Kementerian PPN/ Bappenas

SIPA
Sustainable Infrastructure Programme in Asia

UNDP

ASSESSMENT AND POLICY DIRECTION FOR ENERGY-BASED WASTE MANAGEMENT (WASTE TO ENERGY) RDF CASE STUDY: TOWARDS THE DEVELOPMENT OF A ROADMAP FOR WTE EXPANSION IN INDONESIA, 2026-2045

1st Book

GAP ANALYSIS ON RDF IMPLEMENTATION

Supported by:

Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

IKI INTERNATIONAL CLIMATE INITIATIVE

OECD

Collaboration with:

Executive Summary

CONDITIONS AND WASTE MANAGEMENT ISSUES IN INDONESIA

Indonesia faces significant challenges in waste management, with waste generation reaching 68–70 million tons as of 2023. However, only 48.61% of the waste has been managed, while the remaining ends up in final processing site (tempat pembuangan akhir /TPA)[1]. The pressure on TPA capacity is projected to increase until 2028[2], which may cause serious environmental impacts if not properly addressed. Around 41–42% of Indonesia's waste is still sent to TPA[3], and 40.09% of TPA still operate using an open dumping system[4]. This highlights that Indonesia is facing a waste crisis due to its dependence on TPA-based disposal systems. Improving waste governance has thus become a national priority to build a more sustainable waste management system that can respond to current challenges.

One of the solutions being adopted is the use of refuse-derived fuel (RDF) technology, which processes waste into an alternative fuel that is more environmentally friendly and can be used in various industries, including coal-fired power plants (PLTU). RDF also helps minimize the volume of waste sent to TPA. This is because RDF utilization, if implemented at scale, is seen as a potential driver of economic growth, job creation, and reduced dependence on fossil fuels. Nevertheless, RDF still needs further assessment to ensure its appropriateness and sustainability as part of Indonesia's waste management strategy.

RDF POTENTIAL IN THE DEVELOPMENT OF INDONESIA

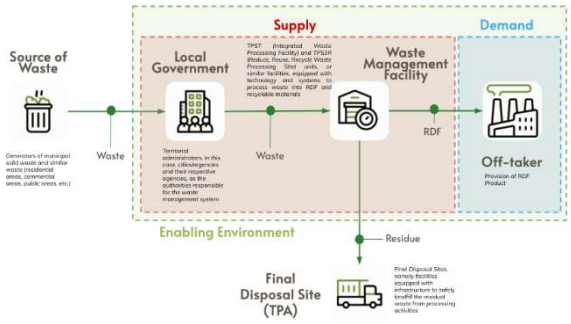
When properly planned and implemented, RDF plays a vital role in reducing dependency on fossil fuels while also addressing the growing concern over TPA capacity. In addition to that, RDF supports national energy policy and contributes to reducing greenhouse gas (GHG) emissions. In line with this policy direction, RDF has been included as part of the national strategy for energy transition and sustainable waste management, positioning it as one of the key efforts to reduce environmental impact and carbon emissions.

National Waste Processing[5]	Target of RNE[6]	GHG Emission Reduction[7]
100% of households are targeted to have full access to waste collection services by 2045.	The energy transition aims to reach peak emissions by 2035 and achieve net zero emissions by 2060.	The targeted reduction in greenhouse gas (GRK) emissions is 31.89% by 2030 through domestic efforts and 43.20% with international support. Converting 4.6 million tons of waste is projected to reduce 1.9 million tons of CO_2 equivalent (CO_2e).
Waste processed at waste treatment facilities is expected to reach 90%, including 35% waste being recycled by 2045.	The renewable energy mix (EBT) target by 2030 is set at 19%–21%.	
	The EBT mix target by 2060 is projected to reach 70%–72%.	

