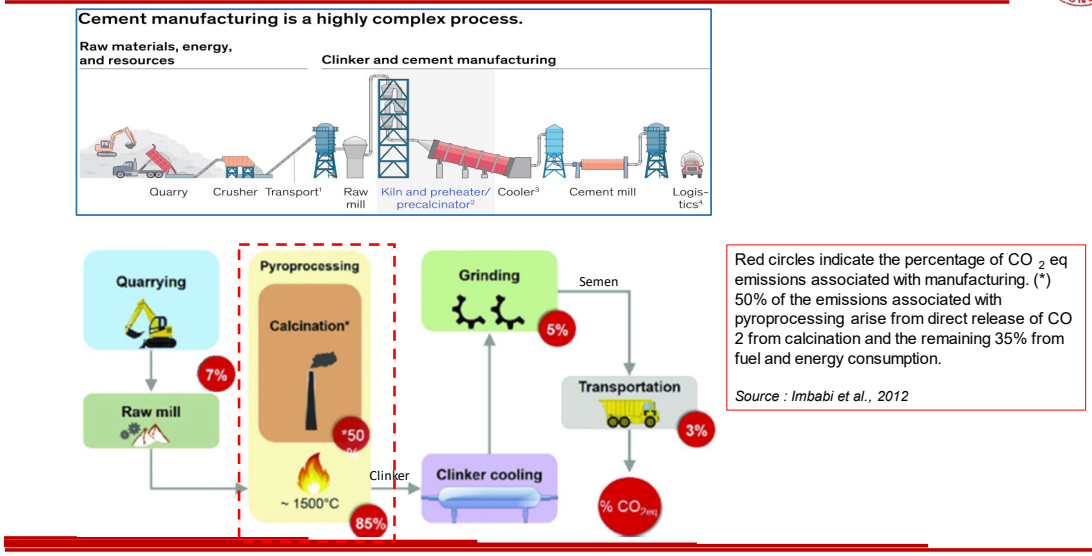


Figure 2.2.1.3.6. Sources of CO_2 within the cement production flow
(Source: Indonesia Cement Association[21])

According to information from interviews with the ICA, the percentage of alternative fuel used by the cement industry in Indonesia is 7.8% (as of 2022). At this time, there are no targets in place for the percentage of alternative fuel to be used. There is a move to incorporate a target percentage within CO_2 reduction targets set for each industry in order to achieve Indonesia's overall decarbonisation goal of net zero CO_2 emissions by 2060, although the view is that it would be difficult to set uniform targets because of differences in the level of difficulty in acquiring alternative materials in different areas.

ITP is committed to implementing reclamation and afforestation programmes at its operating and mining sites. In order to mitigate adverse impacts on biodiversity, mining is planned and implemented and areas are reclaimed in accordance with Regulation No. 7 of 2014 by the Minister of Energy and Mineral Resources and in line with established environmental documentation formats, such as environmental impact assessments (AMDAL), environmental management plans/environmental monitoring plans (RKL/RPL), RKAB, landfill plans, and quarterly reports. Reclamation activities include land management (soil preparation), afforestation, erosion and sedimentation control, and maintenance/management of vegetation. Reclamation activities also take local biodiversity conservation programmes into account when returning land back to its original condition.[22]

ITP's management system for accepting waste is based on an analysis of the raw materials on each incoming truck and product analysis for certain product badges. Conditions for accepting waste are set based on licensing conditions and negotiations with individual companies. ITP only accepts waste materials that meet these standards. Recent issues that ITP has faced include difficulties handling waste due to contamination with foreign materials and restrictions on chlorine and other components. ITP's expectations of Amita's business development aims have also been reflected in its commitment to increasing the volume of quality waste it receives that can be processed in a stable manner.

21 Indonesia Cement Association, "Readiness of Decarbonization in the Cement Industry in Indonesia: Issue and Challenge".

22 ITP website: https://indocement.co.id/Keberlanjutan/Kebijakan-dan-Program/Pelestarian-Lingkungan-Hidup (Accessed 11 February 2024).

2.2.1.3.3. Actual hazardous waste treatment conditions and competitors

While investment in Indonesia opened up to promote economic growth, so too did the use of B3 waste as materials in business activities in different sectors. This resulted in an increase in illegal dumping of B3 waste, which according to the provisions set out in "Law No.32/2009 on Environmental Protection and Management" and "Governmental Regulation No. 101/2014 on B3 Waste Management", must be properly disposed of, and if managed poorly, can cause any number of environmental problems. Some examples of problems that have occurred include illegal dumping of B3 waste, temporary storage areas for B3 waste that do not meet technical requirements, leakage of B3 waste from storage areas due to technical or aging factors, overcapacity in B3 waste storage areas, and negligence in the management of B3 waste causing emergency conditions in areas such as Banten Province, Special Capital Region of Jakarta, West Java Province, East Java Province, North Sulawesi Province, South Sumatra Province, Riau Province and Kalimantan Island.

Problems with B3 waste can lead to environmental contamination or the generation of contaminants and cause water, soil and even air quality to degrade. Impacts are not only limited to the environment; they can also affect human life and health. According to Indonesia's Ministry of Environment and Forestry's database, in 2019, the size of the area contaminated by B3 waste was 1,117,161.76 m^2 and the weight of B3 waste and contaminated soil was 1,239,756.56 tonnes. In addition to the occurrence of on-site contamination incidents, a total of 40 emergencies related to B3 waste from different business activities have been recorded through July 2019. KLHK has been directly involved in handling 10 of these cases, while business operators managed by local governments have responded directly in other cases. Reports on responses must be submitted in writing on a regular basis to the Minister of Environment and Forestry, the provincial governor, and regency governor/mayor, as stipulated in the provisions of Governmental Regulation 10/2014.

Amita also conducted an independent on-site survey of waste processors (platformers) that produce alternative raw materials and fuel for cement. Although some platformers are already in business, all are relatively inexperienced, and none have been able to supply alternative fuel with the quality ITP requires. All of the five companies the team visited to check their sites lacked adequate quality control and product mixing capabilities. All of the platformers responded that their experience was limited and that they were interested in Amita's experience and technologies.

2.2.1.3.4. Survey on related regulations and licenses

The Indonesian government enacted Law No. 11 of 2020 on Job Creation ("Omnibus Law"), to attract investment and create jobs. In response to this, the government started working on improving the business environment by clarifying legal regulations and simplifying the permit and licensing process. For example, they have put the process of acquiring permits and licenses online (OSS system), integrated a number of unsystematic laws and regulations (revised 76 laws and regulations and allowed two to expire), and created a system that emphasises the monitoring process, rather than the acquisition of multiple permits. Processes were also centralised in competent ministries at the same time, with the central government the fundamental location of authority.

Penalties for violations are shown in Table 2.2.1.3.6. In 2020, it became mandatory for companies to use digital manifests and equip trucks transporting waste with GPS systems so they could be tracked. In addition, the budget for enforcing laws and regulations has increased about 1.5 times from approximately Rp 2 billion in 2015 to about Rp 3 billion in 2021 as seen in Table 2.2.1.3.7, an indication that enforcement of such laws and regulations is being strengthened.

Table 2.2.1.3.6. Laws and regulations on B3 waste in Indonesia
(*Table created by survey team based on information from local consultants)

Laws and ordinances	Offender	Penalty
Environmental Protection Act No. 9 of 2009	Article 102: Any person involved in the management of B3 waste without a permit Article 103: Any person who fails to properly manage B3 waste	Fine between Rp 1 billion and Rp 3 billion, and imprisonment between 1 and 3 years
	Article 106: Any person who imports B3 waste without a permit	Fine between Rp 4 billion and Rp 12 billion, and imprisonment between 1 and 3 years
Law No. 11 of 2020	Article 98: Any person who wilfully causes air, water, marine, or other type of environmental pollution	Fine between Rp 3 billion and Rp 10 billion, or imprisonment between 3 and 10 years
Governmental Regulation No. 22 of 2021	Article 514 paragraph 1 letter a.: Corporations that have only a business licence, but not environmental permit	Article 515: 2.5% of the investment, with a maximum fine of Rp 3 billion
	Article 514 Paragraph 1 letter b. Corporations that have neither an environmental permit, nor a business license	Article 516: 5% of the investment, with a maximum fine of Rp 3 billion
	Article 514 paragraph 1 letter c. Corporations that wilfully cause air, water, marine, or other type of environmental pollution	Article 517: Fine of Rp 3 billion
	Article 514 paragraph 1 letter d. Corporations that do not fulfil business obligations associated with environmental permits	Article 518: Fines between Rp 1 billion and Rp 5 billion for minor offenses, between Rp 10 billion and Rp 15 billion for medium-scale offenses, and between Rp 20 billion and Rp 25 billion for serious offenses
	Article 514 paragraph 1 letter e. Corporations that did not have an authorised individual present when AMDAL was acquired	Article 519: Fine of 10% of AMDAL preparation costs
	Article 514 paragraph f. Corporations that wilfully cause air, water, marine, or other environmental pollution in dereliction of duty	Article 520: Fine up to Rp 3 billion

Table 2.2.1.3.7. Number of violations and arrests related to B3 waste and national budget (Source: KLHK[23])

FY	Number of cases handled by environmental authorities							Budget (Rp billion)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
2015	238	5	48	118	25	56	4	219.98
2016	597	10	220	150	40	301	3	203.02
2017	1094	9	126	134	39	631	4	212.28
2018	1428	11	158	166	23	917	2	359.14
2019	700	8	182	156	13	100	2	445.91
2020	829	6	40	26	34	90	2	310.14
2021	505	22	*	3	*	*	*	293.50*

(1) Number of environmental assessments, (2) Number of court cases, (3) Number of fines, (4) Number of arrests for violations, (5) Number of court settlements, (6) Number of industrial pollution incidents, (7) Number of arrests for pollution incidents

The process for obtaining a permit or license involves completing basic business registration, an environmental impact analysis (AMDAL), and acquiring a construction permit before buildings can be constructed and operations can begin. First, a company must complete procedures to establish a corporation and acquire a business number (NIB), and then proceed to the steps for obtaining a permit (below). Businesses are expected to start operations approximately three years after registration is completed.

(1) Land use permit (4 to 5 months)
Applications to be submitted to the Ministry of Investment and Bogor Land Office.
(2) Engineering permit/PRETEK (period unknown)
Can be prepared at the same time as the land use permit in (1).
(3) Public briefing (period unknown)
Dialogue and consultation with residents in surrounding areas. Can be prepared at the same time as the land use permit in (1). Requires a minimum posting period of 10 days. List of concerns from briefings and interviews with residents in surrounding areas and report to be attached to the Appendix of implementation plan. If multiple communities are located in the vicinity, public briefings should be conducted for all of them.
(4) Preliminary AMDAL (2 to 3 months)
Application should be submitted to KLHK's AMDAL office. Time required depends on the content of application documents and competence of consultants. Therefore, consultants should be carefully selected from the PTSP (list of qualified consultants). A technical meeting should be held at this stage with the following participants: the applicant (Amita), consultants, experts, and related ministries.
(5) Traffic impact assessment (4 months)
Application should be submitted to the Ministry of Transportation. Approval must be obtained before the AMDAL application is submitted.
(6) Preparation of AMDAL documents (period unknown)
Put together application documents, including results from the traffic impact assessment in (5) and prepare the AMDAL application for submission.
(7) AMDAL (2 to 3 months at the earliest, usually 6 to 7 months, 12 months in worst case scenario)
The application should be submitted to KLHK's AMDAL office. Two meetings will be held at this stage. The first will be attended by experts and relevant ministries (same as those in (3)). The second meeting will be with communities located in areas around the factory (all communities near the factory) with the same participants as those in (3). KLHK will organise both meetings,

[23]KLHK: DG of Law Enforcements Annual Report 2021

and dates/times will be specified within one to two weeks after the AMDAL application is submitted. The applicant will receive revision notes after the second meeting (within 50 days according to regulations). Once the applicant revises and resubmits the documents based on the revision notes, a second review will be conducted (multiple reviews may be conducted as needed). The competence of the consultant is important here as the schedule can be significantly affected by how quickly and accurately information can be revised.

(8) Building permit (3 to 4 months)
The application should be submitted to the Public Works Office of Bogor Regency.

(9) Construction and start of operations
After the steps in (8) are completed, construction can finally start on the building, with operations starting as soon as facilities are completed. The B3 Waste Department will monitor operations every six months after the start date.

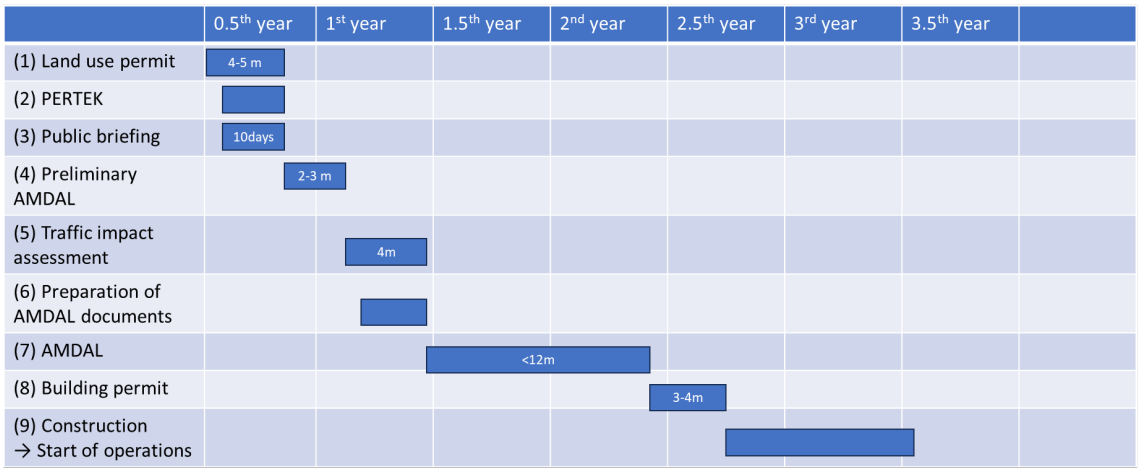


Figure 2.2.1.3.8. Timeline for acquiring permits and approval
(Source: Table created by survey team based on information from KLHK)

2.2.2. Consideration of business feasibility

2.2.2.1. Progressing to business development

(1) Progress of JV with ITP

Amita has continued to exchange ideas in an open dialogue with ITP. First, market research was conducted in order to develop the feasibility study. Existing waste items to be accepted were carefully examined, reviewed drop lists were checked and reconsidered, new items for consideration were organised, appointments were made with clients, and visits were conducted. Interviews were conducted on-site to sort out existing issues, check the quality of raw materials, calculate acceptable levels of capacity together with Tokuyama Corporation, and consider proposals on improving the environment for receiving waste. CAPEX and OPEX were also calculated based on ITP's track record and included in the feasibility study, and a financial assessment was conducted on waste receiving prices and volume × land and facilities, which was divided up into optimistic, realistic and pessimistic scenarios, which confirmed that the business was sufficiently attractive in terms of figures.

Next, discussions are progressing on the establishment of a JV based on the completed F/S. With the potential for business development drawing attention, discussions have expanded out to other companies with connections to ITP and joint discussions are continuing with a look ahead at the possibility of collaboration among three companies.

(2) Progress of development of MOU with Jababeka

Amita has been in discussions with Jababeka to examine sludge generated from wastewater treatment, recycling of waste generated by tenant companies in the industrial park, and the possibility of developing different businesses around waste. The two companies signed an MOU in October and have been working together to exchange detailed information. Potential businesses include the development of a digital platform based on the same concept as the AMITA Smart Eco service offered by the company in Japan (Figure 2.2.2.1), and a business plan for a circular platform targeting household waste that comprehensively integrates Amita's MEGURU platform in Japan and existing platforms, such as the waste bank already in operation on-site (Figure 2.2.2.2.).

However, the progress of the survey has been impacted by a major internal reorganisation within Jababeka on 1 January 2024. The future direction of this project will need to be confirmed with the new department, and is expected to take longer than expected, although this will need to be examined in the next fiscal year or later.

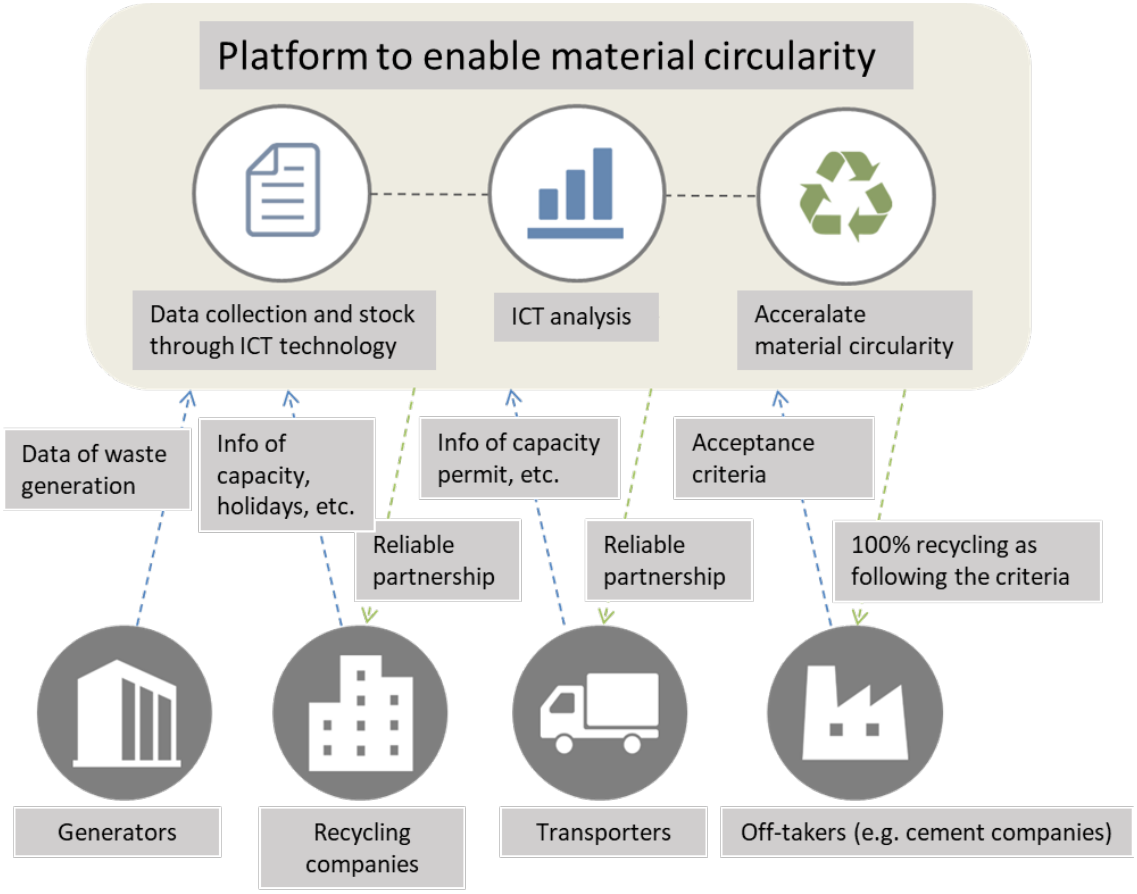


Figure 2.2.2.1. Draft plan for digital platform project
(Source: Figure created by survey team)

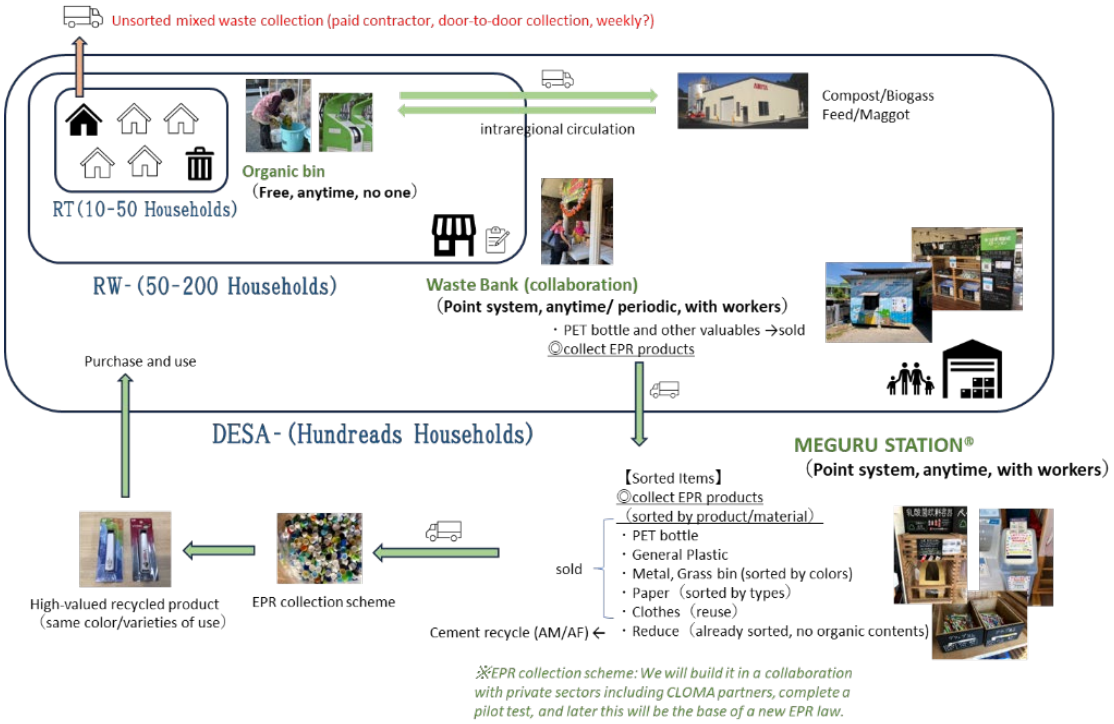


Figure 2.2.2.2. Circular platform plan in Indonesia
(Source: Figure created by survey team)

2.2.2.2. Projected business model

A draft plan for this business model follows below. The plan includes details on the production of alternative fuel for cement plants using solid and liquid waste, such as sludge from wastewater treatment, incinerator ash, dust, waste activated carbon, waste oil, waste acid, waste alkali and others generated by manufacturing plants in West Java Province, Special Capital Region of Jakarta, Banten Province and other regions in western Java, with a tentative scale of introduction.

[Scale of introduction]

1. Production of AFAM (solid)
   Site area: 20,000 m^2
   Processing capacity: 8,000t/month
   * Use of building, facilities and equipment currently in operation.

2. Production of AF (liquid)
   Site area: 7,500 m^2
   Processing capacity: 3,000t/month
   * Based on building facility standards at Amita Ibaraki Plant.

[Types of waste to be treated]
The following B3 wastes generated from a range of manufacturing plants will be treated: sludge from wastewater treatment, incinerator ash, dust, waste activated carbon, waste oil, waste acid, waste alkali and others.

2.2.2.3. Challenges related to business development and future direction

Challenge 1: Market survey on liquid waste

This fiscal year, the survey focused on solid B3 waste. However, over the course of the survey, Amita found that there was a strong market need for liquid B3 waste and have started a recycling business for liquid waste. Over the next fiscal year, Amita will move ahead with market research on liquid B3 waste, put user (ITP) standards into place, and examine the equipment that needs to be installed. Little progress has been made on the introduction of facilities for receiving liquid B3 waste by ITP in comparison with Japan, so it will be necessary to examine the introduction of such facilities at ITP as well.

Challenge 2: Linkages and collaboration with existing platforms

From this fiscal year, the team has exchanged with existing platforms to identify Amita's competitive advantages in Indonesia. Amita's strategy for expansion into Indonesia is to move into the market and engage with existing companies as much as possible. Amita believes that assuring the quality of alternative materials for cement is a challenge that all local platformers face and that the company's 40-plus years of experience can be utilised in this respect. Amita will continue to optimise treatment flow, including transportation, and develop business schemes to resolve issues that local companies face.

Challenge 3: Discussions with partners to establish a JV

Discussions are currently in progress with ITP and a company with connections to ITP on the likely establishment of a JV. Amita will work over the next fiscal year to reach consensus on the groups involved, investment ratio and division of roles, as well as obtain agreement on the use of land around ITP in relation to site selection.

Challenge 4: Actions to acquire permits and approvals

Amita will exchange ideas with the KLHK AMDAL office and environmental consultants to ensure the smooth acquisition of permits and approvals. The team will need to clarify the next steps in the process, including the organisation of items that can be submitted for application at the same time.

Challenge 5: Assistance in developing guidelines for proper treatment of waste

Amita will strengthen cooperation with the Indonesia Cement Association and KLHK to prevent the illegal dumping of B3 waste and promote proper treatment. The team would like to use Japan's expertise to help develop the guidelines, which are currently being formulated in a timely manner.

Challenge 6: Securing a stable supply of waste

Amita will now start to move ahead at full speed to secure incoming waste in preparation for the start of operations. It will be necessary to establish a scheme for collaboration with existing platforms and to organise sampling and expected transactional conditions.

In addition to the above six challenges, the F/S, facility design and other conditions will need to be closely examined. With the assumption that it will take approximately three years to obtain permits and licenses, Amita will first work on securing the market and engage in discussions with KLHK and consultants to gain consensus on existing investment schemes.

2.3. Survey on converting general waste into cement fuel and compost

2.3.1. On-site survey

2.3.1.1. Survey background and objectives

(1) Background and objectives

Beetle provides intermediate treatment services for industrial waste in Kitakyushu City. With its involvement in demonstration projects on the installation and operation of general waste separation and composting facilities in Surabaya through Nishihara Shoji, a key player in the group company, Beetle has explored different avenues of scaling up these activities to develop intermediate treatment operations for general waste in Indonesia since 2016.

The focus at the outset of activities was the introduction of an intermediate treatment facility (capacity: approximately 100 to 200 t/d) that would combine the separation of general waste with the collection of recyclable waste and composting. However, this idea was abandoned because it was determined that it would be complicated to ensure the viability of the business in the face of difficulties in acquiring processing (tipping) fees from the municipal budget or that these fees would be too low, and challenges in terms of selling the compost produced. Soon after, Indonesia's first facility for refuse derived fuels (RDF) started operations in Cilacap Regency in Central Java Province in 2020. With momentum growing for the demand of RDF as an alternative fuel to coal, the group examined the potential for producing compost and RPF[24] simultaneously, which has a higher calorific value than typical RDF. To date, this concept has been proposed and coordinated in Karawang Regency (West Java Province), Bandar Lampung City (Lampung Province), and Padang City (West Sumatra Province), but has yet to move onto the next stage.

Table 2.3.1.1.1 provides an overview of Nishihara Shoji and Beetle's track record of achievements in Indonesia and background on activities.

Table 2.3.1.1.1. Track record of achievements and background of activities by Nishihara Shoji and Beetle in Indonesia (Source: Survey team)

Year	Activities
2013	Installation and start of operations of the Super Depo waste separation facility in Surabaya City (project subsidised by the Ministry of Foreign Affairs) (Figure 2.3.1.1.1)
2014	Installation and start of operations of the Wonorejo composting centre (processing capacity: 20 t/d) in Surabaya City (JICA verification survey) (Figure 2.3.1.1.1)
2016	Feasibility study on a large-scale intermediate treatment facility in Surabaya City (Ministry of the Environment of Japan's support program on Overseas Expansion of Japanese Waste Management and Recycling Industry)
2017	Feasibility study on a large-scale intermediate treatment facility in Balikpapan City (Ministry of the Environment of Japan's support program on Overseas Expansion of Japanese Waste Management and Recycling Industry) (Figure 2.3.1.1.2)
2018	Follow-up survey in Balikpapan City (subsidised by Kitakyushu City)
2020	Survey on the introduction of an intermediate treatment facility for converting municipal waste into RPF and compost in Karawang Regency and Bandar Lampung City
2021 2022	Survey on the introduction of an intermediate treatment facility (capacity: 300 t/d) for converting municipal waste into RPF and compost in Padang City
2023	Participation in this survey

[24] Japan RPF Industry Association: "RPF" is an abbreviation for Refuse derived paper and plastics densified Fuel, which is a high-grade solid recovery fuel primarily composed of waste paper and waste plastics from mostly industrial waste for which material recycling is quite difficult. (Definition provided by the Japan RPF Industry Association, https://www.jrpf.gr.jp/rpf-1)

The purpose of this survey was to examine the feasibility of Beetle's involvement in a project to achieve the simultaneous production of RPF and compost from municipal waste in West Java Province through intermediate treatment.

Figure 2.3.1.1.1. Super Depo waste separation facility (left) and Wonorejo composting centre (right), installed and operated by Beetle in Surabaya City (Photos courtesy of Nishihara Shoji)

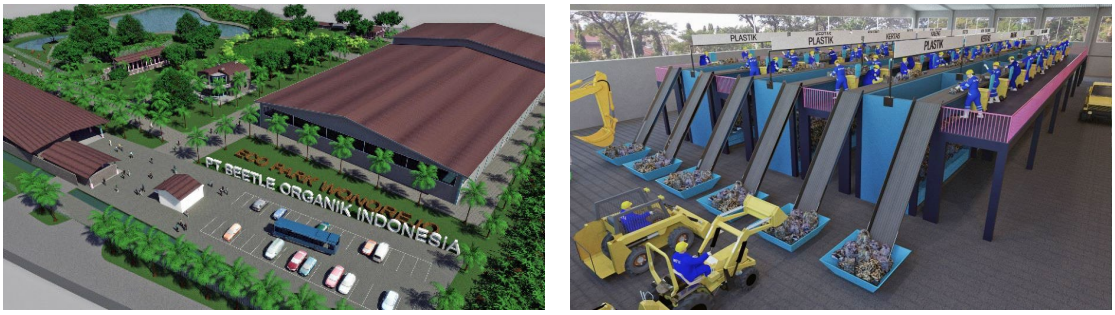


Figure 2.3.1.1.2. Computer-generated image of the large-scale intermediate treatment facility considered for Balikpapan City (Photos courtesy of Nishihara Shoji)

(2) Project concept

This project focuses on improving the viability of this business by scaling up the processing capacity of the intermediate treatment facility demonstration project by Beetle in Surabaya City and increasing the value of the resources output from operations.

The processes used in facilities that produce RDF are relatively simple and include sorting, crushing, sifting, drying, compressing and packaging. Since RDF is already used as fuel in existing cement plants and boilers, both initial and running costs are lower than those for incineration and gasification facilities, which offers a strong economic advantage (Figure 2.3.1.1.3).[25]

[25] PAGE (2021) Policy recommendation: rapid assessment on the effectiveness of green stimulus in the waste sector: https://www.un-page.org/static/14a3c187a005e4f3c3fa7bd9379869c6/2021-indonesia-rapid-assessment-on-the-effectiveness-of-green-stimulus-in-the-waste-sector-in-indonesia-2021.pdf

Type of Technologies	Initial Investment Cost (in IDR)	Capital cost (in IDR per ton)	O&M cost (in IDR per ton)	Total Cost (in IDR per ton)
RDF	85 - 425 B	170.000 - 425.000	170.000 - 340.000	340.000 - 765.000
Incinerator	510 B - 1.275 T	374.000 - 935.000	340.000 - 595.000	714.000 - 1.53 M
Gasification	1.36 T - 2.04 T	595.000 - 765.000	595.000 - 680.000	1.1 - 1.46 M
Anaerobic Digestion	240 T - 340 T	204.000 - 323.000	170.000 - 255.000	374.000 - 578.000

Source: Waste to Energy Option in MSWM, GIZ, 2017.

Figure 2.3.1.1.3. Comparison of Waste Management Cost (Source: PAGE, 2021)

RDF is a fluff fuel material commonly produced and consumed in Indonesia that is dried and shredded after valuable and foreign materials are removed and organic waste is mixed in. RDF is considered to fall under "RDF-3", one of seven RDF categories defined by the American Society for Testing and Materials (ASTM)[26]. According to information acquired through interviews during this survey, this type of RDF has a low calorific value (max. 3,000 kcal/kg). This contrasts with the RDF proposed by Beetle, which also falls under the RDF-3 category, but has a higher calorific value that does not contain organic waste.

Combining the sorting, recycling, and composting processes, as implemented by Beetle in Surabaya City, will make it possible to separate out and compost food waste that has a high moisture content and ship out the remaining combustible waste (plastic, paper, cloth, rubber, other) for use as high-calorie RDF (5,000 kcal/kg or more). This is similar to RPF, a solid waste fuel produced from plastic and paper that is commonly used in Japan (Table 2.3.1.1.2). RPF has a number of advantages: it has a lower chlorine content than RDF, which can cause kilns to deteriorate and impede operations, and contains less ash residue that must be landfilled. Cement calcination processes also require a calorific value that is close to that of coal as temperature control has a significant impact on the quality of clinker. Although most coal produced in Indonesia is low-grade with a lower calorific value than coal produced in Australia and other countries, a calorific value of 4,000 to 5,000 kcal/kg is common. While RDF with a low calorific value below 3,000 kcal/kg must be blended with coal or other high-calorie materials to adjust the calorific value, conversely, HC-RDF can be used as a material to regulate the calorific value of low-calorie RDF, as it has the same or higher calorific value than coal (Figure 2.3.1.1.4).

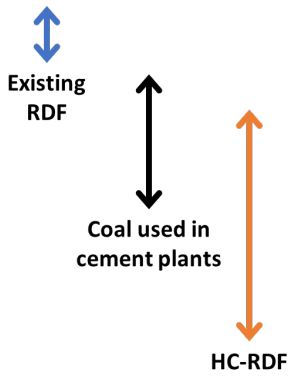
With these competitive advantages in place, Beetle assessed the possibility that the company could guarantee the viability of business operations, which had been difficult to achieve in the company's previous attempts at recycling and composting alone, since they could expect to bring in a higher purchase price compared to the more prevalent low-calorie RDF used in Indonesia.

Table 2.3.1.1.2. Differences between RDF and RPF (Source: Survey team, prepared based on information from the Japan RPF Industry Association[27])

Item	RDF	RPF
Composition	Contains organic waste	Does not contain organic waste
Moisture content	High	Low
Calorific value	3,000 - 4,000 kcal/kg	5,000 - 10,000 kcal/kg
Chlorine concentration	High	Low
Ashing rate	Below 20%	Below 7%

[26] Refuse-derived fuel in Indonesia (2022): https://ipen.org/documents/refuse-derived-fuel-indonesia

[27] Japan RPF Industry Association: https://www.jrpf.gr.jp/rpf-1/rpf-5



kcal/kg	Coal rank (kcal/kg)	Indonesia (million ton)
3,000		
4,000	<5,100	34,319.67
5,000	5,100 – 6,100	81,023.11
6,000	6,100 – 7,100	9,122.99
7,000	>7,100	2,143.58
8,000		
9,000		
10,000		
	Total	126,609.34

Geological Agency of Indonesia, Indonesian Coal Book 2016/2017

Figure 2.3.1.1.4. Comparison of available coal resources in Indonesia by grade and RDF calorific values (Source: Survey team, table prepared based on information from the Geological Agency of Indonesia, Indonesian Coal Book 2016/2017)

In Indonesia, the term RDF is used to describe solid waste fuels in a broad context. The term SRF (Solid Recovered Fuel) is also used interchangeably at times for solid waste fuels that do not contain hazardous waste, although in NDCs and other official documents, RDF is often used in a broad sense. Since the term "RPF" is not commonly used, this section will continue using the term "RDF", which is more familiar in Indonesia, and refer to high-calorie RDF as "HC-RDF" to distinguish it from the more common low-calorie RDF.

The intermediate treatment facility for municipal waste (general waste) in this project is expected to have a processing capacity of 200 to 300 t/d. General waste that has not been separated is sorted into valuables, organic materials, combustibles, and other types of waste at the facility on a sorting line. Valuable materials are sold, and organic waste is composted for use in municipal park greening projects and for other purposes. Combustible waste is processed into HC-RDF, which is delivered to cement plants and factories with large industrial boilers for use as an alternative fuel to coal. The residual hazardous waste and other materials that are difficult to recycle are transported to final disposal sites to be landfilled. Beetle aims to achieve a high recycling rate of about 90% and help find solutions to issues facing society through these processes, such as extending the service life of final disposal sites (Figure 2.3.1.1.5).

Although alternative fuel production facilities do not fall under the JCM Model Projects scheme because they do not directly reduce energy-derived CO_2 emissions (they are considered to be indirect reductions), Beetle believes that this project will have a significant impact on reducing CO_2 emissions by limiting the amount of coal used at cement plants and other facilities, lowering methane gas emissions from final disposal sites, and cutting fuel consumption with fewer vehicles used for transportation.

As part of the city's compliance with the Plastic Resource Circulation Act, Kitakyushu City has commissioned Beetle to process all general household waste (i.e., plastic containers, packaging and plastic products), which is converted into Cube Plastic Fuel (CPF), an alternative to coal produced from plastic waste, for delivery to cement plants and other facilities. The company is also dedicated to actively promoting the introduction of machinery and labour-saving methods into the sorting process to recover resources from waste. Beetle believes that it can provide intermediate waste treatment facilities and services that meet local conditions and needs through a combination of a wide range of technologies and expertise on the intermediate treatment of waste, recycling and the production of alternative fuels developed over the years in Japan, with the ability to adapt to local conditions developed in Surabaya City, in order to build a model that can be expanded out to other cities in Indonesia.

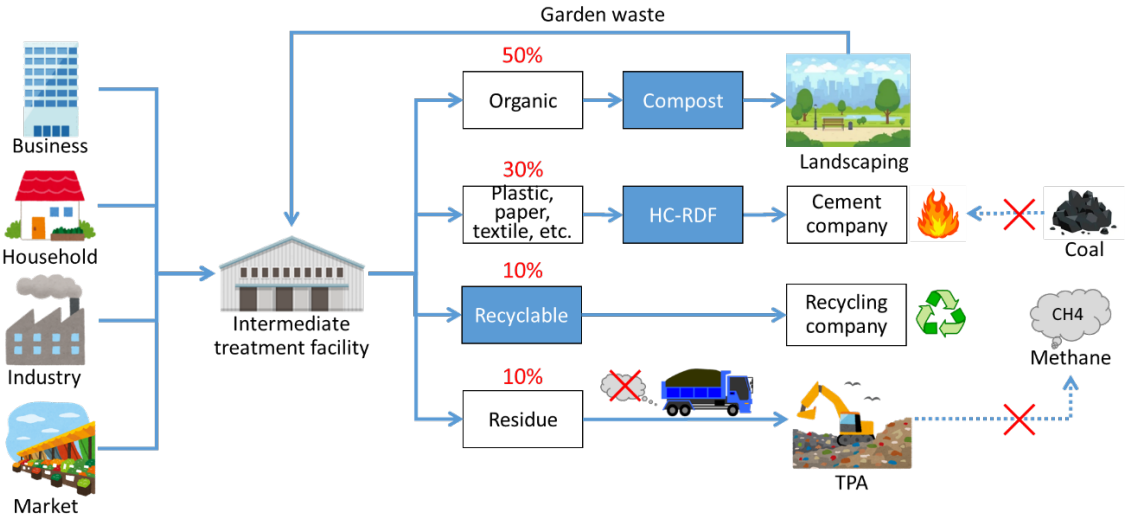


Figure 2.3.1.1.5. Conceptual drawing of a viable intermediate treatment facility
(Source: Survey team)

2.3.1.2. Survey subjects and methods

A basic survey was conducted this fiscal year, the first year of a three-year study, to shed light on current conditions and gain a sense of the survey's future direction and scope.

In addition to conducting research on the feasibility of this project in West Java Province, Beetle conducted site visits and interviews at existing RDF facilities and similar facilities converting municipal waste into fuel in other regions of Indonesia to identify good practices and understand current conditions and challenges. The objective of this survey was to identify issues and potential for developing the project, share the concept of the proposed project and the advantages of Beetle's technologies and expertise, and discern points that needed to be revised in the proposed project.

Beetle also visited a wide range of central government agencies, related local governmental departments, international organisations, and private companies to conduct interviews and engage in discussions, in order to gain insight into the policies, issues, and subsidies related to RDF and other similar facilities converting municipal waste into fuel in Indonesia.

Four field visits were conducted this fiscal year to achieve these targets. Additional surveys were also conducted during these field visits. These are described in separate chapters and therefore not included here.

<u>1st survey</u>

- Dates: 4 to 16 September 2023
- Participants:
  - Kitakyushu City Environment Bureau: 1 (10 to 16 September)
  - Beetle Engineering: 2 (1 self-financed) (10 to 16 September)
  - Institute for Global Environmental Strategies: 2

- Locations:

Organisation type	Name of organisation (facility/office)
Central government agencies	Environmental Agency, West Java Province
	Waste Management Division, Ministry of Environment and Forestry
	Integrated Waste Management Division, Ministry of Public Works and Housing
Local governments	Environmental Agency, Cilacap Regency (SBI Cilacap Factory)
	Environmental Agency, Banyumas Regency (BLE TPA Banyumas)
	Environmental Agency, Cilegon City (TPSA Bagendung Cilegon)
	Jakarta Metropolitan Environmental Agency (TPST Bantar Gebang)
	Environmental Agency, Sidoarjo Regency (TPA Griyomulyo)
	Environmental Agency, Surabaya City (Super Depo, Wonorejo compost centre)
	Environmental Agency, Denpasar City (Kesiman Kertalangu TPST, Padang Sambian TPST, Tahura TPST)
Government-related agencies	PMO TKPR Jabodetabek-punjur
	Asosiasi Semen Indonesia
Municipal corporations	Java Barat Bersih Lestari (JBL)
Companies	PT Indocement Tunggal Prakarsa Tbk
	PT Solusi Bangun Indonesia Tbk
	PT PLN Indonesia Power
	PT Suparma Tbk

2nd survey

- Dates: 25 to 29 October 2023
- Participants:
  - Beetle Engineering: 2 (1 self-financed)
  - Institute for Global Environmental Strategies: 1
- Locations:

Organisation type	Name of organisation (facility/office)
Local governments	Environmental Agency, Depok City (TPA Cipayung)
	Environmental Agency, Cilegon City (TPSA Bagendung Cilegon)
Companies	PT PLN Indonesia Power (PLTU Suralaya)
	PT Indocement Tunggal Prakarsa Tbk
	PT Cemindo Gemilang

3rd survey

- Dates: 12-18 November 2023
- Participants:
  - Institute for Global Environmental Strategies: 1
- Locations:

Organisation type	Name of organisation (facility/office)
Central government agencies	West Java Branch, Ministry of Public Works and Housing
Local governments	Environmental Agency, Bandung City
Diplomatic missions	Embassy of Japan in the Republic of Indonesia
Government-related agencies	Asosiasi Semen Indonesia
Companies	PT Cemindo Gemilang

4th survey

- Dates: 21 to 26 January 2024
- Participants:
  - Kitakyushu City Environment Bureau: 2
  - Beetle Engineering: 1 (21 to 24 January)
  - Institute for Global Environmental Strategies: 2
- Locations:

Organisation type	Name of organisation (facility/office)
Local governments	Cilegon City • Mayor's office • Department of Environment (TPSA Bagendung Cilegon, TPST ASARI) • Waste banks (Bank Sampah Menderma, Bank Sampah Berkah Lestari, Bank Sampah Ikhtiar)
	Development and Planning Department, Banten Province
	Environmental Agency, Serang Regency (TPST Kibin, TPSA Bojong Menteng planned construction sites)
International organisations	The World Bank
	JICA Indonesia
Companies	PT Sinar Mas Land

2.3.1.3. Survey results

(1) Related policies, laws and regulations

Measures on promoting the introduction of RDF

The Indonesian government issued Presidential Decree No.97/2017, setting a waste management target to achieve a 30% reduction and 70% treatment of household waste by 2025.[28] The decree also includes an implementation plan for 2017 to 2025 in Annex II, which also contains plans for the use of waste as an alternative fuel for the cement and RDF industries, with targets to install RDF facilities in 10 cities by 2025.