[1] National Waste Management Information System 2024
[2] National Medium-Term Development Plan (RPJMN) 2025–2029
[3] Ministry of Energy and Mineral Resources, Presentation Material at Bioshare Series #14, October 2024..
[4] Ministry of National Development Planning (Bappenas), Presentation Material at FGD 1: Preparation of the Roadmap for RDF Development in Indonesia, December 2024..
[5] National Long-Term Development Plan (RPJPN) 2025–2045
[6] Indonesia's National Energy Policy
[7] *Enhance National Determined Contribution Indonesia,* 2022.

THE URGENCY OF STUDYING RDF IMPLEMENTATION GAPS

The application of RDF has the potential to serve as an alternative solution to improve sustainable waste treatment, thereby reducing the residual waste (timbulan sampah) that ends up in TPA. However, to ensure the appropriate and optimal implementation of this technology, a comprehensive gap analysis must first be conducted. ***Book 1: Study on RDF Implementation Gaps*** is aimed at assessing various key factors related to RDF development in Indonesia, including relevant policies and regulations, infrastructure and technological readiness, as well as available financing schemes. Moreover, this study also seeks to develop strategic recommendations for RDF implementation as part of a more sustainable waste management effort.



This study is structured based on the grouping of supply, demand, and enabling environment within the RDF process flow implemented in Indonesia:

- **Supply** or RDF supply, covers the entire process from collection to the conversion of waste into RDF.
- **Demand** or RDF utilization, refers to its use by industries/offtakers that use RDF as an alternative fuel source in their production processes.
- **Enabling Environment** or the provision of a supporting ecosystem, includes policies, incentive mechanisms, and other measures aimed at encouraging the sustainability of RDF production and increasing its market demand within relevant industries.

GAPS IN RDF IMPLEMENTATION IN INDONESIA

RDF has begun to be implemented in several industries in Indonesia as an alternative fuel derived from waste, particularly in the cement and power generation sectors. However, in practice, the utilization of RDF in Indonesia still faces various challenges that must be addressed to ensure optimal development.

Aspect	Key Gap Points
RDF Supply	
Governance	• There are no established policies or guidelines to define the entity and institutional framework for RDF management, including tools for performance monitoring. • No technical guidance is available regarding work arrangements in RDF management to support the use of produced RDF.
Planning	Not all regencies/cities have integrated RDF projects into their waste management planning documents.

Infrastructure & Technology	• RDF supply sustainability is not yet secured, and TPST (intermediate processing facilities) are still suboptimal in meeting *offtaker* needs.
	  ○ Of the 221 RDF facilities, only 22% demonstrate good operational performance, while over 78% operate below capacity.
	• Potential industries exist in several regions, but RDF facilities are either unavailable, suboptimal, or undercapacity.
	  ○ RDF distribution to various industry sectors is limited by technical quality specifications required by *offtakers*.
	  ○ Some facilities are designed for certain industries only, limiting flexibility to produce RDF according to different specifications.
	• Limited human resource capacity in terms of planning and contractor expertise.

Aspect	Key Gap Points
Financing	• RDF financing still relies heavily on government funding, while private sector involvement remains limited. • Operating and maintenance costs of RDF production facilities have not yet adopted a sustainable business model. • The average waste management budget allocation by local governments is only 0.64% (based on Kementerian Dalam Negeri data 2024).
Environmental and Social Protection	• RDF is not yet included in local governments' waste and climate policies. • Lack of formal community involvement and limited public education regarding the benefits of RDF.
RDF Utilization	
Infrastructure and Technology	• High investment is required to replace/modify equipment and build supporting infrastructure in the *offtaker* industries. • Non-cement industries such as fertilizers, paper, steel, and chemicals have potential to utilize RDF, but many are still in the early assessment stages. The transition requires innovative and high-risk technology with high upfront investment, discouraging companies from full implementation.
Financing	Lack of attractive RDF incentive schemes to encourage potential offtakers.
Environmental and Social Protection	• Emission quality standards for RDF use are stricter compared to non-hazardous waste (non-B3), even though RDF is classified as non-B3. ○ Regulations are currently limited to the cement industry that uses RDF as a main fuel. • Industry lacks capacity to manage diverse emissions effectively.
Supporting Environment	
Regulation and Norm, Standard, Procedure, and Criteria (NSPK)	• Specific RDF technology implementation as part of the renewable energy mix (EBT) is not yet fully supported by comprehensive regulatory frameworks. • Limited availability of NSPK (technical standards and procedures) supporting RDF implementation. ○ Available NSPK: SNI for PLTU co-firing, RSNI BBSS for the cement industry, and RDF fuel quality standards.
Market Development	• RDF production and utilization capacity remains unbalanced. • Absence of clear technical standards causes industries to be reluctant to invest in RDF utilization.
Incentive Schemes	• Lack of fiscal and non-fiscal incentive mechanisms to promote RDF use. • Limited incentives/support provided to local governments that implement RDF.
Capacity Strengthening	No institutional support exists to enhance human resource capacity for RDF implementation, including training and curriculum development.
Research and Development	Limited collaboration in RDF research between government, academia, and industry.