Environmental regulations for the cement industry when co-firing RDF

The Environment and Forestry Ministerial Decree No.19/2017[29] on emission standards for business activities in the cement industry stipulates that the industry shall comply with emission standards set out in Annex III of the decree (Table 2.3.1.3.1) when co-firing RDF produced from household waste, and that monitoring inspections will be conducted once every four years. The standards stipulate that the content of dioxins and furans must be 0.1ng TEQ/Nm^3 or less to be in compliance.

[28] Presidential Regulation No. 97/2017: https://peraturan.bpk.go.id/Details/73225/

[29] Ministry of Environment and Forestry Regulation No. 97/2017: https://jdihn.go.id/files/146/P.19%20(1).pdf

Table 2.3.1.3.1. Emission standards for the cement industry when co-firing RDF produced from household waste (Annex III of the Environment and Forestry Ministerial Decree No.19/2017) (Source: Annex III, Environment and Forestry Ministerial Decree No.19/2017)

No	Parameter	Satuan	Nilai Baku Mutu Emisi
1	Partikulat*	mg/Nm^3	60
2	Sulfur Dioksida (SO2)*	mg/Nm^3	650
3	Nitrogen Oksida (NO_X)*	mg/Nm^3	800
4	Hidrogen Fluorida (HF)*	mg/Nm^3	2
5	Hidrogen Klorida (HCl)	mg/Nm^3	20
6	Karbon Monoksida (CO)*	mg/Nm^3	625
7	Cadmium (Cd)	mg/Nm^3	0,2
8	Merkuri (Hg)	mg/Nm^3	0,2
9	Lead (Pb)	mg/Nm^3	5
10	Arsenik (As)	mg/Nm^3	1
11	Nikel (Ni)	mg/Nm^3	0,5
12	PCDD/F (Dioxin dan Furan)**	ng TEQ/Nm^3	0,1

Licenses and permits for waste disposal operations

Environmental impact assessments (AMDAL) are required when constructing waste treatment facilities in Indonesia. Documents and procedures required for the AMDAL vary depending on the size and type of business; details can be found in Environment and Forestry Ministerial Decree No.4/2021[30]. Licenses (Swakelola[31]) must also be issued by each municipality in order to collect, transport and treat waste. In its capacity as a participant in the project on the intermediate treatment of general waste, Beetle will not be involved as a construction company or engage in the collection, transportation or treatment of waste; rather, the company will conclude contracts with implementing partners to provide technical and advisory services. Therefore, these details are omitted here.

Target RDF production facilities

RDF that is produced from general waste is expected to be primarily co-fired with coal or biomass fuel in kilns at cement factories or boilers at coal power plants. In light of the cost of collection and transportation, RDF production facilities should ideally be located nearby. The Ministry of Environment and Forestry (KLHK) and Ministry of Public Works and Housing (PUPR) have both published potential maps for RDF facilities that show the locations of existing cement factories and coal power plants (Figures 2.3.1.3.1 and 2.3.1.3.2). Both ministries have also started to investigate the introduction of RDF into existing facilities with industrial boilers.

[30] Ministry of Environment and Forestry Regulation No. 4/2021: https://peraturan.bpk.go.id/Details/210998/permen-lhk-no-4-tahun-2021

[31] https://bppk.kemenkeu.go.id/balai-diklat-keuangan-makassar/artikel/definisi-dan-tipe-swakelola-481542

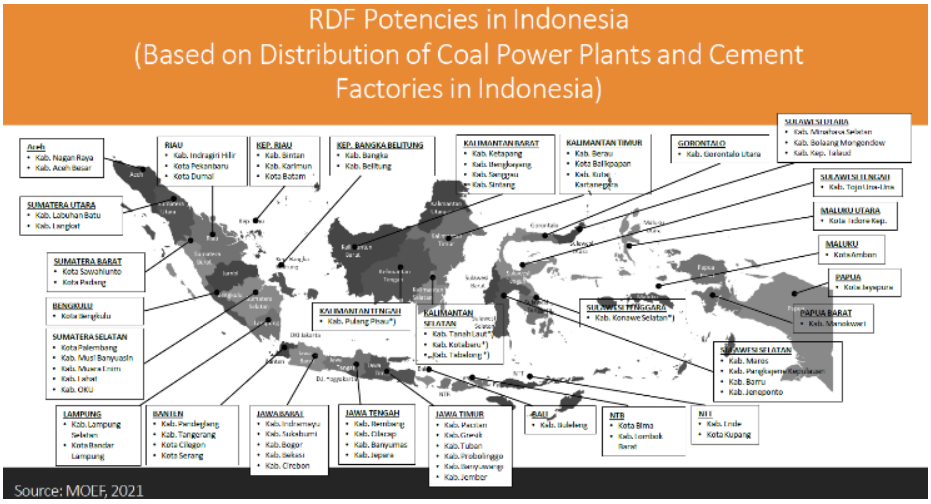


Figure 2.3.1.3.1. RDF potential map in Indonesia (2021)
(Source: Ministry of Environment and Forestry of Indonesia)

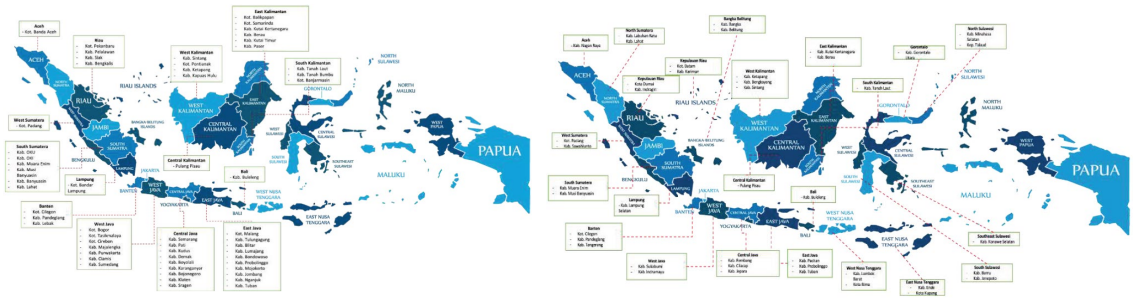


Figure 3. RDF Potential Location with Offtaker of Cement Industry

Figure 4. RDF Potential Location with Offtaker of PLTU

Figure 2.3.1.3.2. Location of existing cement factories (left) and coal powered plants (right) in the RDF potential map in Indonesia (2021)
(Source: Ministry of Public Works and Housing of Indonesia)

RDF guidelines

With support from GIZ, KLHK developed guidelines for RDF in 2016 for the production of RDF from general household waste and its use as an alternative fuel for coal in cement factories and coal power plants, in order to promote its proper production and use (Figure 2.3.1.3.3).

KLHK is planning to update the guidelines, as since its publication, Indonesia's first RDF plant started operations (in 2020 in Cilacap Regency, Central Java Province), knowledge about production has increased, and cement factories and other offtakers are beginning to call attention to issues, such as insufficient calorific values. As a start, KLHK has commissioned the national Sarana Multi Infrastruktur (PT SMI) to conduct an inventory survey of related organizations.

During discussions with KLHK's Waste Management Division in this survey, officials expressed a desire to collaborate in updating the guidelines.

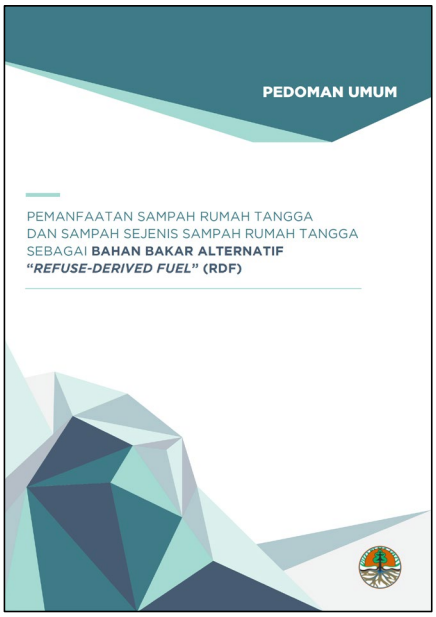


Figure 2.3.1.3.3. Cover of RDF Guidelines by KLHK in 2016
(Source: KLHK, 2016)

(2) Alternative fuel trends in the cement industry

Asosiasi Semen Indonesia (ASI) is an association of cement industries established in 1969 with 15 member companies. A summary of the outcomes of interviews with ASI follow.

- Cement market trends in Indonesia (2016-2023) indicate that production capacity increased annually from 99.4 Mt/y to 118.9 Mt/y. This is expected to increase between 2% to 4% each year over the next five years.
- The coal-firing rate for alternative fuels in cement power plants in Indonesia in 2022 was 7.8%, while SGI, SBI, and ITP all achieved a rate of about 20%. Although the cement industry does not have specific targets for co-firing rates for alternative fuels, ASI intends to increase this rate to 19.8% by 2030.
- In the cement industry, alternative fuels to coal include hazardous waste (B3), industrial waste, biomass, and general waste (municipal waste). Industrial waste is the most common alternative (at 70% to 80%), with general waste and biomass accounting for a smaller percentage.
- The Indonesian government considers the cement industry to be RDF's largest consumer sector, with a potential for 8,000 t/d.
- The Ministry of Industry of Indonesia requested ASI to formulate a roadmap to decarbonisation for the cement industry to 2060. ASI requested the assistance of the survey team to prepare this roadmap.

(3) Trends in existing/planned RDF facilities

This section provides an overview of the major trends identified through site visits and interviews for RDF facilities and other structures that are already installed or have installation plans in place in West Java Province and other regions.

<u>West Java Province</u>

West Java has taken the lead in planning the wide-area RDF Nambo project in the province, with the intention of producing RDF from municipal waste collected from Bogor City, Bogor Regency, Bekasi City, Depok City, and South Tangerang City, which will then be offtaken by ITP. Although plans have been in progress since 2010 with an initial capacity of 1,000 t/d, the scale has gradually

expanded to 1,500 and 2,000 t/d. There have been two bidding rounds for the project, but the facility has yet to be constructed or put into operation.

Currently, the plan for the Nambo project is to install an RDF facility with the capacity to process 1,800 to 2,300 t/d of general waste. PT Java Barat Bersih Lestari, a subsidiary of the infrastructure developer PT Jasa Sarana funded by West Java Province, is expected to operate the facility, which will be jointly funded by JT Jasa Sarana and the company with the successful bid. During the survey, Beetle was informed that bidding would take place sometime in 2023 and a decision would be made in January 2024, but no new information has been received about the progress of this process.

In addition to the Nambo project, an RDF production facility is being constructed under a project financed by the World Bank with a loan to PUPR called the "Improvement of Solid Waste Management to Support Regional and Metropolitan Cities (ISWMP)[32]". Plans are also in place to construct several RDF production facilities in Bandung City, Bandung Regency, Depok City, and Indramayu Regency, with a total processing capacity of 1,000 t/d. With the exception of the pilot facilities that have already been installed, operations are scheduled to start in 2026 (See 2.3.2.2. The World Bank's ISWMP Project).

PT SCG Indonesia, the Indonesian subsidiary of Thailand's Siam Cement Group (SCG), also plans to build an RDF facility (capacity: 330 t/d) in Sukabumi City that is capable of producing 100 t/d of RDF.[33]

Regions outside of West Java Province

Outside of West Java Province, TPST Bantar Geban, a large-scale RDF facility, has already been installed and is in operation. This final disposal facility was constructed by the Jakarta Metropolitan Government at Jakarta's TPA Bantar Gebang final disposal site and has been designed with a processing capacity of 2,000 t/d. The Jakarta Metropolitan Government also plans to construct an RDF facility in the Rortan district of North Jakarta (processing capacity: 2,500 t/d) and an RDF facility in the Pegadungan district of West Jakarta (processing capacity: 2,000 t/d). The bidding process is scheduled to take place in fiscal 2024. Beetle was also informed by several sources about plans to construct RDF facilities with a processing capacity of 2,000 t/d in East and South Jakarta.

Plans under the World Bank's ISWMP project call for the construction of RDF production facilities or Bahan Bakar Jumputan Padat (BBJP) plants (capacity: 200 to 300 t/d) in four locations outside of West Java Province: Tuban Regency (East Java Province), Cilegon City (Banten Province), Padan City (West Sumatra Province), and Gianyar Regency (Bali Province), which are slated to start operations in 2026 (See 2.3.2.2 The World Bank's ISWMP Project).

Other RDF production facilities visited during this survey to check on their operational status included facilities in Denpasar City (Bali Province, processing capacity: 1,020 t/d), Cilacap Regency (Central Java Province, processing capacity: 200 t/d, with a current capacity of 150 t/d), Banyumas Regency (Central Java Province, processing capacity: 200 t/d, with a current capacity of 50 t/d), and Sidoarjo Regency (East Java Province, processing capacity: 300 t/d, with a current capacity of 50 t/d). No facilities had met production targets.

There are additional plans to construct an RDF production facility (capacity: 300 t/d) in Aceh Province.[34]

Based on this information, it is clear that there are many plans in place to construct several RDF facilities throughout Indonesia.

(4) Examples of RDF production facilities

This section includes an overview of major RDF production facilities that were visited during this field survey.

[32] World Bank: Improvement of Solid Waste Management to Support Regional and Metropolitan Cities: https://projects.worldbank.org/en/projects-operations/project-detail/P157245

[33] Ibcsd: https://ibcsd.or.id/news-insights/scg-breaks-ground-on-innovative-rdf-technology-project-in-sukabumi-bolstering-sustainability-efforts/

[34] Aceh Province: https://dlhk.acehprov.go.id/2021/09/pemerintah-aceh-jalin-kerjasama-dengan-pt-solusi-bangun-indonesia-tbk-untuk-pengelolaan-sampah-di-tpa-regional-blang-bintang/

SBI Cilacap RDF plant

This is Indonesia's first full-scale RDF production plant, which started operations in 2020. The plant was constructed with funding from PURP, KLHK, the Danish government, Central Java Province, Cilacap Regency, and SBI.

The plant receives general waste, which is crushed, fermented at high temperatures for 21 days per batch through a biomembrane method (where waste is covered with membrane sheets and fermented by force aeration with blowers) to remove moisture, and then sieved to produce RDF (Figure 2.3.1.3.4). The plant was designed with a processing capacity of 200 t/d, but actual maximum production is 150 t/d.

Fresh waste is not used as raw material. Instead, the plant uses waste that has lain at the final disposal site for about a month, where organic matter has decomposed and most moisture has been removed.

Unilever Indonesia pays Rp 100,000/tonne of RDF produced at Cilacap, as part of offset payments under its extended producer responsibility (EPR) for plastics. Seventy percent of the RDF produced is counted as part of the company's offset (since about 70% of RDF is plastic). This is a voluntary practice by companies since Indonesia does not yet have guidelines or rules covering EPR.

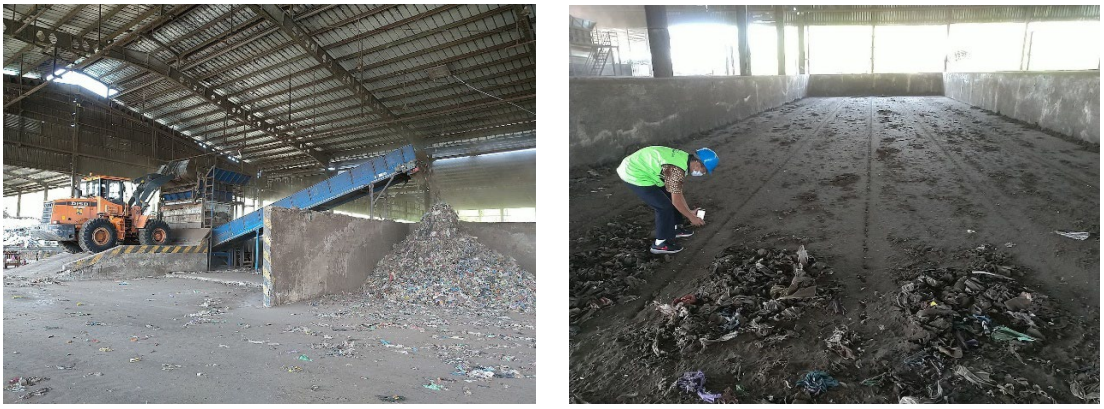


Figure 2.3.1.3.4. Waste crushing process (left) and biomembrane pit (right) at the SBI Cilacap RDP plant (Source: Photos by survey team)

TPST Bantar Gebang

Constructed and managed by the Special Capital Region of Jakarta, this large-scale RDF plant has a processing capacity of 2,000 t/d and started operations in July 2023. The plant was established and completely funded by the Special Capital Region of Jakarta, with the bidding process conducted under the design and build (DB) selection process, with PT Adhi Karya emerging as the successful bidder. The plant is operated and managed by the Special Capital Region of Jakarta following the introduction of Korean technology, installation of equipment and conduct of test operations by PT Adhi Karya.

Plans call for 1,000 t/d of the plant's 2,000 t/d capacity to be covered with fresh waste and the remaining 1,000 t/d to be covered with waste excavated from the final disposal site. Fresh waste is placed in a storage pit where moisture is removed (2 days), which is then sorted, crushed, sieved, dried (outside in the sun and by agitation → rotary kiln), and stored. The RDF produced through this process is also used as fuel for rotary kilns (Figure 2.3.1.3.5). However, RDF is produced from waste excavated from the landfill through a simple process that involves only the removal (sieving) of stones and other foreign matter and crushing. It was apparent that the plant was able to produce a large amount of RDF from waste excavated from the landfill, but were clearly not able to process even 1,000 t/d from fresh waste.

Two cement companies, ITP and SBI, are contracted for RDF offtake. Standard requirements for offtake include moisture content of less than 20%, size of less than 5 cm, and calorific value greater than 3,000 kcal/kg. RDF offtake prices follow a formula based on coal index prices and are reviewed on a monthly basis (USD 24 to 44/kg).

Figure 2.3.1.3.5. Receiving and storage pit for fresh waste (left) and sorting line (right) at TPST Bantar Gebang RDF facility (Source: Photos by survey team)

RDF production facility in Denpasar City

With support from PUPR for the construction of the facility, PT Bali Citra Metro Plasma Power (BCMPP) was awarded a long-term, 20-year contract by Denpasar City to operate the facility. BCMPP installed machinery and equipment.

The facility consists of three plants located at different sites in Denpasar with a total processing capacity of 1,020 t/d. The main facility, Kesiman Kertalangu TPST (KK), is equipped with a drying (rotary kiln) and compaction process. Padang Sambian TPST is not equipped with a drying and compaction process, which requires sorted and crushed waste to be transported to KK for processing. Wood chips and pellets are produced exclusively for use as fuel for KK's rotary kilns at Tahura TPST. With the use of 100% biomass fuel in KK's drying process, the facility has achieved complete in-house production.

The facility's RDF production process includes sorting, crushing, sieving, separation by weight, and drying (rotary kiln) after waste is received, followed by compacting into briquettes in a briquette machine, or compacting and packaging waste into bales (1 tonne per unit) before shipment (Figure 2.3.1.3.6).

Some bales are transported by ferry to Tuban Regency (East Java Province), where they are offtaken by cement plants, such as PT Solusi Bangun Indonesia Tbk (SBI) (Approximately 70% of the offtake price is ferry transportation costs).

Figure 2.3.1.3.6. Sorting line (left) and rotary kiln dryer (right) at Kesiman Kertalangu TPST RDF production facility (Source: Photos by survey team)

(5) Demand for RDF and other materials, offtake conditions, and purchase price

Demand for alternative fuels

A summary of the status and future targets for acceptance of alternative fuels for coal at cement and electric power companies interviewed in this survey can be found in Table 2.3.1.3.2. All companies are actively engaged in promoting the acceptance of alternative fuels and have significant capacity.

Table 2.3.1.3.2. Current status and targets for acceptance of alternative fuel for coal at cement and electric power companies interviewed in this survey
(Source: Table created by survey team based on content of interviews)

Offtaker	Current status of acceptance of alternative fuel	Acceptance targets for alternative fuel
PT Indocement Tunggal Prakarsa Tbk (ITP)[35]	18.1% (2022, actual)	25% (2025) 42% (2030)
PT Solusi Bangun Indonesia Tbk (SBI)[36]	1,582,844 t/y (2022, actual)	Min: 1.0 Mt/y (2025) Min: 1.4 Mt/y (2030)
PT Cemindo Gemilang	6% (2023, actual)	22% (2030)
PT PLN Indonesia Power (IP)	2% (2023, actual)	10% (2025)

Purchase prices for alternative fuels

Purchase prices for RDF and BBJP (factory gate prices excluding transportation costs) from cement factories, coal power plants, and factories equipped with boilers (offtakers) are shown in Table 2.3.1.3.3, based on information received from producers and offtakers interviewed during this survey (Information has been made anonymous to protect the identity of companies and other organisations). The purchase price of RDF ranged from Rp 350 to 700/kg, with Rp 400 to 500/kg the most common figure cited. Many offtakers adjusted unit purchase prices based on quality, such as calorific value and moisture content. However, BBJP purchase prices varied widely, ranging from Rp 400 to 1,500/kg, with significant differences between offtakers (regions).

Table 2.3.1.3.3. Purchase prices for RDF and BBJP based on information from interviews during this survey (Source: Table created by survey team based on content of interviews)

Types of alternative fuels	Offtaker	Rp/kg	Notes
RDF	Cement Plant A	400	
	Cement Plant A	350～500	Prices adjusted based on quality
	Cement Plant B	450	
	Cement Plant B	450～500	Prices adjusted based on quality
	Cement Plant C	400	Prices adjusted based on quality
	Plant (boiler) A	700	
	Plant (boiler) B	500～600	Prices adjusted based on quality
BBJP	Coal power plant A	1,500	
	Coal power plant B	400	
	Coal power plant C	880	

[35] ITP (2022): https://www.indocement.co.id/resource/03.%20Investor/3.8.4%20Presentasi%20Hubungan%20Investor/2022_FY_Indocement_ENG_FINAL.pdf

[36] SBI (2022): https://solusibangunindonesia.com/wp-content/uploads/2023/04/SBI_SR_2022_Final.pdf

Offtake status and conditions for RDF in cement plants

- Although most RDF was accepted in fluff form, it was compressed and packaged in bales and briquettes in Denpasar when transported over long distances by ship to cement plants in East and Central Java.
- Acceptance criteria varied for each cement plant, but generally speaking, criteria focused on moisture content of less than 20% or 25%, calorific value of more than 3,000 kcal/kg, and fluff size of 2 to 5 cm or 5 to 8 cm. In some cases, cement plants were willing to accept fluff sizes of 20 cm or more.
- Many RDF did not meet moisture content requirements, in particular. Even if RDF does not meet acceptance criteria, it is currently accepted by factories and used by mixing or adjusting it with materials with higher calorific content. However, if RDF falls below the criteria for acceptance, purchase unit prices are adjusted accordingly.
- Some companies called for RDF with higher calorific values. They specifically indicated the desire for a calorific value of at least 3,000 kcal/kg. However, some companies specified the need to secure quantity over quality.
- Some companies noted the need to limit co-combustion ratios to about 5% because of RDF's high chlorine content. It will be necessary to install facilities, such as for chlorine bypass, in order to increase the co-combustion ratio in the future.

Offtake status and conditions for BBJP in coal power plants

- Five alternative fuels are used as standard in coal power plants: (1) BBJP, (2) sawdust, (3) rice husks, (4) palm residue (PKS, palm kernel shells), and (5) wood chips.
- PT PLN Indonesia Power (IP)'s target is to replace 100% of coal with biomass in order to increase the biomass co-firing rate to 10% by 2025. Currently the rate is only 2%.
- Biomass fuels used in coal power plants are divided into three size classes depending on the boiler system: (1) fine fluff for pulverised coal (PC) boilers, (2) pellets for circulating fluidised bed (CFB) boilers, and (3) briquettes for stoker boilers. Co-combustion with biomass and other alternative fuels is easiest in stoker boilers, followed by CFB boilers, with PC boilers the most difficult of the three.
- Although it is difficult to process woody biomass and other materials into fine particles for PC boilers, BBJP (compost) holds an advantage in that it can be easily processed into fine particles by sieving. It is also difficult to process plastics into fine particles, which requires a dedicated crusher.
- PI has conducted research into BBJP since 2017, although it initially had a different name. A power plant in Lombok achieved a 3% co-firing rate with BBJP. A power plant in Cilacap also achieved a 5% co-firing rate with BBJP.
- Recommended acceptance criteria for BBJP include up to 10% of impurities allowed (100% organic origin recommended), moisture content of less than 20%, and calorific value of more than 3,500 kcal/kg of dried organic matter in particulate form.
- RDF and BBJP differ primarily in terms of organic content, with BBJP having a minimum organic content of 80%. Acceptance criteria vary between power plants, but PI permits impurities up to 10%.
- The calorific value of BBJP produced with organic waste from markets has a moisture content between 20% and 25% and a calorific value of 3,400 kcal/kg. However, the calorific content can reach 4,000 kcal/kg when plastic is mixed in.
- Although mixing plastic in increases the calorific value, the use of 100% organic matter is a safer option because the inclusion of plastics may introduce uncertain elements into boiler operations. PT PLN Nusantara Power in East Java Province requires the use of 100% organic matter.
- BBJP is mixed into coal silos and introduced together with coal into boilers. It is not recommended to mix plastic in boilers, as plastic will melt in the heat (about 70℃) of feeders used to feed the mixture into boilers.

(6) Processing capacity

- The survey team conducted a number of site visits to large- (capacity: over 1,000 t/d) and medium-sized (capacity: 200 to 300 t/d) RDF production facilities. None have achieved processing capacity targets.
- The process for producing RDF from waste excavated from final disposal sites appeared to be capable of producing about 1,000 t/d of RDF since organic matter was already decomposed and dried, and only required the mixture to be sieved to remove stones and other foreign matter and then crushed.
- It was clear that facilities using fresh waste were struggling to process even 100 to 200 t/d. There were a particular number of facilities with single-track sorting lines that did not have sufficient processing capacity for the volume of waste. It was evident that the facility designers lacked the knowledge required.
- The drying process for both RDF and BBJP has an important role to play in meeting quality requirements for offtakers. However, the lack of fuel for the drying process (rotary kiln) poses a potential obstacle in cases such as Denpasar, where operations require 100% biomass fuel.

(7) Financing

- Most RDF production facilities were built with funding from donors (mainly PUPR), with the exception of TPST Bantar Gebang, which was self-financed by the Jakarta Metropolitan Government.
- Many stakeholders indicated the lack of investors, other than donors, for capital investment to be a challenge. It was evident that the environment is not conducive for inviting investment from the private sector due to a lack of profitability and high risks, such as when bids are submitted but ultimately are not successful.
- Examples of facilities installed and funded by offtakers include those in Sukabumi City (funded by SCG) and Aceh Province (funded by SBI).
- Several of those interviewed indicated that even in facilities constructed with support from donors, profits were negligible or in the negative numbers due to high operating costs and low profits from the sale of RDF/BBJP.
- Several cases were also observed where transportation costs were high and profitability was low due to offtakers being located a distance away from facilities.
- Several production facilities pointed out that the most profitable part of the business is not the profit on sales of RDF and BBJP, but the collection and sale of valuables (especially recycled plastics).

(8) Facility operating structure and capacity

- Most RDF production facilities are operated by local governments because they are responsible for the disposal of general waste. Some municipalities have outsourced these operations to private companies.
- Local governments often set up and outsource operations to local public corporations (BUMD: Badan Usaha Milik Daerah) or regional public service corporations (BLUD: Badan Layanan Umum Daerah) due to restrictions on engaging in business.
- Often, BUMD and BLUD do not have the technical capacity to carry out such operations. In many cases, they seem to form JVs by selecting private companies that have the technology and expertise either voluntarily or through a bidding process, or outsourcing operations.
- Local government regulations limit contracts with the private sector to five years. However, Denpasar city has signed long-term, 20-year contracts with a private company.
- Although tipping fees are paid to some private operators, (in the case of Denpasar) most local governments do not pay tipping fees.
- While machinery for sorting and other processes had been installed at large- and medium-sized RDF production facilities, many employees were still working on manual sorting lines, suggesting that the use of machinery was not resulting in expected staff reductions. There

were 160 and 115 workers employed at TPST Bantar Gebang in Jakarta and Kesiman Kertalangu TPST, respectively.

- Operators reported that machinery breakdowns in several production facilities make it difficult to maintain productivity and continue operations. In addition to the low performance of equipment and facilities, low operational capacity was also observed. Little consideration is also given to maintenance and backup systems.
- When central government agencies or local governments are involved in the procurement of equipment for installation, the equipment and machinery purchased must comply with domestic production rates (TKDN)[37]. The TKDN rate for the waste management sector is 30%, which may limit the introduction of higher quality imported machinery and may be a factor in the number of breakdowns and other problems.

2.3.2. Business feasibility considerations

2.3.2.1. Narrowing down targets

The project's direction was examined in light of the results of the field survey summarised in 2.3.1 On-site survey. Unfortunately, no potential cases were found among the RDF projects that are currently planned or other projects and opportunities in West Java, which was the target of this survey. However, opportunities for collaboration were identified with the ISWMP project in Cilegon City (Banten Province), as well as other projects in the province that may hold potential for collaboration in the future.

2.3.2.2. The World Bank's ISWMP Project

The World Bank is implementing a project on the "Improvement of Solid Waste Management to Support Regional and Metropolitan Cities (ISWMP)" over a five-year period from 2020 to 2025, with the aim of improving urban waste management capacity in Indonesia. Eight cities in the Citarum river basin area[38], once considered to be the world's most polluted river, are the target of this project. However, other municipalities in Indonesia were also included as part of the project since the dense populations of these cities leave them with a lack of space to install large waste treatment facilities.

In this project, the World Bank provides loans to PUPR, which are provided to local governments in the form of subsidies to be used for the construction of waste treatment facilities that are handed over to the municipalities once completed. PUPR ultimately selected six municipalities located outside the cities and regencies in the Citarum river basin area from a long list of 39 municipalities across Indonesia. Table 2.3.2.2.1 shows the target cities and waste treatment facilities that are planned for construction, as identified through interviews with relevant subjects.

When selecting the target municipalities for this project, PUPR took the following selection criteria into account: commitment on the availability of a budget to be appropriated for the operation of waste management facilities (minimum Rp 250,000/t or USD 16/t), lack of social conflicts (opposition) in communities located in the areas around proposed construction sites, and an environment in which projects could be immediately implemented.

The majority of waste treatment facilities are RDF production facilities with a processing capacity of 200 to 300 t/d. However, some local governments show a preference for producing BBJP or compost depending on their relationships with offtakers. EPC contractors selected by PURP through a bidding process design and build the factories, with the Environmental Agency in each municipality soliciting bids for operators. Depending on the municipality, contracts may be awarded on a voluntary basis without a bidding process by BLUD or other agencies under the jurisdiction of the municipality.

In essence, bids, designs, construction and commissioning for all facilities under this project will follow the same timeline, with the aim of handing over facilities to target municipalities by the end of 2025 so that commercial operation can begin from January 2026. The initial and projected (estimated)

[37] JETRO, "Indonesia's growing policy to prioritise domestic products and domestic production rates" (27 May 2022): https://www.jetro.go.jp/biz/areareports/2022/003612eed40eba00.html

[38] Guardian: https://www.theguardian.com/global-development/2020/nov/02/rotten-river-life-on-one-of-the-worlds-most-polluted-waterways-photo-essay

schedules for BBJP/RDF facilities in Cilegon City, as identified in this survey, are shown in Table 2.3.2.2.2. At the time of writing (February 2024), this process is already three to four months behind schedule, with the possibility of further delays.

Table 2.3.2.2.1. Target cities and plans for the construction of waste treatment facilities under the World Bank's ISWMP project (Source: Table created by survey team based on content of interviews)

Province	City/Regency	Facility name	Processing capacity (t/d)	Notes
West Java Province	Bandung City	TPST Cicukang Holis	20	RDF 18 t/d, BSF 2t/d
		TPST Nyengseret	~~100~~ ↓ 55	
		TPST Taman Tegalega		
		~~TPST Cicabe~~		Designed processing capacity: 45 t/d. Construction suspended due to opposition from residents located nearby.
		Gedebage	390	New facility. Increase from originally design capacity of 300 t/d to 390 t/d.
	Bandung Regency	TPST Cicukang Oxbow	50	Increase Oxbow processing capacity from 10 t/d to 50 t/d instead of Cicabe.
	Depok City	TPST Cipayung	300	
	Cimahi City[39]	TPST Santiong, TPST Lebak Saat	50	
	Indramayu Regency[40]		300	
East Java Province	Tuban Regency[41]			
Banten Province	Cilegon City[42]	TPSA Bagendung	200	Mainly expected to be the production of BBJP.
West Sumatra Province	Padang City[43]		300	
Bali Province	Gianyar Regency			Preference for production of compost due to distance from RDF offtaker.

[39] Cimahi City: https://cimahikota.go.id/berita/detail/82343-siapkan-strategi-khusus-pemkot-cimahi-upayakan-tahun-2025-tak-bergantung-pada-tpa-sarimukti#googtrans(id|id)

[40] Indramayu Regency: https://diskominfo.indramayukab.go.id/mengenal-kebijakan-waste-to-energy-kabupaten-indramayu/

[41] Tuban Regency: https://tubankab.go.id/entry/tuban-jadi-lokasi-pembangunan-fasilitas-pengolahan-sampah-berteknologi-rdf

[42] Cilegon City: https://cilegon.bco.co.id/pemerintahan/blud-upt-tpsa-bagendung-segera-dibentuk-segini-nilai-perkiraan-penjualan-bbjp-per-tahun/

[43] Padang City: https://www.padang.go.id/wako-hendri-septa-merasa-senang-kota-padang-akan-diberikan-bantuan-program-rdf-pemerintah-pusat

Table 2.3.2.2.2. Timeline for BBJP/RDF facilities in Cilegon City (original and projected)
(Source: Table created by survey team based on content of interviews)

Activities	Original plan	Projected plan (estimated based on interviews)
Bid for design and build (DB) contractor	September to October 2023	January 2024
Facility design	October to December 2023	February to March 2024
Facility construction	January to October 2024 (10 months)	March 2024 to January 2024 (10 months)
Test run (commissioning)	November 2024 to October 2025 (12 months)	February to December 2025 (10 months)
Facility handover (PUPR to Cilegon City)	January 2026	January 2026
Start of commercial operation	January 2026	January 2026

2.3.2.3. ISWMP project in Cilegon City

Cilegon City (Banten Province), an industrial port city located at the northwestern edge of Java island, is home to a number of heavy and chemical industries, including state-owned Krakatau Steel (Persero) Tbk PT.

PT PLN Indonesia Power (IP)'s PLTU Suralaya, one of the largest coal power plants in Indonesia, is also located in Cilegon. The city was selected as the recipient of support from the World Bank's ISWMP project due to its history of working together on the production and offtake of BBJP, an alternative solid fuel produced from general waste.

PLTU Suralaya consumes 40,000 tonnes of coal per day and is planning to increase its biomass co-firing rate to between 10% and 15% by 2025 (at 10%, the capacity to receive alternative fuels can be estimated at 4,000 t/d). The current co-firing rate hovers at about 2% (700 to 800 t/d) and is mostly comprised of rice husks and sawdust, while BBJP is only about 10 t/d. Another advantage is that PLTU is only about 30 km away from TPSA Bagendung Cilegon, the demonstration site for BBJP.

Cilegon City launched a study on BBJP in 2021 in consultation with IP and conducted the first pilot test at 5 t/d. After additional improvements, operations started at a demonstration site (30 t/d) in November 2022, with BBPJ provided to IP. Both facilities were installed with funding from IP. The 30 t/d site has been able to produce about 10 t/d of BBJP, but production is unstable.

Under the ISWMP, a waste treatment facility with a processing capacity of 200 t/d is planned for construction on the premises of TPSA Bagendung Cilegon; the site had already been cleared when the survey team visited in January 2024 (Figure 2.3.2.3.1). IP's offtake conditions stipulate that at least 90% of the BBJP is organic in origin, and the allowable amount of plastic and other foreign matter is less than 10%.

Waste (60% from households, 25% from markets, 15% from parks) was collected and sorted at the 30 t/d demonstration site. The waste was then fermented at high temperatures for five to six days to remove moisture (Figure 2.3.2.3.1), crushed, sieved and separated (20-mm mesh), dried in the sun, and finally sieved and separated again (5-mm mesh) before shipping the BBJP produced to IP.

At the time this report was prepared, a detailed design and layout of the facility was not available, although it is expected that the specifications will essentially be similar to other RDF facilities in the ISWMP. The fermentation process used at the 30 t/d demonstration test site will not be incorporated into the processes at the 200 t/d facility, and the material will be dried in a rotary kiln after it is sorted, crushed and sieved. As with the facility in Denpasar, biomass (wood chips and pellets) is expected to be used as fuel in the rotary kiln, requiring the procurement of a biomass fuel and processing processes. A photovoltaic system will also likely be installed on the roof of the plant, with a portion of the electricity used to come from renewable energy sources.

After installation and commissioning by PUPR, the facility will be transferred to Cilegon, and operations will be managed by BLUD, which was set up by the city in July 2023. However, BLUD only had experience operating the 30 t/d demonstration site and was concerned about managing the

operations of a plant on a scale of 200 t/d, and requested technical assistance from Beetle. BLUD has the legal authority to collaborate with private companies, including foreign corporations, and Cilegon City is currently in the process of preparing a Standard Operating Procedure (SOP) for BLUD.


Figure 2.3.2.3.1. BBJP demonstration test site (left) at TPSA Bagendung Cilegon (capacity: 30 t/d) and proposed site for construction of 200 t/d plant to be installed under ISWMP (Source: Photos by survey team)

RDF offtakers

Waste resources and dry waste are also separated out during the sorting process when producing BBJP, in addition to organic waste. This offers an added benefit in that waste resources can be sold and dry waste can be processed into HC-RDF and sold at higher prices than typical RDF.

In terms of RDF offtakers, PT Cemindo Gemilang (Cemindo), the third largest cement company in Indonesia after the SIG/SBI Group and ITP, has an integrated cement factory (Bayah plant) in the southern part of Banten Province, which is about 150 km away from Cilegon City. However, with seven grinding plants throughout the country, including in Ciwandan (Cilegon City), 3,000 t/d of clinker is transported daily over land to the city from the Bayah plant, and to other cities by ship from Cilegon Port. Approximately 100 trucks make this round-trip every day between Baya and Cilegon, and since the trucks are empty on the return trip to Bayah, loading RDF on the trucks may be a way to increase transportation efficiency and reduce costs.

The cement factory in Bayah consumes 4,000 t/d of coal and has a target of increasing the co-firing rate of alternative fuels to 22% by 2030. With its current RDF co-firing rate of less than 1%, the factory has a great deal of leeway in terms of accepting alternative fuels. Cemindo is already in discussions with municipalities in Banten Province, including Cilegon City, about procuring RDF and has expressed interest in this proposal.

Demand for RDF is also expected to be strong from the large concentration of steel mills and chemical plants, and the numerous industrial boilers in Cilegon City.

Other collaboration needs

Cilegon City made two additional specific requests to improve the operational capacity of BBJP/RDF production facilities (capacity: 200 t/d) that go beyond technical cooperation with Beetle: (1) to produce RDF from excavated waste from the TPA Bagendung final disposal site, and (2) to improve the informal sector, such as waste pickers, in the city and boost waste collection and recycling by effectively using (formalising) the informal sector through the establishment of a central waste bank. Cilegon City is hoping to work with Beetle in these areas as well.

2.3.2.4. Reasons for selecting the ISWMP project in Cilegon City

After inspecting the RDF and BBJP facilities in different locations during this survey, the study team considered the ISWMP project in Cilegon City to be particularly promising for the reasons listed below.

- A processing capacity of 200 t/d is highly feasible (compared to the 300 t/d capacity being envisioned in the ISWMP project).
- A regional city, Cilegon has a smaller population, generates less waste, and has little traffic congestion, which makes handling easier.
- The final disposal site (TPA Bagendung) has 20 more years of landfill space available, allowing it to be used as a safety net in the unlikely event that the plant is shut down. Since it is operated by Cilegon City, the risk is low that the city will refuse to accept residual waste.
- The city has committed to paying PUPR a tipping fee of Rp 250,000/tonne or more.
- It is reasonable to expect that BBJP and RDF can be produced simultaneously. It is also easy to utilise Beetle's technical expertise to provide a comparative advantage over other operators.
- With cement companies expressing the need for RDF with higher calorific values, a shift to HC-RDF is expected in the future. For this reason, the project can be pushed out as a proactive and progressive model.
- There are offtakers for both BBJP and RDF in the city, and BBJP prices are higher than those for RDF. There are a number of options for RDF offtakers in the city, including cement factories and plants equipped with boilers.
- Higher purchase prices than those for typical low-calorie RDF can be commanded by processing RDF into HC-RDF.
- Although this is an ISWMP project, BLUD in Cilegon City has already selected the management body, and a direct request for technical assistance was sent to Beetle, eliminating the need to take part in the bidding process.
- There is no capital investment required at the initial stage and participation is low risk (although additional capital investment may be required for some improvements after the facility is turned over to Cilegon City).
- Cilegon City's DLH is highly motivated, communicative and easy to work with.

2.3.2.5. Waste management conditions in Cilegon City

Waste management conditions in Cilegon City are summarised below, based on information obtained through interviews with the city's Environmental Agency (DLH) and onsite visits during field surveys.

- Cilegon City is divided into eight Kecamatan (clusters) and 43 Kulurahan (districts). DLH manages waste in four operational areas, which have their own UPDT (Regional Technical Implementation Unit).
- Cilegon City's population was 455,721 in 2022, which generates an estimated 228 t/d of waste (calculated at 0.5 kg/day per capita). Approximately 203 t/d of this amount is collected and dumped into a final disposal site (collection rate: approximately 89%) (Source: Cilegon City DLH). Estimates for the amount of waste disposed at the final disposal site were based on truck capacity since there are no truck scales available.
- TPA Bagendung is the only final disposal site. Landfilling started in 1999, and space is expected to remain available for about 20 more years.
- There are a total of 256 primary waste collection points (TPS) in Cilegon City. TPS-3R with recycling functions can be found at two of these points (one plastic oil conversion facility and one composting facility). There are no other recycling facilities.
- There are a total of 38 waste bank units in the city.
- The key challenges for DLH in waste management include: (1) improving public awareness, and (2) increasing the number of waste banks. DLH intends to establish a central waste bank

since there is none in the city and increase the number of waste banks to 43, one in each of the 43 Kulurahans.

2.3.2.6. Potential areas for city-to-city cooperation between Cilegon and Kitakyushu

The delegation from Kitakyushu paid a courtesy visit to Mayor Helldy Agustian on 22 January during the field survey in January 2024, where they exchanged ideas with the director of DLH and other city executives.