RECOMMENDATIONS AND STRATEGIES

To address the various challenges, this study recommends a number of strategic actions that should be taken to support stakeholders in the event RDF is chosen as a solution for waste management. Based on the study's findings, the following key recommendations have been formulated as priority steps:

	Key Recommendation	Responsible Institutions
1	**Policy Strengthening (*policy-driven*):** Includes incorporating RDF into the EBT mix, revising Presidential Regulation 35/2018 (RDF option in *waste-to-energy/WtE*), and updating Presidential Regulation 97/2017 to serve as a regulation for waste management transformation.	Ministry of National Development Planning (Bappenas), Ministry of Energy and Mineral Resources, Ministry of Environment
2	**RDF Facility Provisioning** based on: waste issues, availability of *offtakers*, and economic scale (reference: RDF Cilacap 120 tons/day).	Ministry of National Development Planning (Bappenas), Ministry of Public Works, Ministry of Environment, Local Government
3	**Balancing RDF Supply and Demand** by considering: quality standardization, competitiveness with other EBT sources, and availability of utilizing industries.	Ministry of Public Works, Ministry of Industry Ministry of Energy and Mineral Resources Ministry of Home Affairs
4	**Long-term Cooperation Agreements** to ensure continuity and investment return for RDF utilization.	Ministry of Industry Ministry of Energy and Mineral Resources Ministry of Home Affairs.

	Key Recommendation	Responsible Institutions
5	**Integration of RDF into the Circular Economy** through regulation on circular economy to strengthen industry support.	Ministry of National Development Planning (Bappenas) Ministry of Environment
6	**Strengthening RDF Demand through Industry** by enforcing RDF usage obligations in industry through regulations (starting with state-owned enterprises in 2030) and establishing incentive mechanisms.	Ministry of National Development Planning (Bappenas) Ministry of Energy and Mineral Resources Ministry of Industry Ministry of Finance, Ministry of Environment, Kementerian BUMN

Furthermore, the study also formulates strategic recommendations to address the challenges in RDF implementation and support its long-term sustainability.