During the meeting, the two cities agreed to support technical cooperation between BLUD and Beetle to ensure the success of the ISWMP project (capacity: 200 t/d). Since BLUD is a municipal corporation, they are not permitted to collaborate independently with companies from overseas. Therefore, both cities agreed to move ahead using a two-tiered collaborative structure that includes first exchanging a letter of interest (LOI) between the two cities, and then having BLUD and Beetle sign another LOI under that. With these LOIs in place, the two cities will conduct a study on city-to-city collaboration projects in fiscal 2024 to 2025. Based on the results of this study, the two cities will work on the possibility of developing an MOU in the future once an agreement is reached on specific areas of collaboration.

2.3.2.7. Potential for the development of RDF projects in Serang Regency (Banten Province)

During the field survey in January 2024, the survey team identified an additional opportunity to take part in intermediate treatment projects for general waste in Banten Province, in addition to the possibility of being involved in a similar project together with Cilegon City. This project was identified through discussions with Banten Province, Serang Regency, and Sinar Mas Land.

Background

Banten Province is made up of eight cities and regencies: the province's capital city of Serang, Cilegon City, Serang Regency, Lebak Regency, Pandeglang Regency, Tangerang Regency, Tangerang City, and South Tangerang City (Figure 2.3.2.7.1). The densely populated cities of Tangerang Regency, Tangerang City and South Tangerang City, which are located near the capital city of Jakarta, generate a large amount of waste (Figure 2.3.2.7.2), yet none have a final waste treatment facility, which poses a challenge in disposing of waste. The TPA Rawa Kucing final disposal site in Tangerang City closed down due to a fire in October 2023. The TPA Cipeucang final disposal site was also forced to close due to problems with overload, and Tangerang Regency has no final disposal site.

South Tangerang City has transported waste to Serang City and Bogor Regency for dumping; however, now that the final disposal site in Serang City is reaching full capacity, the city has entered into consultations and discussions with Sinar Mas Land, a developer in Banten Province and South Tangerang City, to identify a new final disposal site. These discussions resulted in a proposal for inter-municipality collaboration in which South Tangerang City, which lacks available land, would construct an intermediate treatment facility (RDF production facility) in Serang Regency in return for Serang Regency, which has land but no final disposal site and no funds for development, to provide land and the two municipalities to jointly use the facility.

Figure 2.3.2.7.1. Map of Banten Province and location of 8 municipalities (Source: Alamy[44])

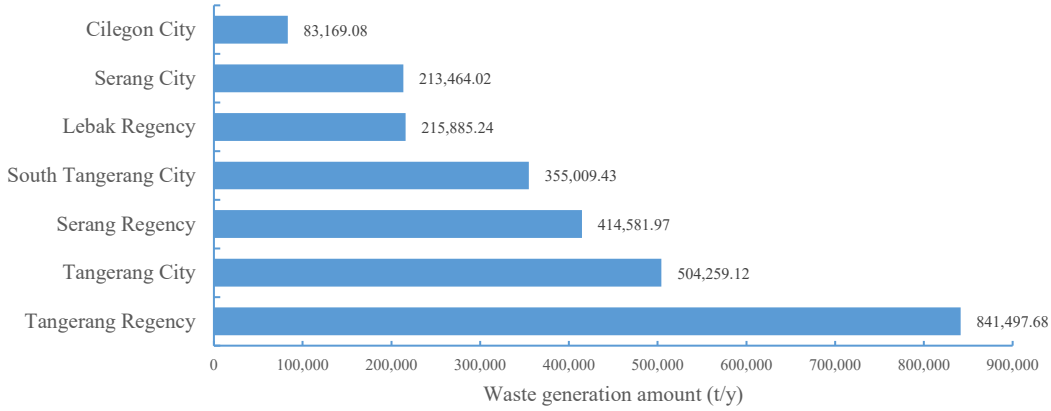


Figure 2.3.2.7.2. Amount of waste generated annually in 8 municipalities in Banten Province (Source: Graph generated by the survey team based on information from SIPSN and KLHK[45])

Plans for a final disposal site and intermediate treatment facility

Two candidate sites have been selected in Serang Regency. The study team visited one of them, a 10-ha site in Bojong Menteng district. At this time, the site is a rice field with no road to approach the area (Figure 2.3.2.7.3).

The concept includes a plan to construct an intermediate treatment facility to process the entire amount of general waste received from South Tangerang City and Serang Regency (1,000 t/d from each for a total of 2,000 t/d) into RDF. A proposal for collaboration was discussed in which Sinar Mas Land (SML) would purchase land and install and develop facilities, while ITP would offtake the RDF at its cement plant in Citeureup (Bogor Regency) and Serang Regency would construct the approach road. As SML had no experience in waste management, they consulted with ITP. Beetle emerged as a potential technical partner, leading to discussions between all parties and an inspection visit to the candidate site.

Sinar Mas Land suggested a proposal for ITP, Serang Regency, and Beetle to collaborate in conducting a feasibility study on the facility. In more specific terms, Beetle has been requested to conduct a waste composition study in South Tangerang City and Serang Regency to look into facility specifications and provide input to estimate costs.

44 Alamy: https://www.alamy.com/banten-administrative-and-political-vector-map-indonesia-image235744520.html

45 SIPSN, KLHK: https://sipsn.menlhk.go.id/sipsn/

Challenges and directions

Challenges include the risk of abruptly installing a 2,000 t/d processing facility, and that the ITP cement plant, where the RDF offtaker is expected to be located, is a distance of about 120 km away. However, the coal power plant in Lontar (Tangerang Regency) is about 57 km away, so it may be possible to consider offtaking BBJP there, or transporting RDF to Cilegon City (about 50 km away) by loading RDF onto trucks for transport on the daily return trip between Cemindo Gemilang's Bayah plant and Cilegon City.

During next fiscal year's survey, the survey team will continue to focus on collaborative projects with Cilegon City and conduct basic surveys on waste composition and other studies to explore related possibilities.

Figure 2.32.7.3. Proposed site for intermediate treatment facility at Bojong Menteng in Serang Regency (left) and TPST Kibin intermediate waste treatment facility in Serang Regency (right) (Source: Photos by survey team)

2.3.3. Feasibility and potential for future development

The outcomes from this fiscal year's survey indicate that Beetle will be able to provide technical support for the operation of a 200 t/d BBJP/RDF facility in cooperation with BLUD in Cilegon City. This will serve as a stepping stone to Beetle's involvement in the intermediate treatment of general waste in Indonesia. The outcomes also suggest that the cities of Kitakyushu and Cilegon could work together to support Beetle by collaborating in the field of waste management through a city-to-city partnership. It is too early, however, to evaluate and determine the feasibility of these activities because of the many uncertainties. The survey in the next fiscal year should improve the accuracy of the outcomes in these areas.

2.3.3.1. Issues and measures to consider for the feasibility of the project and future profitability (Beetle)

The treatment facility (capacity: 200 t/d) is scheduled for completion and commissioning next fiscal year. However, the following points must be examined and studied before any determination can be made about the feasibility of the project and future profitability.

- Signing of LOI: An LOI must be signed between BLUD and Beetle, in addition to the LOI between the two cities, based on the agreement between Kitakyushu and Cilegon during the January 2024 visit.
- Signing of MOU: If promising materials and information are found once the LOI is signed that indicate the potential for developing the project further and it is necessary to have a stronger form of collaboration, the agreement could be taken one step further with the signing

of an MOU. The possibility of signing a business agreement with BLUD as a private sector partnership rather than signing an MOU would also need to be discussed and considered.

- Signing of NDC: Since this would be a technical partnership, it will be necessary to consider signing a non-disclosure agreement (NDC) to prevent information about Beetle's technology and expertise from being leaked externally, regardless of the type of contract.
- Evaluation of design, facility specifications, throughput and project profitability: The most important action in next year's survey will be on-site visits to evaluate the design, specifications, throughput, and project profitability of the facility throughout the commissioning period (approximately 10 months during 2025) by the facility design and installation contractor once the facility has been constructed. In the case that throughput is lower than expected (only 50 t/d, which would be one-fourth that of the designed capacity of 200 t/d, for example), it is unlikely that the contractor will respond to changes to the fundamental design or facility, or to expand additional capacity, although they may accept requests for improvements during the commissioning period. Therefore, it will be important to evaluate and coordinate what improvements, if any, can be made to increase throughput and output quality, to determine whether a profit can be guaranteed through additional investments and changes, and the amount of commissioning fees that are likely to be received from BLUD.
- Evaluation of equipment, capital investment and other factors required to improve throughput and quality: If additional capital investment is required following the evaluation of the facility's design, specifications, throughput, and profitability, it will be necessary to clarify the amount of investment required, how equipment will be procured, and which party will bear the cost (i.e., would BLUD have the capacity for this, or would Beetle also need to bear costs). If additional equipment must be installed, one particular point of note would be to determine whether required equipment could be procured within 30% of the TKDN since this would fall under public sector purchasing.
- Format of contract with BLUD and outsourcing contract fees: If, based on the results of the evaluation of profitability and capital investment, it is determined it would be advantageous for Beetle to take part in the project, the next step would be to enter into contract negotiations with BLUD. In addition to the contract format, the contracting party, whether it will be a Japanese corporation (Beetle) or an existing local corporation (PT Beetle Organik), needs to be considered and determined. Detailed discussions will also be needed on outsourcing contract fees, as this will change depending on profitability, Beetle's expected role, level of capacity of BLUD staff, and level of commitment Beetle can offer.
- Capacity building: Since BLUD only has the experience and expertise to operate the 30 t/d pilot facility, they will need to build the appropriate capacity to operate a 200 t/d plant. The provision of onsite education and training should be considered in order to build the capacity of BLUD staff. It will also be necessary to consider the preparation of operation manuals for safe and efficient operation.

2.3.3.2. Issues and measures to be considered for city-to-city cooperation (Kitakyushu)

- Signing of LOI: The two cities agreed to sign an LOI during the delegation's visit to Cilegon in January 2024. The LOI must be signed in February 2024 to ensure that Cilegon City can officially take part as a co-applicant in the survey for next fiscal year's city-to-city collaboration project.
- Signing of MOU: If promising materials and information are found once the LOI is signed that indicate the potential for developing the project further and it is necessary to have a stronger form of collaboration, the agreement could be taken one step further with the signing of an MOU between BLUD and Beetle. As with the LOI, the first step would likely be to have an MOU signed between the two cities, followed by an MOU between BLUD and Beetle. However, the Ministry of the Interior of Indonesia must be notified and give approval when

an MOU is signed between municipalities, which is expected to take a great deal of time and effort. Therefore, it will be necessary to carefully assess the necessity and potential impact of the MOU before signing.

- Identification of challenges and needs for waste management: While no specific requests were made to Kitakyushu City in terms of cooperation during discussions with Cilegon DLH this fiscal year, it is expected that Kitakyushu will continue to work on gaining an understanding of Cilegon's waste management challenges and needs in next fiscal year's survey.
- Identification of potential areas for cooperation and collaboration: Kitakyushu will need to identify what support and coordination will be appropriate based on an understanding of Cilegon's challenges and needs in waste management. For example, the two cities could partner together to examine and implement measures for separation of waste at source if promoting source separation would alleviate the burden of the sorting process at the 200 t/d processing facility and improve throughput.
- Field visits to Japan: Better understanding must be cultivated between the two cities in order for Kitakyushu to promote city-to-city cooperation with Cilegon. In addition to visits by delegations from Kitakyushu to Cilegon, invitations should also be considered and extended to Cilegon officials to visit Kitakyushu and inspect waste-related facilities and Eco-Town in next fiscal year's or the year after next survey.

2.3.3.4. Direction for the next fiscal year

No potential projects were identified in West Java Province during this year's survey, although others were found in Banten Province. Therefore, the theme of "decarbonising the cement industry" will not change in the next fiscal year, but the study will continue with a shift in direction to include Banten Province as a target area. Surveys on the simultaneous production of RDF and BBJP and city-to-city collaboration will only be conducted in Banten Province. Other surveys will be carried out in West Java Province.

2.4. Survey on maximising and optimising the process of converting waste into raw materials for cement

2.4.1. On-site surveys

2.4.1.1. Background and objectives

The team visited ITP's Citeureup plant as part of the "Survey on converting industrial waste into raw materials and fuel for cement" in order to investigate the impact of using fuel and alternative feedstock provided by Amita to ITP on operational processes and quality, and to provide technical guidance and exchange ideas with ITP.

2.4.1.2. Survey subjects and methods

Two field surveys were conducted in the process of this study.

1st survey
Dates: 6 to 9 September 2023
Survey company: Tokuyama Corporation
Survey team members: Daigo Fujinaga, Toru Egashira
Schedule

6 September:	Arrive in Jakarta
7 September	Ministry of Environment and Forestry
	Indonesia Cement Association (Asosiasi Semen Indonesia, ASI)
	Jababeka
8 September	
	AM ITP (Kick-off WHR, site visit to related facilities)
	PM ITP (Kick-off ARM&AF, site visit to related facilities)
9 September	Return to Japan

2nd survey
Dates: 23 to 25 January 2024
Survey company: Tokuyama Corporation
Survey team members: Kotaro Okamura, Takahide Hotta, Daigo Fujinaga, Toru Egashira
Schedule

23 January	Arrive in Jakarta
24 January	Visit Indocement, meetings
	09:00-10:30: Questions about safety training and advance materials
	10:30-12:30: Plant visit
	13:30-16:00: Discussions
25 January	Return to Japan

2.4.1.3. Results of survey

(1) Use of Amita's hypothetical alternative materials and fuel
① Alternative raw materials
⇒Potential alternatives for natural clay were considered.

○Quality:

Alkali is currently nearing upper limits, which poses difficulties depending on the quality of the alternative material.

○Facilities/equipment:

Facilities/equipment are in place to add materials to limestone transporters or to weigh and feed in materials from a dedicated hopper for secondary raw materials. Materials can be supplied as long as there is extra capacity. Amita's products will be supplied from a

dedicated hopper for secondary raw materials.

② Alternative fuel

⇒The capacity of existing supply facilities can be increased, boosting throughput to 20,000 to 30,000 tonnes/year.

○Quality:

Caution is needed because high chlorine content may cause blockages in preheaters or have other unintended impacts.

(2) Increases in other alternative fuel

①In the P8 plant, 28% of alternative fuel is used only in the temporary furnace.

In the future, the main waste alternative for thermal energy will be RDF. However, RDF is difficult for kilns to process, so all kilns would need to be replaced with temporary furnaces to achieve the 2030 target replacement rate of 60%. The plant will need to be switched over to intermittent operation due to the lower load on the coal mill for the temporary furnace.

②The rpm of the preheater IDF is at maximum speed with no margin for error.

If alternative fuels for thermal energy are increased in the future, there are concerns about the following potential impacts:

- Decrease in clinker production capacity due to a decline in emission intensity
  ⇒Caution is needed for pressure resistance since augmenting the IDF increases the negative pressure on the top of the preheater. High-efficiency coolers, IDF augmentation, and pulling exhaust gas to other lines are options that are being considered.

- Increase in gas temperature at preheater outlet
  ⇒Temperatures rise as emission intensity declines. Water or other liquid must be sprinkled at the gas outlet duct at the PH top cyclone.

- Increase in unburned gas
  ⇒High CO concentrations did not pose a problem because the dust collection equipment is not E/P (electrostatic precipitator). Hot discs and other equipment are being tested, which, if effective in complete combustion, should be considered for adoption in other systems.

- Impacts from changes in combustion
  ⇒Damage to refractory materials and increased dioxin in flue gas resulting from changes in combustion position and drops in temperature should be monitored.

(3) Other

- It is currently difficult to procure only quality materials that can be used in kilns, since many alternative materials (waste) are often miscellaneous mixtures.
- Facilities were designed for the use of low-grade coal mined in the local area.
  ※Coal mill capacity seems to also have been designed for low-grade coal.

2.4.2. Future directions

ITP has a sufficient level of technical capacity and is making reasonable investments to reduce the use of coal. They appear to have a good understanding of all of Tokuyama's recommendations. The next action will be for ITP to send Tokuyama samples of alternative materials they handle for Tokuyama to evaluate and provide feedback. As pertinent information is exchanged where appropriate, it will be possible for more efficient information to be provided by inviting ITP engineers to visit Tokuyama's plants in the upcoming fiscal year so they can observe how a chlorine bypass is operated and alternative materials (wastes) are being used.

3. Workshops and conferences

3.1. Workshops with local stakeholders

Since all the survey items in this study are designed to identify and develop projects and/or business-related collaboration with ITP, a face-to-face workshop was held as a kick-off meeting with ITP. Management and technical personnel from ITP and four organisations in the survey team gathered together to talk about and exchange ideas on related initiatives and survey plans. Attendees also participated in a site visit to ITP's facilities.

Presentation slides are attached in the Annex.

Date: 8 September 2023, 8:30 - 17:00
Location: PT Indocement Tunggal Prakarsa Tbk (ITP)
Participants:

- ITP: 7 persons
- JFE Engineering India (JFEEI): 2 persons
- JFE Engineering Indonesia: 2 persons
- Amita Corporation: 2
- Tokuyama Corporation: 2 persons
- IGES: 2 persons

ITP's initiatives (ITP)

Founded in 1975, ITP's Citeureup plant is one of the largest cement plants in the world. It is the only one in Indonesia that produces white cement. There are a total of 15 kilns (Citeureup: 10, Cirebon: 2, Tarjun: 1, Maros: 2) with a production capacity of 27 Mt/y.

To date, IDR 1 trillion has been invested in initiatives to reduce CO_2 emissions by promoting the use of alternative fuels, increasing the use of hydraulic cement, and reducing the use of OPC cement.

Alternative fuels include waste tires, biomass, and RDF, and input facilities have already been installed, with the goal of increasing production up to 1.5 Mt/y by 2030. Alternative feedstocks include fly ash.

Outline of the proposed city-to-city collaboration project (IGES)

IGES presented an overview of the city-to-city collaboration programme and JCM Model Projects. This was followed by a detailed explanation about the scope of this study, implementation structure, and overview of each survey.

During the Q&A session, ITP suggested the advantages of partnering with municipalities near the cement plants in consideration of the potential for reducing transportation costs in relation to the production of RDF from municipal waste.

Power generation through a waste heat recovery system (JFE Engineering India)

JFE Engineering India (JFEEI) provided participants with an explanation about their corporate profile and track record in power generation through a waste heat recovery (WHR) system.

During the Q&A session, ideas were primarily exchanged on the following points:

- Installation of the WHR system was considered for three kilns (P8, P11, and P14).
- Engineering capacity is required to ensure continuous operation so that even if one kiln is temporarily shut down for maintenance or other reason, other kilns will not be affected.
- The electricity generated by WHR will be used only for the plant's own consumption and will not be sold to PLN (state-owned electricity company).
- Measures to increase the amount of electricity generated include increasing the amount of alternative fuels and a switch from air-cooled to water-cooled systems. Water-cooled systems can generate more electricity, but require a larger volume of water, resulting in losses in pump power and equipment, as well as the need to secure water resources.
- A remote monitoring system could be installed to allow operations to be monitored remotely from Tokyo.

- Data items (shared prior to the meeting) required for the design of the WHR system were reviewed, and ITP will provide input and feedback.
- ITP will not own the carbon credits during the legal durable period (9 years) because the CO2 is credited by JCM (between the two governments), but after the monitoring period, they can be claimed by ITP as their CO2 emission reduction credits.
- In terms of civil construction other than the WHR system, ITP intends to award the contract to the EPC as a single package.
- ITP also intends to install a dryer that dries alternative fuels using waste exhaust heat, but this will be separated from the WHR system that JFEEI will be in charge of. The design of the WHR system should be based on the installation of an alternative fuel dryer facility.
- JFEEI will not be able to estimate OPEX because it does not know the cost of utilities, labour, or other related items. Thus, OPEX calculations will be handled by ITP based on input from JFEEI.
- Once information on individual costs for the WHR system and construction is available, the project must be evaluated for ITP to determine its feasibility. This will not be covered under this F/S. Participants confirmed that this F/S will only be used to provide input for ITP to evaluate and determine the feasibility of the project.
- Almost all components of the WHR system, including turbines, will be made in India.
- JFEEI expects that detailed calculations and design will take about three months after receiving data from ITP. With estimates for construction costs by ITP anticipated to take about one month, information on overall cost is expected to be available around February 2024.
- JFEEI may travel to Indonesia one more time to meet with ITP for additional explanations, confirmation and coordination of the detailed proposal, if necessary.

Site visits to the kilns where WHR system is to be installed

The team visited the sites and confirmed the location of P8, P11, and P14 kilns, the conditions of surrounding facilities, processes from pre-heater to kiln, sites where the WHR system will be installed, and locations where facilities such as power generation equipment and alternative fuel dryers can be installed.

Tokuyama's initiatives (Tokuyama Corporation)

Tokuyama's market share of cement production in Japan is 7.3%, but its share of exports is 10.4%. The actual introduction of waste-derived alternative fuels and materials is 1.7 million tonnes/year (1.58 million tonnes/year for alternative materials and 120,000 tonnes/year for alternative fuels).

During the Q&A session, ITP pointed out that the ratio of their alternative materials is as low as 3%, and that they would like to increase it, but there is a lack of appropriate feedstock. Tokuyama pointed out that Japan uses a lot of construction sediment which is difficult to obtain in Indonesia as it must be purchased.

Beetle Engineering's initiatives (IGES)

IGES introduced Beetle Engineering's concept of producing RDF and compost simultaneously from general waste, emphasising that this process can result in a higher-calorie RDF than typical RDF.

During the Q&A session, ideas were exchanged on the Nambo RDF project (processing capacity of 2,000 t/d), which is being promoted by West Java Province. It was noted that the biggest challenge is the lack of an investor, especially for processes that use rotary kilns for drying, which results in higher OPEX. ITP stated that they are able to consume all RDF produced.