Aspect	RDF Supply	RDF Utilization	Supporting Environment
Governance and Regulation	• Develop guidelines to determine RDF managing entities. • Improve performance monitoring mechanisms. • Develop operational work arrangements in RDF management.		• Integrate RDF into national development strategies. • Revise regulations related to WtE and waste management transformation • Strengthen NSPK and technical standards.
Infrastructure and Technology	• Develop RDF technology design standards. • Melakukan modernisasi fasilitas RDF yang belum optimal. • Melakukan evaluasi teknis berkala • Memetakan potensi *offtaker* RDF.	Introduce reward/incentive mechanisms.	Strengthen local RDF support infrastructure through policy and incentives.
Financing and Incentives	• Develop PPP (KPBU) schemes. • Formulate access to green financing. • Align RDF CAPEX cost recovery with RDF performance. • Establish clear RDF cost guidelines (tipping fee).	Develop fiscal and non-fiscal incentive schemes for RDF utilization in industry.	• Design tax and investment schemes. • Develop streamlined permitting/licensing procedures. • Strengthen RDF price formulation mechanisms.
Environmental and Social Protection	• Set RDF emission reduction targets in GHG policies. • Develop guidelines for calculating emission reductions. • Develop green jobs schemes.	Revise BME requirements for RDF users.	• Integrate RDF into environmental protection planning. • Improve coordination mechanisms for regional RDF emission reporting.
Market Development	Ensure RDF supply continuity by involving actors, securing offtakers, and guaranteeing RDF quality.	• Promote RDF use across multiple industries. • Encourage the creation of RDF purchase agreements between local governments and investors.	• Strengthen market mechanisms by supporting buyer-seller interaction. • Promote RDF purchase contract models across sectors.
Capacity Building and Research	• Provide technical assistance to local governments (Pemda). • Develop technical standards and human resource competencies in RDF planning.	Enhance technical research for more efficient RDF technologies.	• Establish a national research center for RDF. • Strengthen research collaboration between government, academia, and industry.

This study provides a recommendation model for RDF supply and management, including financing schemes for RDF implementation. It involves relevant ministries, institutions, facility operators, and RDF *offtakers*. The model that illustrates *government-driven* RDF implementation offers regulatory certainty and full government support, but presents challenges in terms of efficiency in both management and funding. On the other hand, *private-driven* implementation offers greater efficiency but requires government oversight. A hybrid model involving both government and private sector support demands more complex coordination among all stakeholders.

Overall, RDF holds significant potential to address waste issues and support Indonesia's transition toward more sustainable energy. However, to achieve optimal benefits, an

integrated and collaborative effort is required between government, the private sector, and various other stakeholders. By providing an enabling ecosystem in terms of *supply*, *demand*, and *enabling environment*, RDF can serve as a long-term solution to manage waste more effectively while minimizing its negative environmental impact.

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List of Abbreviations

Abbreviation	Full Form
3R	Reuse, Reduce, Recycle
APBD	Regional Revenue and Expenditure Budget (*Anggaran Pendapatan dan Belanja Daerah*)
APBN	State Revenue and Expenditure Budget (*Anggaran Pendapatan dan Belanja Negara*)
ASN	State Civil Apparatus (*Aparatur Sipil Negara*)
ASTM	American Society for Testing and Materials
B2B	Business to Business
B3	Hazardous and Toxic Substances (*Bahan Berbahaya dan Beracun*)
BaU	Business as Usual
BBA	Alternative Fuel (*Bahan Bakar Alternatif*)
BBJP	Solid Refuse-Derived Fuel (*Bahan Bakar Jumputan Padat*)
BEP	Break-Even Point
BLPS	Waste Management Service Assistance (*Bantuan Layanan Pengelolaan Sampah*)
BLUD	Regional Public Service Agency (*Badan Layanan Umum Daerah*)
BPDLH	Environmental Fund Management Agency (*Badan Pengelola Dana Lingkungan Hidup*)
BME	Emission Quality Standard (*Baku Mutu Emisi*)
BSF	Black Soldier Fly
BTS	Sanitation Technology Center (*Balai Teknologi Sanitasi*)
BUMD	Regional-Owned Enterprise (*Badan Usaha Milik Daerah*)
BUMDes	Village-Owned Enterprise (*Badan Usaha Milik Desa*)
BUMN	State-Owned Enterprise (*Badan Usaha Milik Negara*)
CAGR	Compounded Annual Growth Rate
CAPEX	Capital Expenditure
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilization and Storage
CFB	Circulating Fluidized Bed
CPOS	Current Policy Scenario
CSR	Corporate Social Responsibility
DED	Detailed Engineering Design (*Detail Engineering Design*)
DMO	Domestic Market Obligation
EBT	New and Renewable Energy (*Energi Baru dan Terbarukan*)
ENDC	Enhanced Nationally Determined Contribution
EPA	Environmental Protection Agency
ESG	Environmental, Social, and Governance
FCR	Full Cost Recovery
FS	Feasibility Study
GESI	Gender Equality and Social Inclusion (*Kesetaraan Gender dan Inklusi Sosial*)
GRK	Greenhouse Gas (*Gas Rumah Kaca*)
HEESI	Handbook of Energy & Economic Statistics of Indonesia
HGBT	Specific Natural Gas Price (*Harga Gas Bumi Tertentu*)
IKPS	Waste Management Performance Index (*Indeks Kinerja Pengelolaan Sampah*)
ISWMP	Indonesia Solid Waste Management Project
Jakstrada	Regional Policy and Strategy (*Kebijakan dan Strategi Daerah*)
Jakstranas	National Policy and Strategy (*Kebijakan dan Strategi Nasional*)
JETP	Just Energy Transition Partnership
JV	Joint Venture
KEN	National Energy Policy (*Kebijakan Energi Nasional*)
KPBU	Government and Business Entity Cooperation (*Kerja Sama Pemerintah dan Badan Usaha*)
KPR	Home Ownership Credit (*Kredit Kepemilikan Rumah*)
KSDPK	Government Cooperation with Third Parties (*Kerja Sama Pemerintah dengan Pihak Ketiga*)
LCCP	Low-Carbon Compatible Scenario
LTS-LCCR	Long-Term Strategy for Low Carbon and Climate Resilience
MBOE	Million Barrels of Oil Equivalent

Abbreviation	Full Form
MBT	Mechanical Biological Treatment
MSW	Municipal Solid Waste
MW	Megawatt
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization (*Organisasi Non-Pemerintah*)
NSPK	Norms, Standards, Procedures, and Criteria (*Norma, Standar, Prosedur, dan Kriteria*)
NZE	Net Zero Emission
O&M	Operation and Maintenance
OPEX	Operational Expenditure
PAD	Regional Own-Source Revenue (*Pendapatan Asli Daerah*)
PEN	National Economic Recovery (*Pemulihan Ekonomi Nasional*)
PKS	Cooperation Agreement (*Perjanjian Kerja Sama*)
PLN	State Electricity Company (*Perusahaan Listrik Negara*)
PLTSa	Waste-to-Energy Power Plant (*Pembangkit Listrik Tenaga Sampah*)
PLTU	Steam Power Plant (*Pembangkit Listrik Tenaga Uap*)
PPN	Value Added Tax (*Pajak Pertambahan Nilai*)
PPP	Public-Private Partnership
PROPER	Company Performance Rating Program in Environmental Management (*Program Penilaian Peringkat Kinerja Perusahaan*)
PSEL	Waste-to-Electricity Processing (*Pengolahan Sampah Menjadi Energi Listrik*)
R&D	Research and Development (*Penelitian dan Pengembangan*)
RDF	Refuse-Derived Fuel
RKPD	Regional Government Work Plan (*Rencana Kerja Pemerintah Daerah*)
RPJPD	Regional Long-Term Development Plan (*Rencana Pembangunan Jangka Panjang Daerah*)
RPJPN	National Long-Term Development Plan (*Rencana Pembangunan Jangka Panjang Nasional*)
RPJMD	Regional Medium-Term Development Plan (*Rencana Pembangunan Jangka Menengah Daerah*)
RPJMN	National Medium-Term Development Plan (*Rencana Pembangunan Jangka Menengah Nasional*)
RPO	Renewable Purchase Obligation
RSNI	Draft of Indonesian National Standard (*Rancangan Standar Nasional Indonesia*)
RUED	Regional General Energy Plan (*Rencana Umum Energi Daerah*)
RUEN	National General Energy Plan (*Rencana Umum Energi Nasional*)
RUKN	National Electricity General Plan (*Rencana Umum Ketenagalistrikan Nasional*)
SDGs	Sustainable Development Goals (*Tujuan Pembangunan Berkelanjutan*)
SDM	Human Resources (*Sumber Daya Manusia*)
SIH	Green Industry Certificate (*Sertifikat Industri Hijau*)
SIINSAN	Sanitation Infrastructure Information System (*Sistem Informasi Infrastruktur Sanitasi*)
SIPSN	National Waste Management Information System (*Sistem Informasi Pengelolaan Sampah Nasional*)
SLL	Sustainability-Linked Loan (*Pinjaman Terikat Keberlanjutan*)
SNI	Indonesian National Standard (*Standar Nasional Indonesia*)
SOP	Standard Operating Procedure
SRF	Solid Recovered Fuel
TKDN	Local Content Requirement (*Tingkat Komponen Dalam Negeri*)
TPA	Final Disposal Site (*Tempat Pembuangan Akhir*)
TPS	Temporary Waste Storage Site (*Tempat Penampungan Sementara*)
TPST	Integrated Waste Processing Site (*Tempat Pengolahan Sampah Terpadu*)
TPST 3R	Integrated Waste Processing Site (Reuse, Reduce, Recycle) (*Tempat Pengolahan Sampah Terpadu 3R*)
TRL	Technology Readiness Level (*Tingkat Kesiapan Teknologi*)
TSR	Thermal Substitution Rate (*Substitusi Energi Panas*)
UNFCCC	United Nations Framework Convention on Climate Change
UPTD	Regional Technical Implementation Unit (*Unit Pelaksana Teknis Daerah*)
WtE	Waste to Energy