Amita's initiatives (Amita Corporation)

Amita reported on its business model and the progress of the field surveys conducted so far. They noted that in Indonesia, a large amount of industrial waste continues to be sent to final disposal sites, and that there is considerable potential to accept and treat this waste due to high tipping fees. Expectations were expressed that through this study, it may be possible to shorten the time required to

obtain permits for hazardous (B3) waste treatment with support through channels between the governments of the two countries.

During the Q&A session, the issue of a high chlorine content in waste materials was cited as the reason for the low 3% alternative material use in ITP. In terms of alternative material, ITP mainly accepts fly ash and steel slag, but not sludge from the paper and textile industries, which have high chlorine content. It was agreed that a technical exchange on the promotion of the introduction of alternative fuels and materials would be held during the next visit with Tokuyama's engineers.

Site visits to RDF-related facilities

The team visited the RDF feeding facilities at P14 and P11, as well as the RDF processing facilities and storage area for general waste received from neighbouring municipalities.

Figure 3.1.1. Workshop at ITP (left) and site visit to the cement plant (right)
(Source: Photos by the survey team)

3.2. Participation in meetings held in Indonesia

In order to gather information for this study, the team participated in an online seminar on the carbon market in Indonesia organised by the JETRO Jakarta Office.

Date: 15 January 2024
14:00 - 15:30 (Jakarta time, UTC+7), 16:00 - 17:30 (Japan time, UTC+9)
Organised by: JETRO Jakarta Office
Co-organised by: Jakarta Japan Club and PwC Indonesia
Agenda:
(1) Contribution of Japanese companies to decarbonisation in Indonesia (JETRO Jakarta Office)
(2) Current status of the emissions trading market in Japan (Environmental Economics Office, Industrial Science and Technology Policy and Environment Bureau, METI)
(3) Current status of the emissions trading market in Indonesia (PwC Indonesia Japan Business Desk)

An announcement was made that Indonesia's first carbon emissions trading market (IDXCarbon) would open on 26 September 2023. The market will be operated by the Indonesia Stock Exchange (IDX) and structured to allow companies to trade emission credits. At the opening ceremony, President Joko Widodo said that he believes the potential carbon market size of Indonesia could reach Rp 3,000 trillion.

The emissions exchange is open to companies that are obligated or willing to voluntarily reduce

their emissions. Companies wishing to participate must register with IDXCarbon[46] for emissions trading. Business owners that have already registered their emission credits with the Ministry of Environment and Forestry's National Registry System of Climate Change Control (SRN-PPI) will also be able to sell their emission credits through the market.

The carbon emissions trading market has two major mechanisms:

- Allowance market: A cap-and-trade system arrangement in which emission allowances (surplus and deficient emissions) are traded among certain companies that are obligated by the government to reduce GHG emissions and are allocated allowances. The cap on GHG emissions that can be emitted by a company is set by a technical certificate on the emission caps for businesses (PTBAE-PU). [47]
- Offset market: A mechanism for entities to trade carbon units generated by reducing GHG emissions through specific projects or other climate change mitigation actions. Entities can purchase carbon units to meet their emission reduction targets. Entities that reduce their emissions are registered by the Ministry of Environment and Forestry through the MRV[48] process, and are issued a GHG emission reduction certificate (SPE-GRK) [49] by the Ministry of Environment and Forestry as evidence of their GHG emission reductions. The SPE-GRK will be traded on the offset market.

This carbon emissions trading mechanism is a voluntary transaction within Indonesia between specific companies that have been allocated emission allowances and/or other companies, and does not seem to have the same scope for international trading of carbon credits as the JCM. On the other hand, as carbon emissions trading progresses in Indonesia and the value of carbon units is recognised in the near future, there is a possibility that interest will shift to carbon emissions trading rather than JCM, where credits are not allocated to companies that have reduced GHG emissions. In the discussions with ITP in this study, there was interest in owning GHG emission reductions rather than using the JCM, so it will be necessary to continue to monitor the trend of carbon emissions trading in Indonesia.

3.3. Related meetings in Tokyo

At the Seminar on City-to-City Collaboration for Zero-Carbon Society hosted by the Ministry of the Environment (in Tokyo, 26 to 27 February 2024), stakeholders from this fiscal year's city-to-city collaboration projects gathered to share achievements and challenges, learn from each other, and network. Since one person from each of the overseas partner cities in this year's adopted projects could be invited to the seminar, an invitation letter was sent to the Environment Agency of West Java Province after communication and coordination with the province. Mr. Helmi Gunawan, Deputy Director of the Environment Agency, was chosen to participate from West Java. Although Mr. Helmi did not have the opportunity to give a presentation at the seminar, he participated in the seminar and IGES supported the discussions.

[46] IDXCarbon: https://www.idxcarbon.co.id/

[47] IDXCarbon: PTBAE-PU: https://idxcarbon.co.id/product-ptbae-pu

[48] MRV: measuring, reporting and verifying greenhouse gas emissions: https://www.env.go.jp/earth/ondanka/ghg/mrv-library/1.whats_mrv.html

[49] IDXCarbon: SPE-GRK: https://idxcarbon.co.id/product-spe-grk

Annex

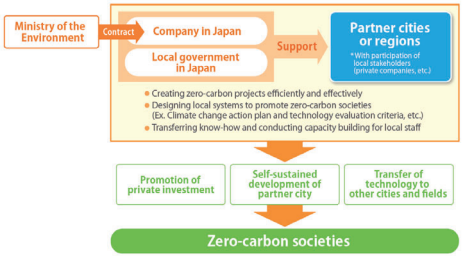
Feasibility Study on Decarbonization of Cement Industry in West Java Province, Indonesia 2023-2025

City-to-City Collaboration for Zero-Carbon Society

5th – 15th September 2023

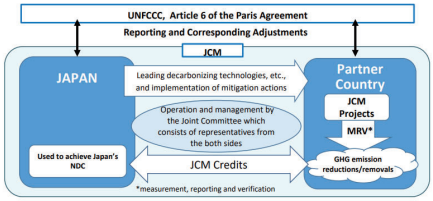
IGES Institute for Global Environmental Strategies

City-to-City Collaboration for Zero-Carbon Society



Subsidy to support implementation of feasibility studies (max 3 years)

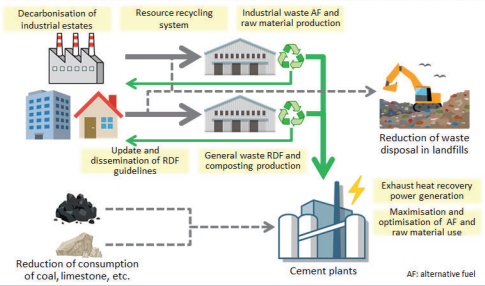
Joint Crediting Mechanism (JCM)



- Governments of Indonesia and Japan signed JCM on August 26th, 2013
- As of 14th April 2023:
  - 49 accepted model projects
  - Expected GHG Emission Reductions: 454,997 tCO2/year
  - Amounts of Credits Issued: 18,418 tCO2

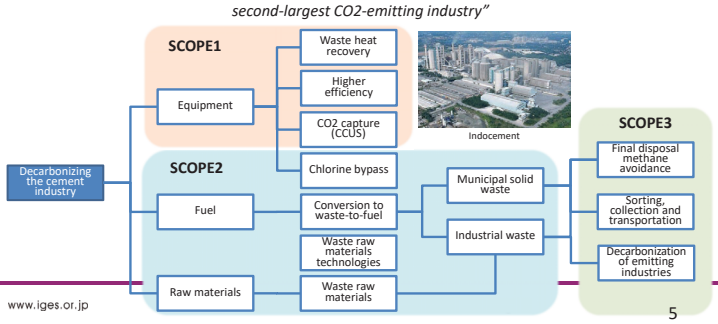
Project outline

CO2 emission reduction and resource recycling throughout the cement industry's supply chain



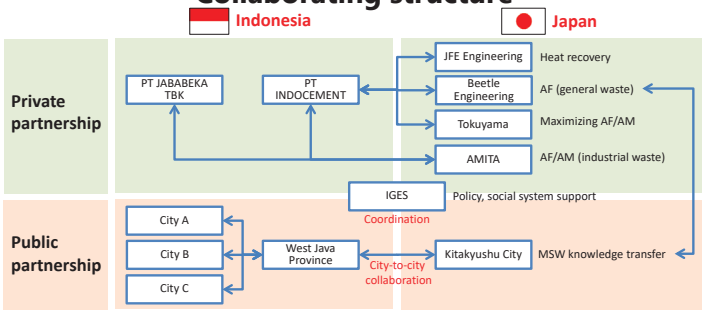
CO2 emission reduction from the entire supply chain

"Cement is the world's third-largest energy-consuming industry and the second-largest CO2-emitting industry"



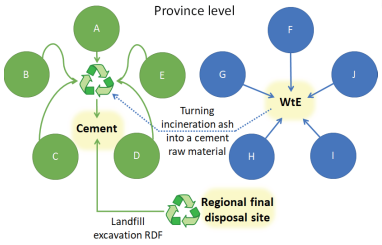
Indocement

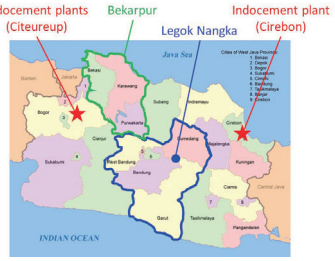
Collaborating structure



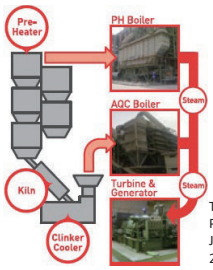
Annex

Municipal solid waste collection area: Regional sharing approach





Waste heat recovery power generation



Tuban Plant
PT Semen Indonesia
JCM Model Project
2014, 28 MW

Padang Plant
PT Semen Padang
NEDO Project
2014, 8.5 MW

Aiming for the adoption of the 2nd JCM Model Project

Cement raw materials and fuels

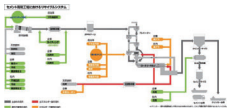
AMITA

Horizontal expansion of scheduled waste business in Malaysian to Indonesia

Beetle Engineering

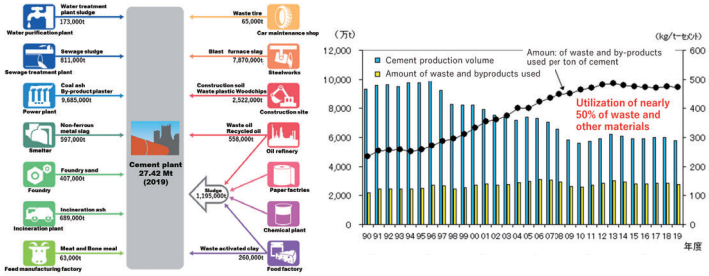
Scaling up of successful model projects in Surabaya City with adding values

TOKUYAMA



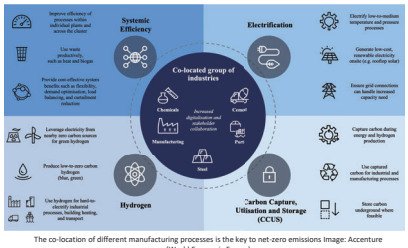
Maximising and optimising the use of raw materials and fuels in cement plants

Advanced recycling in cement industry



https://www.jcassoc.or.jp/

Creation of a net zero industrial cluster



The co-location of different manufacturing processes is the key to net-zero emissions Image: Accenture (World Economic Forum)

Identify potential JCM Model Projects

JABABEKA & CO.
Creating New Cities

Jababeka Industrial Estate

Annex

To: Recipient's name

Tokuyama Corporation

Company Outline

Month, 2023

[Name and affiliation]

Summary

TOKUYAMA 2025

Tokuyama's Mission

Pursuing a new vision with a redefined mission

Slogan: "For the People of Tomorrow"

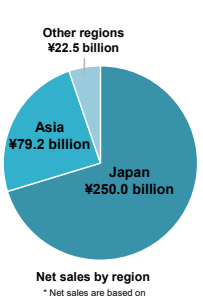
Mission	To create a bright future in harmony with the environment, in collaboration with its customers, based on chemistry
Vision	• Be a value-creative company that places first priority on R&D and marketing • Be a company that never stops challenging new domains while refining and exploiting its unique strengths • Be a company with healthy employees who have healthy families and take pride in their work at their company • Be a company that fosters bonds with people in communities and societies worldwide
Values	• Commitment to customer satisfaction as a profit source • A broader, loftier perspective • Employees who consistently surpass their predecessors • Integrity, perseverance, a playful sprit and boldness

Company Overview

Established	1918
Capital	¥10.0 billion
Net Sales	¥351.7 billion (consolidated basis in fiscal 2022*)
Business fields	Inorganic and organic chemicals, cement, building materials, electronic and advanced materials, life science, eco business and other.
Number of employees	5,909 (consolidated) (As of March 31, 2023)
Number of cosolidated subsidiaries and equity-method affiliates	67 (As of March 31, 2023)

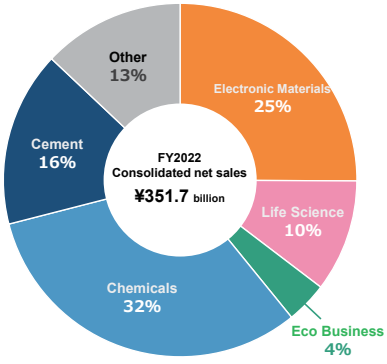
*Fiscal 2022: April 1, 2022 – March 31, 2023

Net Sales by Business Segment



Net sales by region

* Net sales are based on customer location and categorized by country or region.

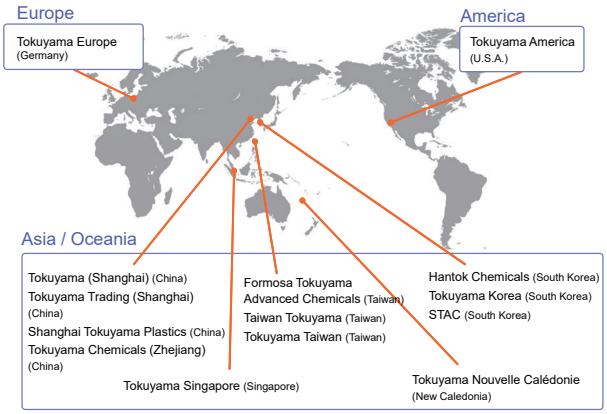


* Net sales for each business segment include inter-segment sales

Business Sites in Japan (non-consolidated)

Annex

Global Network



Businesses at a Glance

Segment	Business Unit	Major Products	Major Group Companies
Chemicals	**Soda and Calcium Chloride**	Soda ash, calcium chloride	Polyvinyl chloride [Shin Dai-ichi Vinyl] Soda ash, calcium chloride [Tokuyama Soda Trading] Hydrogen [Yamaguchi Liquid Hydrogen]
	Chlor-Alkali and Vinyl Chloride	Caustic soda, propylene oxide(PO), chlorine solvents, vinyl chloride monomer	
Cement	**Cement**	Cement, cement-type stabilizer	Cement, ready-mixed concrete, building materials [Tokuyama Tsusho Trading, etc.] Ready-mixed concrete [Hiroshima Tokuyama Ready Mixed Concrete] Building materials [Tokuyama MTech]
	Recycling	Recycling	
Electronic & Advanced Materials	**Silicon**	High-purity polycrystalline silicon	High-purity IPA* for the electronics industry [Taiwan Tokuyama, Tokuyama Singapore, Tokuyama Chemicals (Zhejiang) (China)] Photoresist developer [Hantok Chemicals (South Korea)] Solvent for cleaning metals [Tokuyama METEL] Fumed silica [Tokuyama Chemicals (Zhejiang) (China)] Aluminum nitride substrates [Tokuyama-Dowa Power Materials] * Isopropyl alcohol
	IC Chemicals	High-purity IPA* for the electronics industry, photoresist developer TMHA, IPA for industrial use, solvent for cleaning metals	
	Silica	Fumed Silica	
	Thermal Management Materials	High-purity aluminum nitride	
Life Science	**Fine Chemicals**	Plastic lens-related materials	Laboratory information systems, diagnostic reagents [A&T] Dental materials/equipment [Tokuyama Dental] Microporous film [Shanghai Tokuyama Plastics (China)]
		APIs and intermediates	
	Microporous Film	Microporous film	
	Dental Materials and Equipment	Composite resins for dental fillings	
	Diagnosis	Laboratory information system, diagnostic reagents	
Eco Business	**Environment**	Waste gypsum board recycling	Ion exchange membranes, electrodialyzers [ASTOM] Plaster business/products [FL Tokuyama] Waste gypsum board recycling [Tokuyama Chiyoda Gypsum]
	Ion Exchange Membranes	Ion exchange membranes, electrodialyzers	
Others	**Service and others [Shunan System Sangyo, Tokuyama Kairiku Unso, etc.]**		

History of Tokuyama

Year	Company name	Business structure		Products the company commenced to manufacture	
1918	Nihon Soda Kogyo Co., Ltd.	Inorganic chemical	Soda production	• Soda ash (solvay process) • Caustic soda	
1936	Tokuyama Soda Co., Ltd.		Inorganic general chemical	• Cement • Magnesium carbonate* • Calcium chloride • Caustic soda (electrolytic process) • Precipitated silica (white carbon)*	
1990	Tokuyama Corporation	Petrochemical		• Propylene oxide (PO) • Vinyl chloride (VCM, PVC)	• Chloromethane • Polypropylene (PP)* • Isopropyl alcohol (IPA)
1994		Specialty/processing businesses		• Polyolefin film* • Ion exchange membranes • High-performance plastic window sashes • Plastic lens-related materials • Dental materials and equipment	• High-purity polycrystalline silicon • Fumed silica • High-purity aluminum nitride • APIs and intermediates • High-purity IPA for the electronics industry
2005					
2016		New Foundation **Medium-Term Management Plan 2025**		• Laboratory information system, diagnostic reagents • Microporous film	• Recycling and environment business (waste disposal)
2021					

* We phased out these products.

Medium-Term Management Plan 2025

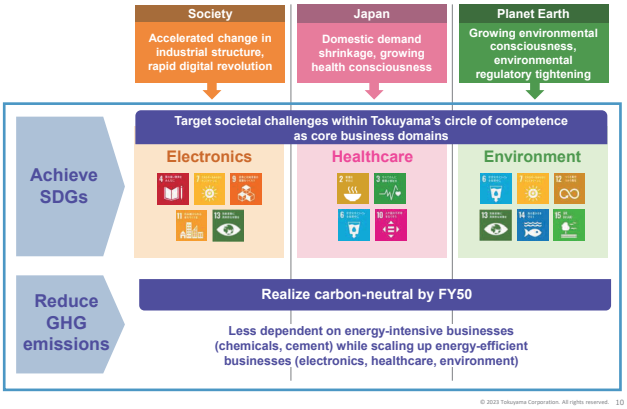
Tokuyama's Aims

Priority Areas

Final Year Targets

TOKUYAMA 2025

Tokuyama's Aims



Priority Areas

Fiscal 2021–2025

1	**Transform business portfolio**	**Increase growth businesses' share of consolidated net sales to over 50%**
2	**Contribute to mitigation of global warming**	**Expedite development/ commercialization of next-gen energy technologies; reduce GHG emissions 30%* by FY30**
3	**Practice socially responsible management**	**Step up high-priority CSR initiatives to lay groundwork for further growth and realize our vision**

* Relative to FY19

Annex

Final Year Targets

KPI	FY20 (Result)	FY25 (Target)	Factors in Achieving Targets
Net Sales (The application of the Accounting Standard for Revenue Recognition)	¥259.2bn*	¥320.0bn	Focus on portfolio transformation Reflect cost inflation
Operating Profit	¥30.9bn	¥45.0bn	Expand operating profit approaching FY25 Revise by changing depreciation method
Growth Business Net Sales Growth Rate	—	CAGR ≥ 10%	Strengthen R&D, accelerate international expansion
ROE	13.2%	≥ 11%	Balance shareholder's equity efficiency and financial base Revise by changing depreciation method

(Note) Assumptions as of FY20: exchange rate (¥/US$) 105, domestic naphtha price (¥/kl) 32,500
* FY20 net sales are approximate amounts based on application of "Accounting Standard for Revenue Recognition," etc., and are listed as reference values

Major Products

- Electronic & Advanced Materials
- Life Science
- Eco Business
- Chemicals
- Cement

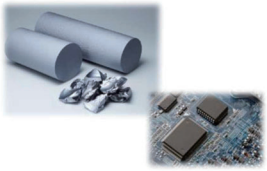
TOKUYAMA 2025

Major Products in Electronic & Advanced Materials

Silicon Business

Polycrystalline silicon for semiconductors
20% share of world market

Major products	Main applications
High-purity polycrystalline silicon	Raw materials for semiconductors silicon wafer



IC Chemicals Business

Tier1 for high-purity IPA,
Supporting miniaturization and purification of semiconductors

Major products	Main applications
High-purity IPA for the electronics industry	Electronic device cleaning and drying
Photoresist developer TMAH*	Developer for photoresist
IPA for for industrial use	Paint and ink solvents
Solvent for cleaning metals	Removing oil during material working

* Tetramethylammonium hydroxide

Major Products in Electronic & Advanced Materials

Silica Business

Top global market share of fumed silica for CMP slurries application

Major products	Main applications
Fumed silica	CMP*slurries agent Prevent paint, bond, and other liquids from dripping

* Chemical mechanical polishing (CMP): One form of wafer planarization technology used in the process of semiconductor production

Thermal Management Materials Business

Heat-dissipation material for semiconductors and other electronic components
75% share of world aluminum nitride powder market

Major products	Main applications
High-purity aluminum nitride	Parts for semiconductor production equipment Heat dissipation material Substrate material

Major Products in Life Science

Fine Chemicals Business

Plastic lens-related materials

World's No. 2 share at 20%

Major products	Main applications
Photochromic dye materials Eyeglass-related materials	Photochromic lenses

APIs and intermediates

Process development driven by organic synthesis technology
Thorough GMP* control

Major products	Main applications
APIs and intermediates	Medicine for dizziness, gastric ulcers, antipsychotics, high blood pressure, etc.