01.

Introduction

1.1 Background

Indonesia's waste management system faces increasingly complex challenges. Waste generation (*timbulan* sampah) in Indonesia is estimated at 68–70 million tons per year, yet only 48.61% was managed as of 2024[1]. Referring to the waste management hierarchy as defined by the United States Environmental Protection Agency (EPA)[8], there are four main stages: 1) source reduction and reuse of valuable materials, 2) recycling and composting, 3) energy recovery, and 4) disposal. In several countries, including Indonesia, this hierarchy has been further developed into a more detailed structure that separates treatment from disposal. This indicates that waste processing should be prioritized before disposal, so that only residual waste (materials that can no longer be utilized) ends up in the final processing site (*tempat pembuangan akhir/TPA*).

In fact, an estimated 41–42% of Indonesia's waste ends up in TPA[3]. Additionally, the *open dumping* method is still applied, with around 40.09% of TPAs operating under this approach[4]. With such a management system, many TPAs in Indonesia are projected to reach maximum capacity by 2028[2]. Notably, in 2023, 35 TPA sites recorded fire incidents[4], indicating a serious crisis in the waste management system. These conditions reflect that Indonesia is facing an emergency in waste management due to high dependence on direct disposal to TPAs. Therefore, structural improvements are urgently needed to create a waste management system that is more sustainable and capable of addressing current challenges.

To respond to these challenges, the Indonesian government has set a national waste management target: by 2045, 100% of waste generated (*timbulan* sampah) must be treated in processing facilities, with 35% through material recovery and 55% through energy recovery. This aims to reduce the amount of residual waste that ends up in TPAs to a maximum of 10%[9]. To achieve this, innovation in waste processing technologies is critical.

Refuse-derived fuel (RDF) has emerged as one of the alternative solutions. RDF converts waste into an alternative fuel with higher calorific value, and in the context of waste management in Indonesia, it contributes to reducing the volume of waste sent to TPAs while simultaneously offering energy recovery benefits.

Not only that, RDF can also support the transition toward clean and environmentally friendly energy. Studies show that each ton of RDF utilized through the co-firing process can reduce emissions by up to 1.75 tons of CO_2[10] compared to the open dumping scenario which produces 0.74 tons of CO_2 per ton, or TPA-based waste management which can emit up to 1.2 tons of CO_2 per ton.