* Good Manufacturing Practice

Major Products in Life Science

Microporous Film Business

Breathable film repels water, but allows air and moisture to pass through

Major products	Main applications
Microporous film "Porum"	Back sheets for disposable diapers Mulching sheets for agricultural use

Dental Materials and Equipment Business

Tokuyama Dental Corporation
Composite resins for dental fillings

Diagnosis Business

A&T Corporation
Laboratory information system, diagnostic reagents

Annex

Major Products in Eco Business

Eco Business

Non-kiln recycling
World's first 100% complete recycling of gypsum boards

Tokuyama Chiyoda Gypsum

Major products	Main applications
Recycle of gypsum boards	100% recyclable gypsum

Ion Exchange Membranes Business

ASTOM Corporation

Ion exchange membranes and electrodialyzers for demineralization and concentration

Advanced Technology for Recycling Photovoltaic Panels Using Low-Temperature Thermal Decomposition

Under joint development with NEDO (New Energy and Industrial Technology Development Organization), aiming for commercialization

Major Products in Chemicals

Soda and Calcium Chloride Business

Only manufacturer of soda ash in Japan
High-quality products as food and beverage additives

Major products	Main applications
Soda ash	Raw material for glass, soap and detergents; food and beverage additives
Calcium chloride	Antifreeze agent

Chlor-Alkali and Vinyl Chloride Business

Energy saving, high-quality products based on a proprietary salt electrolysis technique

Major products	Main applications
Caustic soda	To digest and bleach pulp during paper production
Chlorine derivatives	Polyvinyl chloride Raw material for urethane resin

Major Products in Cement

Cement Business

Creates new business through application of cement technology
Enhanced infrastructure repair materials

Major products	Main applications
Cement and ready-mixed concrete	Civil engineering and construction
Cement-type stabilizers	Ground improvement

Recycling Business

Effective use and recycling of waste and byproducts (waste plastics, sludge and incineration ash) during cement production process

Production Bases

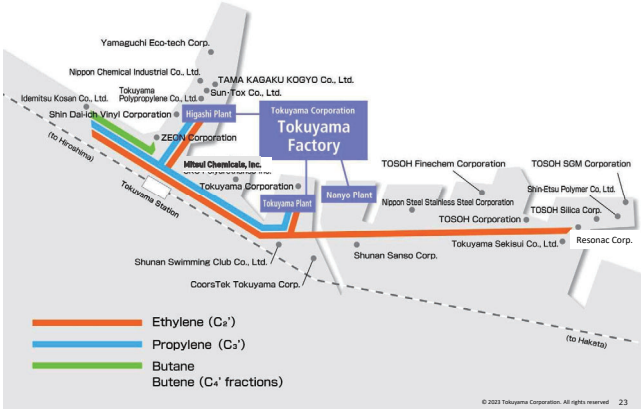
Tokuyama Factory

Kashima Factory

TOKUYAMA 2025

A Bird's-Eye View of the Tokuyama Factory

Shunan Industrial Complex



Annex

Production Capacity of Major Products at Tokuyama Factory

(as of April 1, 2023)

Product	Capacity
Cement * As a production capacity of clinker	4,520,000 tons/Y
Soda ash	200,000 tons/Y
Caustic soda	490,000 tons/Y
Vinyl chloride monomer (VCM)	330,000 tons/Y
Polyvinyl chloride (PVC) [Shin Dai-ichi Vinyl]	145,000 tons/Y
Propylene oxide (PO)	89,000 tons/Y
Chlorinated solvents (methylene chloride, chloroform)	55,000 tons/Y
Fumed silica	15,500 tons/Y
High-purity polycrystalline silicon	8,500 tons/Y
High-purity aluminum nitride powder	840 tons/Y
Isopropyl alcohol (IPA)	74,000 tons/Y
Tetramethylammonium hydroxide (TMAH) * 25% conversion	27,000 tons/Y

Features and Initiatives at the Tokuyama Factory

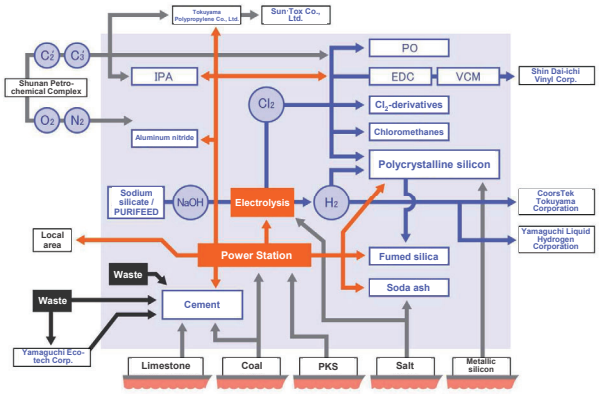
- Integrated Factory
- Zero Emission Factory
- Contributions to Mitigating Global Warming
- Harbor Facilities, Undersea Tunnel

Integrated Factory

Complex of plants of inorganic and organic chemicals, cement, electronic & advanced materials, etc.

Forming integration which can make the most of raw materials, products, by-products, and waste among plants mutually

Material Production Base with Advanced Integrated Management

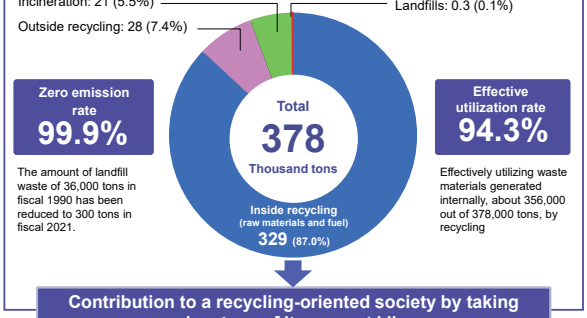


Features and Initiatives at the Tokuyama Factory

- Integrated Factory
- Zero Emission Factory
- Contributions to Mitigating Global Warming
- Harbor Facilities, Undersea Tunnel

Zero Emission Factory

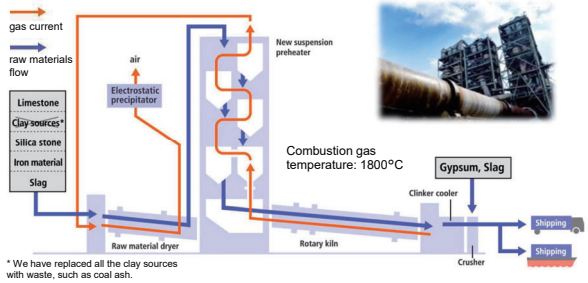
Breakdown of Industrial Waste Handling for Fiscal 2021



Contribution to a recycling-oriented society by taking advantage of its cement kilns

Annex

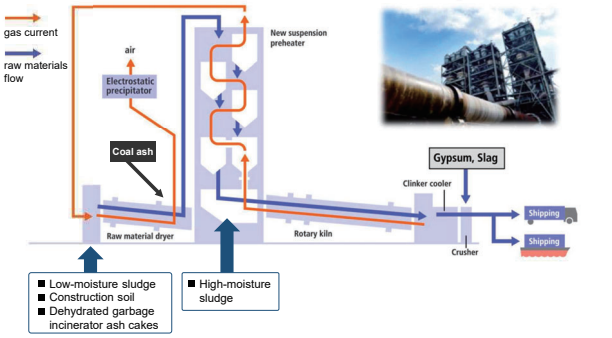
Flow of the Recycling Process in Cement Manufacturing



* We have replaced all the clay sources with waste, such as coal ash.

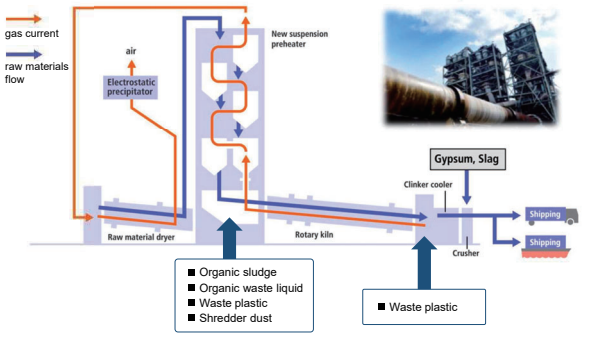
Waste and by-products recycled 1.77 million tons

Flow of the Recycling Process in Cement Manufacturing



Amount recycled as raw materials (material recycle) 1.66 million tons

Flow of the Recycling Process in Cement Manufacturing



Amount recycled as fuels (thermal recycle) 105,000 tons

Features and Initiatives at the Tokuyama Factory

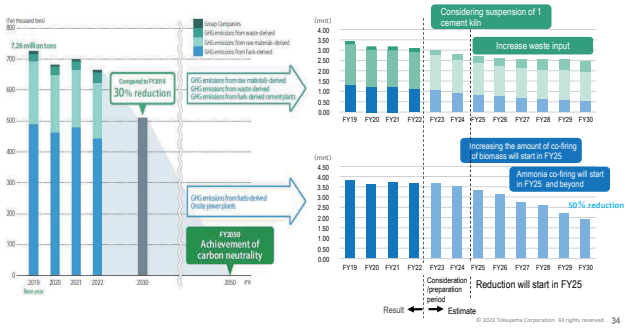
- Integrated Factory
- Zero Emission Factory
- Contributions to Mitigating Global Warming
- Harbor Facilities, Undersea Tunnel

Contribute to mitigation of Global Warming

Reduce greenhouse gas emissions 30% from FY19 by FY30

Originating from fuel (In-house power generation) ▶ Aiming for a 50% reduction in GHG emissions

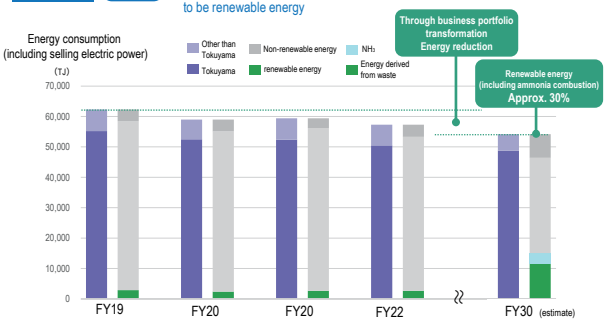
Originating from raw materials and waste (Cement, Chemicals, etc.)
- ▶ Considering suspension of a cement kiln, actively using waste for raw materials and fuel
- ▶ Currently exploring the potential of CCUS technologies, environmentally friendly products, etc.



Contribute to mitigation of Global Warming

Ratio of Renewable Energy Use by FY30 (including ammonia combustion) Approx. 30%

Originating from fuel (In-house power generation) ▶ Define the total amount of electricity generated by biomass, ammonia, and hydrogen to be renewable energy

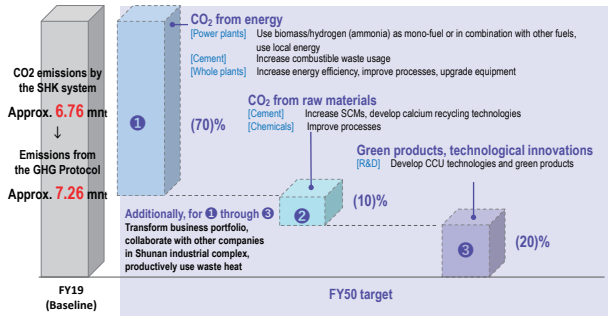


*Energy from thermal recycling of heavy oil ash, sludge (organic, fuel, valuable combustibles), etc., that is effectively utilized in cement processing is not included in energy originating from waste.

Annex

Contribute to mitigation of Global Warming

Aim to reduce energy-originated CO_2 emissions and achieve carbon neutrality by effectively utilizing CO_2 originating from raw materials, developing environmentally friendly products, etc.

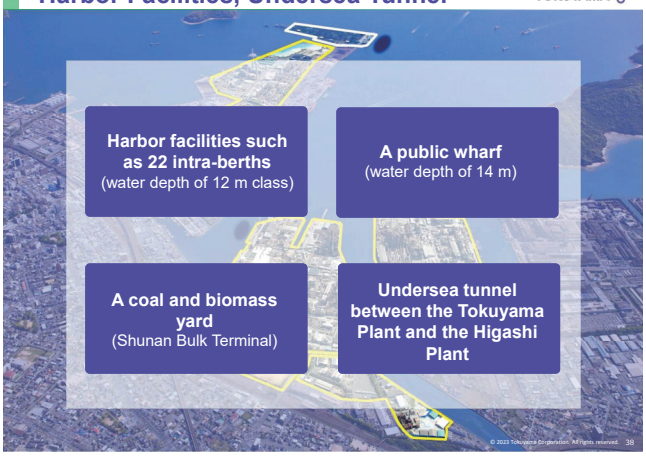


*This chart shows the breakdown of CO_2 emissions reduction targets under the Japanese SHK system

Features and Initiatives at the Tokuyama Factory

- Integrated Factory
- Zero Emission Factory
- Contributions to Mitigating Global Warming
- Harbor Facilities, Undersea Tunnel

Harbor Facilities, Undersea Tunnel



Overall View of Tokuyama Factory Grounds

Kashima Factory

Location: Kamisu, Ibaraki (Kashima Coastal Industrial Zone)
Site area: 101,000 m2

Features of the Kashima Factory

Manufacture of high-value-added products

Life science product manufacturing base contributing to healthcare

Products
- Plastic lens-related materials
- APIs/intermediates
- Dental materials and equipment (Tokuyama Dental)

Using flexible, small production to ship various products around the world

The factory meets diversified needs flexibly, sending products to over 70 countries and regions

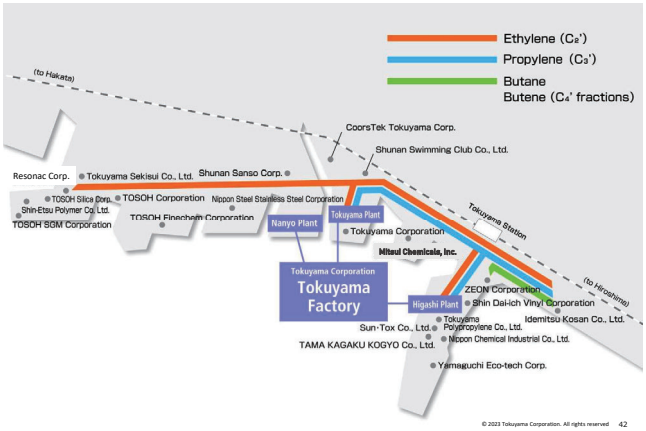
Annex

For the People of Tomorrow

TOKUYAMA

Shunan Industrial Complex

TOKUYAMA



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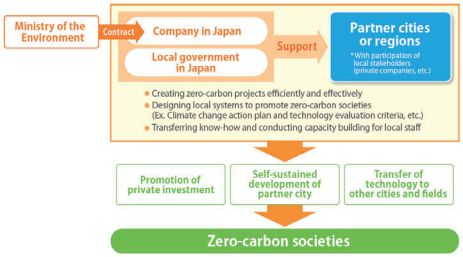
Annex

Co-Production of High-Calorie RDF and BBJP from Municipal Solid Waste

Beetle Engineering
Kitakyushu City
Institute for Global Environmental Strategies (IGES)

8th September 2023
Kick-off meeting with PT Indocement Tunggal Prakarsa Tbk

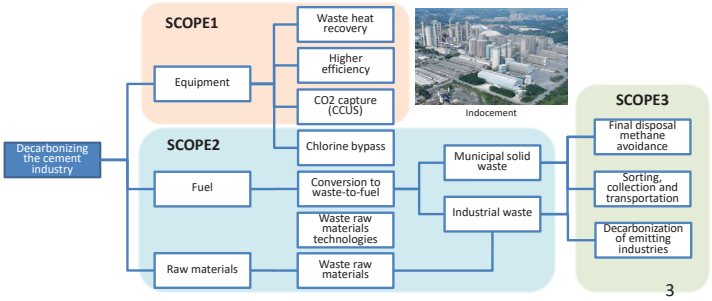
City-to-City Collaboration for Zero-Carbon Society



Subsidy to support implementation of feasibility studies (max 3 years)

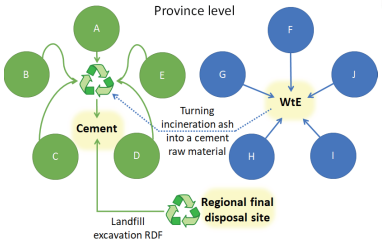
CO2 emission reduction from the entire supply chain

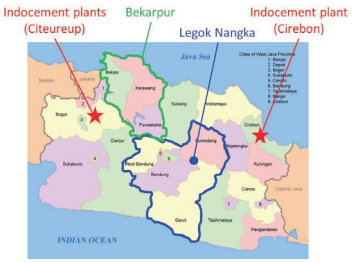
"Cement is the world's third-largest energy-consuming industry and the second-largest CO2-emitting industry"



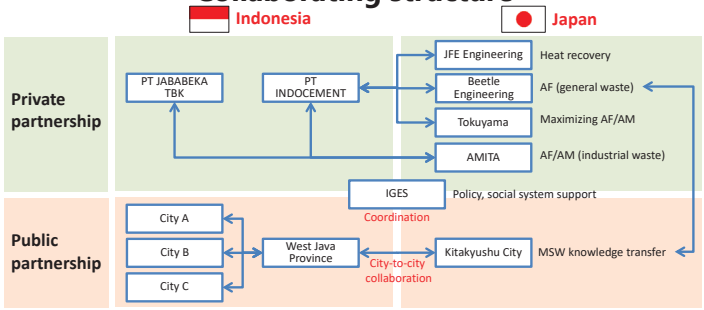
Indocement

Municipal solid waste collection area: Regional sharing approach





Collaborating structure



Existing RDF productions

SBI (Cilacap) type

- Mixed waste including wet organic waste
- Energy intensive process
- Low heating value
- Large CAPEX and OPEX
- Bad odor

PUPR (Denpasar) type

- Waste sorting
- Energy intensive process
- Low heating value
- Large CAPEX and OPEX

Common challenges

- Handling of wet organic waste
- Low heating value
- Stable supply at large quantity

Annex

10-20 ton/day scale

Surabaya City, Indonesia (Nishihara Corporation)

- Established as part of JICA ODA assistance (since 2013)
- Waste segregation facility + 20 ton/day composting center (Takakura Composting Method)
- Waste input: Municipal solid waste (market waste)
- Compost were sold to plantation company

Superdepo Sutorejo
(Waste segregation facility)

Compost Center Wonorejo II

Large-scale organic fertilizer production with PT Pupuk Indonesia

2016: 1,000,000 ton/year

2030: 6,900,000 ton/year

Concept of ECO PARK in Balikpapan city
(PT Pupuk Indonesia & Nishihara Corporation)

What Beetle Engineering can offer

Beetle Engineering

50 years of experiences in waste recycling industry (since 1972)

Waste sorting & recovery
(Super Depo, Surabaya)

Large-scale composting
(Wonorejo II, Surabaya)

RPF/CPF production
(Kitakyushu, etc.)

Concept of HC-RDF + BBJP

City-to-city collaboration in source separation, collection system, etc.

- High recycling rate
- Limited landfilling
- Low energy inputs
- Simple, compact, and short process
- Low CAPEX/OPEX
- Bankable project

Sorting

Mixed waste

- Dry waste 25%
  - Plastics
  - Papers
  - Woods
  - Textile
  - Rubber
  - → Drying, Shredding, Magnetic separation, Baling → HC-RDF
- Wet waste 60%
  - Organic (80% organic, 20% plastic) → Aerobic fermentation (70-80 °C), Maturation, Pelletizing → BBJP (Bahan Bakar Jumputan Padat (BBJP))
- Recyclables 5%
- Residue 10% → TPA

Annex

The Future-design Company

In pursuit of economic and material prosperity, modern society has come to treat people and nature as collateral cost.
AMITA designs a future in which people will find incalculable value in having a harmonious relationship with nature and human lives will not be looked upon as collateral cost.

AMITA

AMITA's Mission

AMITA is committed to achieving a sustainable society that will enhance **natural and relational capital** in a virtuous circle as it grows.

The Future-design Company
Designing the future

AMITA HOLDINGS CO., LTD. As of March 23, 2023

Company Info

- Established — April 1,1977
- Representative — Eisuke Kumano, Hiroyuki Sato
- Number of employees — 232(consolidated)
- Head office — Nakagyo-ku, Kyoto
- Stock listed on —Growth Tokyo(stock code: 2195)

Company Profile

AMITA HOLDINGS CO., LTD.

Head office: Nakagyo-ku, Kyoto
Headed by: KUMANO Eisuke, Chairman and Chief Visionary Officer
SUETSUGU Takahide, President and Chief Integrated Operations Officer
Established: April 1, 1977
Capital: 483,560,300 JPY
Number of employees: 232 (consolidated) (Corporate officers and temporary employees not included)
Stock code: 2195 on TSE Growth Market

Note: AMITA CORPORATION, a subsidiary of AMITA HOLDINGS, changed its name to AMITA CIRCULAR CORPORATION, effective January 1, 2023. AMITA CIRCULAR CORPORATION spun off part of its business into the newly established AMITA CORPORATION, effective January 5, 2023.