[8] Environmental Protection Agency, 21 Februari 2024, (https://www.epa.gov/smm/sustainable-materials-management-non-hazardous-materials-and-waste-management-hierarchy, diakses pada 2 Februari 2025).
[9] Rencana Pembangunan Janka Panjang Nasional 2025-2045.
[10] EFRO, 2022.

Several coal-fired power plants (PLTU) and cement factories in Indonesia have already utilized RDF through co-firing practices. However, the development and application of this technology still face a number of challenges. According to data, from the existing RDF production capacity of approximately 434,350 tons per year, only around 18.5% is absorbed by the industry. This low absorption rate indicates persistent challenges in RDF product quality, which has not yet fully met industry requirements. In addition, other key barriers include limited infrastructure capacity, financing constraints, technological reliability, and the lack of regulations and support systems for RDF facility operations to align with industry demand.

Therefore, given the critical role of RDF in supporting national waste management goals and the transition to clean energy, there is an urgent need for in-depth and comprehensive analysis to identify existing implementation gaps and recommend strategies to address them. In response to this, the Ministry of National Development Planning (PPN)/Bappenas through the Directorate of Housing and Settlement Areas (Direktorat Perumahan dan Kawasan Permukiman) has collaborated with the United Nations Development Programme (UNDP) under the Sustainable Infrastructure Programme in Asia (SIPA) to conduct a study on RDF development in Indonesia. This analysis is expected to serve as a foundational input for the formulation of more effective policies and programs to guide the implementation of waste-to-energy (WtE) initiatives in Indonesia and help achieve the 2045 national targets.

1.2 Objectives of the Analysis

Various challenges in the development and implementation of waste-to-energy (WTE), using RDF as a case study in Indonesia, must be identified and addressed to ensure optimal implementation. Based on the above background, this gap analysis aims to:

1. Analyze the key factors that serve as challenges and enablers for RDF implementation in Indonesia.
    a. Analyze regulatory frameworks, including existing policies and incentives, as well as gaps in the application of RDF standards.
    b. Assess infrastructure capacity, such as waste processing facilities, RDF manufacturing, and distribution networks.
    c. Evaluate technological capabilities, including RDF conversion efficiency and environmental mitigation measures.
    d. Identify financing and investment constraints in RDF, including applicable business models.
    e. Analyze the environmental and social impacts of RDF production and utilization, and assess alignment with environmental sustainability goals.
2. Evaluate the effectiveness of policies and RDF implementation strategies that have been carried out to support waste management.
    a. Review policies related to RDF and the challenges encountered in their implementation across different regions in Indonesia.
    b. Assess the role of RDF in addressing timbulan (waste generation) and its contribution to national waste treatment targets.
    c. Evaluate the involvement and coordination among key stakeholders, including central and local governments and industries, in RDF management and utilization.
3. Formulate strategic recommendations to address identified gaps and challenges, with a focus on strengthening regulations, enhancing infrastructure and technology, optimizing financing schemes, and advancing industry-based RDF utilization strategies.

1.3 Scope

Referring to Regulation of the Minister of Public Works and Housing No. 3 of 2013, waste management flow in Indonesia consists of several stages. These stages begin at the waste source, which may originate from households, commercial areas, public spaces, and others. Ideally, waste should be separated at source by households and industries before being transported to temporary storage facilities (*tempat penampungan sementara/TPS*). From there, waste from TPS is moved to processing sites applying the 3R principles (*reuse, reduce, recycle*) or 3R-based TPS, which function to collect, sort, reuse, and recycle waste at the local or area-based level. Alternatively, waste from TPS may be delivered to integrated waste processing facilities (*tempat pengolahan sampah terpadu/TPST*) to be processed into economically valuable products that can be distributed to offtakers. Any residual waste that can no longer be utilized will be sent to TPA.

In the RDF production process (**Figure 1.1**), waste entering TPST or waste facilities is processed more thoroughly through a series of steps such as shredding, drying, and refining. The RDF produced is then used by industries as an alternative energy source that is more environmentally friendly. As a result, the amount of waste directed to TPA can be significantly reduced.