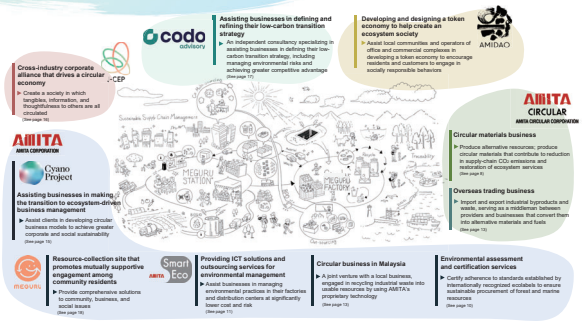
AMITA GROUP
Information current as of March 23, 2023

Wholly owned subsidiary	Wholly owned subsidiary	Wholly owned subsidiary	Joint venture
AMITA CORPORATION	AMITA CIRCULAR CORPORATION	AMIDAO	codo advisory
Transition strategy business	**Circular materials business**	**Ecosystem co-creation business**	**Low-carbon transition advisory**
Assist businesses in achieving greater corporate sustainability ・Define a vision ・Develop strategy ・Create circular business models ・Provide environmental assessment and certification ・Provide ICT solutions ・Provide business-process outsourcing **Assist municipalities in achieving greater community sustainability** ・Create a circular community design ・Create a social business in a community **Operate social systems designing business outside Japan** ・Operate resource-recycling business in Malaysia	**Provide end-to-end solutions for sustainable procurement and resource utilization** ・Develop circular materials ・Develop circular technologies ・Convert waste into circular materials for industrial use ・Provide a circular platform	**Leverage Web3 technology to provide a platform for creating an ecosystem society** ・Establish a DAO structure to carry out solution development projects ・Build a network for co-creating value ・Assist with proof-of-concept field tests ・Assist in issuing tokens (cryptocurrency)	**Assist businesses in defining and refining their low-carbon transition strategy** ・Assist businesses in meeting globally accepted sustainability requirements ・Assist businesses in addressing concerns of foreign investors about corporate environmental risks and greenwashing practices ・Assist businesses in meeting national and regional environmental targets

Wholly owned subsidiary in Malaysia: AMITA ENVIRONMENTAL STRATEGIC SUPPORT (MALAYSIA) SDN. BHD. (AESS)
Joint venture in Malaysia: AMITA BERJAYA SDN. BHD.
(Joint venture established by AESS and the Malaysia-based BERJAYA Group)

(Joint venture established by AMITA HOLDINGS and MCP Japan Holdings)

Business Lines at a Glance



AMITA's WAY

1980	Social issues	Increasing public demand for anti-pollution measures; soaring procurement costs of materials in a financial slump	Turning a volatile supply of waste into a stable supply of usable resources → Closed-loop resource recycling
	Social needs	Alternative resources in place of natural resources	
1990	Social issues	Fast-paced deterioration of the natural environment; widespread depletion of natural resources	Assessing and certifying the traceability in materials procurement → Environmental assessment and certification
	Social needs	Greater environmental stewardship	
2000	Social issues	More rigorous enforcement of regulations and international standards on environmental management	Balancing the risk control and the allocation of corporate resources → Cloud-based services for environmental management
2010	Social needs	Balancing environmental risks and costs	→ End-to-end environmental solutions
2020	Social issues	Pervasive anxiety and loneliness among people	Designing a virtuous cycle of tangibles, information, and people's thoughtfulness to others → MEGURU STATION®
	Social needs	Socially driven circular economy	→ J-CEP
			→ Program for developing circular business models
2022	Social issues	Increasingly stringent environmental restrictions; widening global divide	
2023	Social needs	Achieving low-carbon business management that meets globally accepted standards Visualizing and deepening engagement with stakeholders	→ Low-carbon transition advisory → Token services enabled by Web3 technology

Circular Materials Business

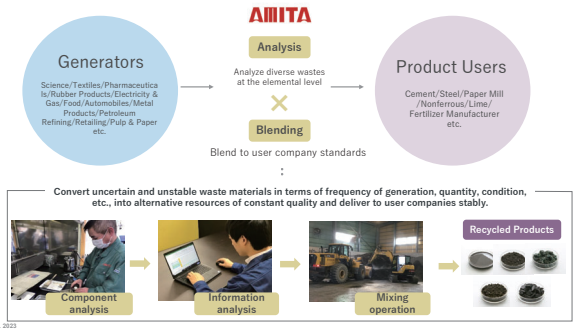
We will enhance our unique "blending technology" and provide an advanced "100% recycling service" that manufactures alternative products from industrial waste to natural resources.
This manufacturing service of circular materials has been proven to contribute to CO2 reduction and restoration of ecosystem services, the more it is utilized.

AMITA

Annex

AMITA's 100% Recycling Operation

"Blending" technology that turns uncertainty into certainty



AMITA's 100% Recycling Operation

Nationwide Resource Recycling Network

The Platform for Resource Recycling

Promoting waste recycling, especially in Asia

Since our founding in 1977, AMITA Group has been committed to 100% recycling of industrial waste.

Since the 1980s, we have been engaged in overseas trading of waste and by-products (valuable resources).

In 2017, we established and began operating a 100% recycling plant in Malaysia in addition to its domestic operations.

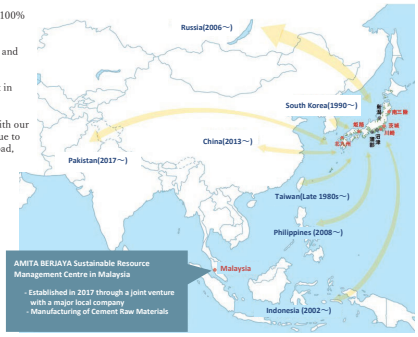
Through our own Resource Recycling Plants and in collaboration with our partners, we will form a resource recycling platform. We will continue to promote the recycling and utilization of resources in Japan and abroad, particularly in Asia, where economic growth is remarkable.

International Trading Regions

Experience : More than 7 countries
( ) ...Transaction start date

Major Alternative Raw Materials and Fuel Conversion Results

Cement / Nonferrous / Steel / Rare metals / Chemicals / Chemical products/ Chemicals, Food additives, etc.



Recycling Services in Malaysia

data 01 Noticeable increase in incoming shipments & Significant contribution to ordinary income

- After a temporary suspension of incoming and outgoing shipments due to the coronavirus, this service was recognized as an essential local social infrastructure, and a permit was obtained from the government to resume operations.
- Strong performance due to increased manufacturing capacity & growing local demand

Investment income based on the equity method related to Malaysian operations

Increased about **8.5** times in 2 years

in 2022

To stabilize and further develop our Malaysian business, we will focus on developing new users of recycled resources and acquiring new projects in order to stabilize shipments.

Medium-term Business Plan

- Development of 100% recycling business in Southeast Asian countries
- Contribution to international resource recycling through collaboration with other companies

AMITA's Products (ARM & AF)

Ash, Slag, Dust, Water treatment Sludge, Waste Plastics, Any solid waste generated from the manufacturing process of various types of industry are used as our materials.

Sourcing raw materials

Ash, Slag, Sludge, Waste Plastics, any Solid waste such as burnt or process residue etc..

How product is used

As Alternative Cement Raw Materials & Aas Alternative Fuel (coal)

End-Users

Cement manufacturers

Production capacity (in Japan)

12,000-13,000 MT / month

Input

Output ARM & AF (solid)

AMITA's Products (SMX)

Waste oil, alkali, acid and waste solvents not reused and discarded for the reason of contamination of impurities are recycled to utilize their calories, which is SlurMix®. Mainly cement manufacturers use this as alternative fuel to coal and heavy oil.

Sourcing raw materials

Liquid waste:
Waste oil, waste acids, waste alkali, sludge, etc..

How product is used

Alternative Fuel of coal and heavy oil

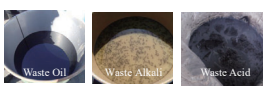
End-Useres

Cement and Steel manufactures
Non-ferrous smelting manufacturers, etc.

Production Volume (in Japan)

1,500-2,000 MT / month

Input



Output AF (SlurMix®)

Annex

DOE Visits to Japan

2014, DOE at AMITA's Kitakyushu Plant

December 2014, DOE at Kitakyushu Eco Park

DOE Visits to Japan

March 2016, DOE at Kitakyushu Eco Park

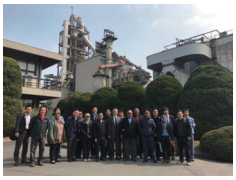
January 2017, at Kitakyushu Eco Park

DOE Visits to Japan

February 2019, at Tokyo, MOEJ
（資源循環局　山本局長）

February 2019, at Ibaraki plant

DOE Visits to Japan



February 2019, at Cement Plant

February 2019, at Automotive Recycle Plant

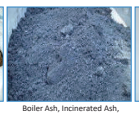
Sustainable Resources Management Centre

Aerial View of AKBK Facility

15 Approved SW Codes

SW 104, 110, 202, 203, 204, 207, 310, 311, 316, 319, 321, 406, 411, 416, 427

Inorganic Sludge, Organic Sludge, Sewerage Sludge, etc.



Boiler Ash, Incinerated Ash, etc.

Foundry Sand、Slag, etc.

Coal Ash, Collecting Ash, EP Ash, etc.

Spent Catalyst, etc.

Shot Powder, Grinding Powder, etc.

Cullet, etc.

Annex

AMITA BERJAYA SDN BHD

ARM & AF Making Process For Cement Co-Processing

(1) Blender ⇒ (2) Dust Collector ⇒ (3) Magnetic Separator ⇒ (4) Vibrating Screen ⇒ (5) Product

MOU signed with "Indocement"

Full-scale start of challenges in indonesia

AMITA HOLDINGS CO., LTD., a preeminent Japanese provider of circular and sustainability solutions and services, today signed a memorandum of understanding (MOU) with PT Indocement Tunggal Prakarsa Tbk. ("Indocement"), a leading cement producer in Indonesia, on conducting a joint feasibility study.

The scope of the study agreed upon in the MOU includes assessing the feasibility of developing and promoting carbon-neutral, circular business models in Indonesia, as a basis for pursuing a business partnership between the two companies in the country

INDOCEMENT HEIDELBERGCEMENT Group

AMITA

Signing ceremony , 19th May 2023

MOEJ City to City collaboration
実施体制 (Project Structure)

	Indonesia		Japan	
案件形成調査 (Private partnership)	PT INDOCEMENT	PT JAVABEKA TBK	JFE Engineering Waste Hear Recovery	Tokuyama Cement recycling
			AMITA Industrial Waste Recycling	Nishihara Municipal Waste Recycling
制度構築支援 (Public partnership)	Bogor Regency Bekasi Regency Cirebon Regency	West Java Province	City of Kitakyushu Eco Town Management	
	KLHK	PT SMI	IGES Overall coordination, RDF Guidelines	

Solution Business
for realizing a circular economy society

MEGURU STATION® ;Mutual Aid Community-based Resource Collection Station

Cyano Project ;Supporting the creation of a circular economy business

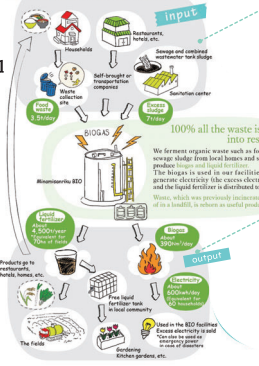
AMITA

Biogas facility where life circulates

Minamisanriku BIO

A local resource circulation model that "turns uncertainty into certainty" in terms of people's social motivation.

Minamisanriku BIO ferments food waste and sewage sludge to produce energy and liquid fertilize



Pre-processing

By Residents Separation of kitchen waste

Foreign matter contamination rate in food waste collected from households is extremely low, around 1%.

Importance

Relationships and circulation omit "pre-processing and post-processing"

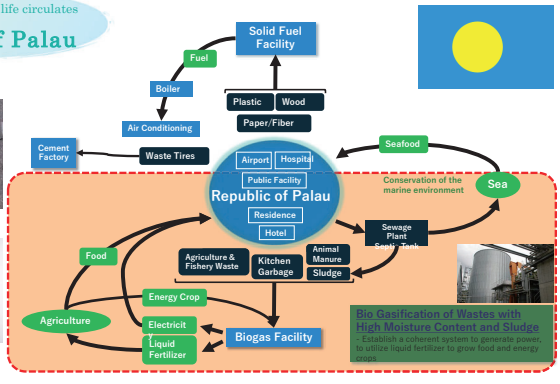
Post-processing

Effective use of digestive juices generated after fermentation

Effective use of liquid fertilizer by residents on farmland and at home, other than wastewater treatment or discharge into rivers using chemicals, etc.

Biogas facility where life circulates

Republic of Palau



Annex

Environmental Assessment & Certification

SCAN ME

Forests twice the size of a baseball stadium are said to be disappearing every minute from the face of the earth. One-third of the global marine resources are being overexploited (based on 2019 data). Businesses have the increasing need to upgrade their supply chain management, including having dependable suppliers of raw materials and mitigating their procurement risks.

Protecting forest resources through:
FSC® forest certification
PEFC forest certification

AMITA was the first to offer FSC® forest certification services in Japan.

Conserving marine environment and resources through:
MSC certification
ASC certification

AMITA was the first to offer MSC/ASC CoC certification services in Asia.

AMITA works with the Soil Association and SCS Global Services to provide forest assessment and certification services.

Helping build a transparent and sustainable supply chain

Ensuring supply-chain traceability

AMITA helps maintain environmentally, socially, and economically responsible management of forest and marine resources.
We certify for sustainable forestry, fishery, and aquaculture, and assess and certify responsible processing and distribution of forest and marine resources as part of our efforts to protect the environment and preserve natural resources.

1999 Launches FSC® forest assessment and certification service.
2006 Launches MSC CoC assessment and certification service.
2010 Becomes an official assessor for MSC CoC certification.
2012 Becomes an official assessor for ASC CoC certification.
2016 Becomes an official assessor for ASC aquaculture certification.

Cloud Services for Environmental management

SCAN ME

Service menus of AMITA Smart Eco solutions

AMITA provides ICT and outsourcing solutions to help corporate clients reduce risks and costs associated with environmental management.

AMITA Smart Eco

Facilitating more efficient and cost-effective environmental management

Smart Sensing
Sensors installed in a waste depot automatically measure the amount of stored waste, eliminating the need for a manual inspection of the depot and streamlining the waste-disposal process.

Smart On-site Patrol
Enables the quick image-, voice-, and text-based sharing of on-site environmental information gathered during routine patrol.

outsourcing

Smart Management
Enables the centralized online management of hazardous-waste manifests (in paper or electronic form), waste-disposal permits, and disposal service contracts. A dedicated staffer checks the documents for regulatory compliance before uploading them into a master database.

Smart Remote Inspection
Enables the remote inspection of the performance of a waste-disposal service provider. Videoconferencing eliminates the need for in-person on-site inspection.

MEGURU STATION®

Accelerating development of "MEGURU STATION ®" to provide integrated solutions to local, corporate, and social issues

Four major issues in the region
- Declining population
- Shrinking employment
- Low birthrate and aging population
- Increased social security costs

Corporate Issues
- Circular economy in practice
- Circular business development
- Procurement of recycled resources
- Plastics issues

Global environmental issues
- Resource depletion
- Climate change
- Energy problems

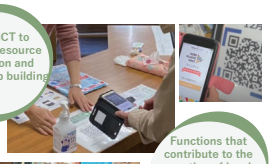
Demonstration area

Minamisanriku Town (Miyagi Prefecture)/ Ikoma City (Nara Prefecture)/ Kobe City (Hyogo Prefecture), Tachiarai Town (Fukuoka Prefecture)

MEGURU STATION®

Separation, collection, and recycling of household waste

Use of ICT to promote resource circulation and relationship building

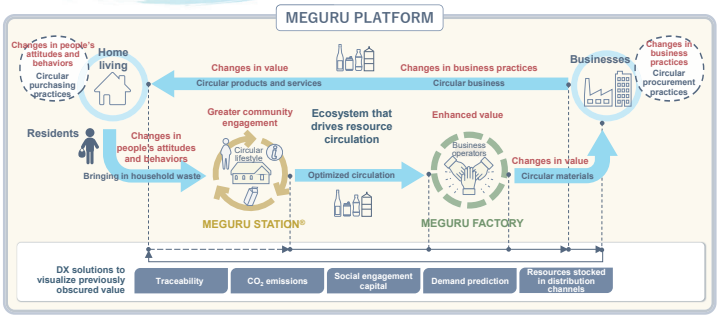


Functions that contribute to the creation of local industries and the promotion of welfare

Mechanisms for community building through mutual aid and mutual assistance among residents

MEGURU PLATFORM

Brings us closer to an ecosystem society



J-CEP

J-CEP

Japan Circular Economy Partnership

Dozens of corporate members of J-CEP have joined forces to develop business models for circular economy in collaboration with community residents, municipal authorities, and universities.

Creating a society in which tangibles, information, and thoughtfulness to others are all circulated

Objectives
1. Optimize resource circulation in Japan
2. Create business models that help achieve a sustainable society

Key initiatives
- Design sustainable products
- Design and implement a scheme for collecting used products and packages from consumers
- Research and develop recycling methods and technologies

Corporate Members List

AMITA HOLDINGS chairs the steering committee of J-CEP and manages its administrative office.
(In alphabetical order. Steering committee members in colors)

- Asahi Kasei Corporation
- Fujimori Kogyo Co., Ltd.
- Marubeni Corporation
- Marubeni Forest Link Co., Ltd.
- Mitsubishi Chemical Corporation
- Mitsubishi Corporation Plastics Ltd.
- Mitsui Chemicals, Inc.
- Nagase Plastics Co., Ltd.
- Nihon Yamamura Glass Co., LTD.
- Nissha Co., Ltd.
- OBAYASHI CORPORATION
- SAKATA INX CORPORATION
- Sekisui Chemical Co., Ltd.
- Sojitz Pla-Net Corporation
- TOYOTA TSUSHO CORPORATION
- Dai Nippon Printing Co., Ltd.
- DIC Corporation
- Kai Corporation
- Kao Corporation
- Kawakami Sangyo Co., Ltd.
- Kracie Holdings, Ltd.
- Lion Corporation
- Maruiten Corporation
- Nestle Japan Ltd.
- Pola Orbis Holdings Inc.
- Rock Paint Co., Ltd.
- S.T. CORPORATION
- Shabondama Soap Co., Ltd.
- Sunstar Inc.
- ThreeHigh Co., Ltd.
- Toppan Inc.
- UCC HOLDINGS CO., LTD.
- Unicharm Corporation

Consumer products

Materials, trading and construction

55 corporate members as of JULY 10, 2023

Resource-circulation and sustainability

ICT solutions

- Chatrobe Inc.
- NEC Solution Innovators Ltd.
- NTT Communications Corporation
- ziggbe Inc.
- Fujitsu Japan Limited
- NEC Corporation

Financial

- Sumitomo Mitsui Trust Bank, Ltd.

9 Observer members

- Hokkaido UNIVERSITY
- Kobe City
- Kobe University Graduate School of Human Development and Environment
- the Ministry of Economy, Trade and Industry
- the Ministry of the Environment
- National Institute of Advanced Industrial Science and Technology
- the Research into Artifacts Center for Engineering, the University of Tokyo
- Smart City Institute Japan
- The University of Kitakyushu

- Allbeam Consulting Ltd.
- AMITA HOLDINGS Co., Ltd.
- CHUBU NIHON PLASTICS CO., LTD.
- EGIS Co., Ltd.
- Fuyo General Lease Co., Ltd.
- General Incorporated Association nancei group
- Hanita Metal Co., Ltd.
- J&T Recycling Corporation
- J-CIRCULARS Inc.
- Kowa Seiko Co., Ltd.
- Pantech Corporation
- Riki Consulting Group,Inc.
- Sanyu Kankyo Sogo Kenkyujo Co., Ltd.
- Sumitomo Mitsui Finance and Leasing Company, Limited
- TBM Co., Ltd.

SCAN ME (JP)

Annex

J-CEP

J-CEP's Joint PoC Projects Built around MEGURU STATION®

Overview | Carried out joint PoC projects to design a resource circulation scheme and create a community engagement space

Project 01 Collect sorted household plastic waste
Project members: AMITA, Kawakami Sangyo, Mitsui Chemicals, Pantech
▶▶▶ Made benches from collected plastic caps and bottles to support Kobe's circular recycling initiative.

Project 02 Promote a mutually supportive community
Project members: AMITA, Nestle Japan
▶▶▶ Offered complementary soft drinks and snack food to visitors to make it a community engagement space.

Project 03 Use ICT solutions to encourage more residents to use the station
Project members: AMITA, NEC Solution Innovators
▶▶▶ Used QR codes to collect data on the number of residents who used the station and to offer them an incentive program.

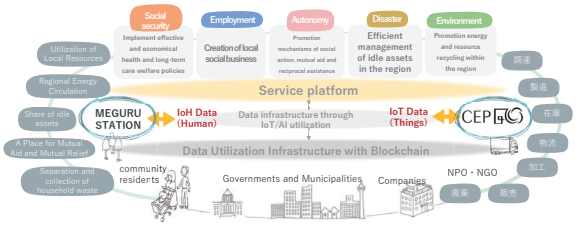
Project 04 Conduct a research and development project for horizontal recycling of plastic packages
Project members: AMITA, Lion, Mitsui Chemicals, Sunstar
▶▶▶ Recycled used toothbrushes into rulers as a PoC trial for sustainable product designing.

Key initiatives for FY 2023 and beyond
Carry out two PoC projects:
01. Operate a prototype BYOB shop to encourage the reuse of bottles and containers
02. Standardize bottles and containers for daily necessities and verify their recyclability from collection to reuse

J-CEP is promoting a cross-industry circular economy.

Platforms necessary to address social issues

We build a platform for stable circulation and promotion of uncertain resources, energy, and people's social behavior throughout society. & We process aggregated information based on unified value (sustainability) and promote innovation to solve social issues.



Sustainable Industry and Lifestyle Design

FY2023 City-to-City Collaboration for Zero-Carbon Society Programme

（Feasibility Study on the Decarbonisation of the Cement Industry in West Java Province, Indonesia）

Commissioned Report

March 2024

Kitakyushu Urban Centre, Institute for Global Environmental Strategies (IGES)

International Village Centre 3F, 1-1-1 Hirano, Yahata-higashi-ku, Kitakyushu City, 805-0062

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