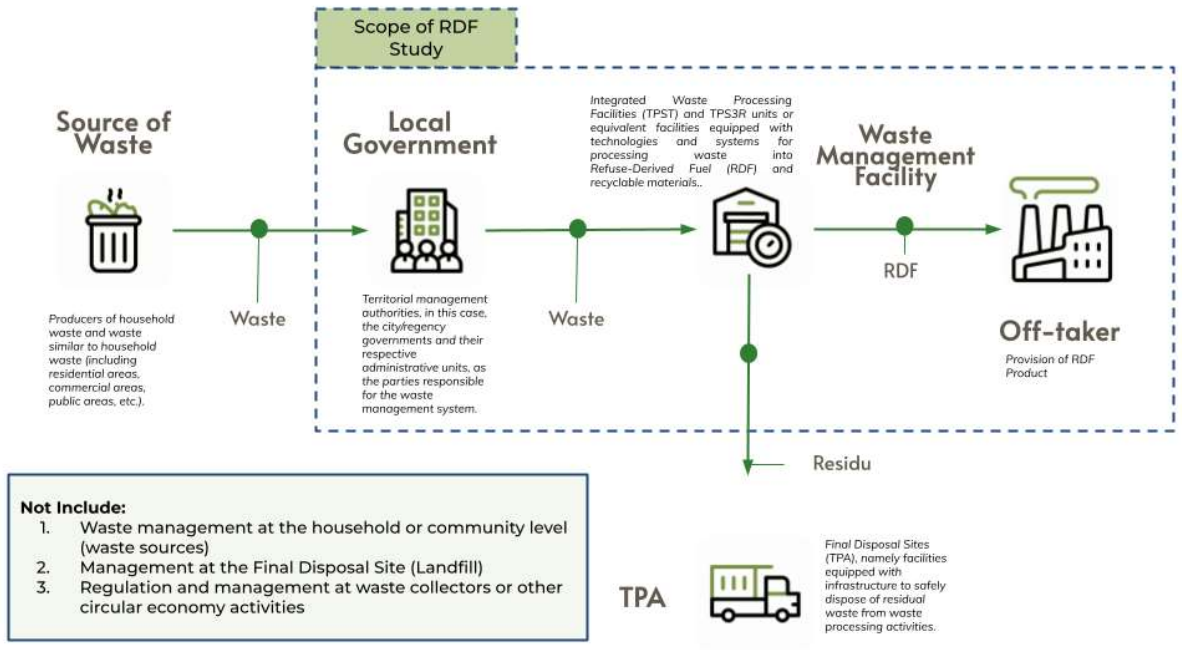

***Figure 1.1** RDF Process Flow*

Based on **Figure 1.1**, this study focuses on analyzing gaps in several critical areas within the RDF process flow, including:

1. Management by Local Government.
   Reviewing institutional roles and regulatory support for RDF expansion.
2. Waste Processing Facilities.
   Evaluating technological capacity to support optimization of RDF production from waste.
3. Offtakers and the RDF Market.

Understanding industry needs related to RDF, including analysis of supply continuity, logistics, and market acceptance challenges.

In this study, these components are analyzed using the categorization of supply, demand, and enabling environment. The RDF process flow is grouped accordingly in the gap analysis, as outlined in **Figure 1.2**, and described as follows:

- **Supply** refers to the provision of RDF, covering all processes from collection to waste treatment into RDF. In this domain, local governments play a key role in the waste management system, particularly in the transport and facility provision necessary to convert waste into RDF.
- **Demand** refers to the industrial utilization of RDF. In this domain, offtakers use RDF as an alternative fuel to replace fossil fuels in their production processes, thereby supporting the energy transition.
- **Enabling Environment** refers to the ecosystem that supports the RDF system to operate effectively and efficiently. This includes policy frameworks, government regulations, incentive mechanisms, and other elements that help ensure RDF production continuity across regions and enhance RDF's attractiveness for industrial offtakers.

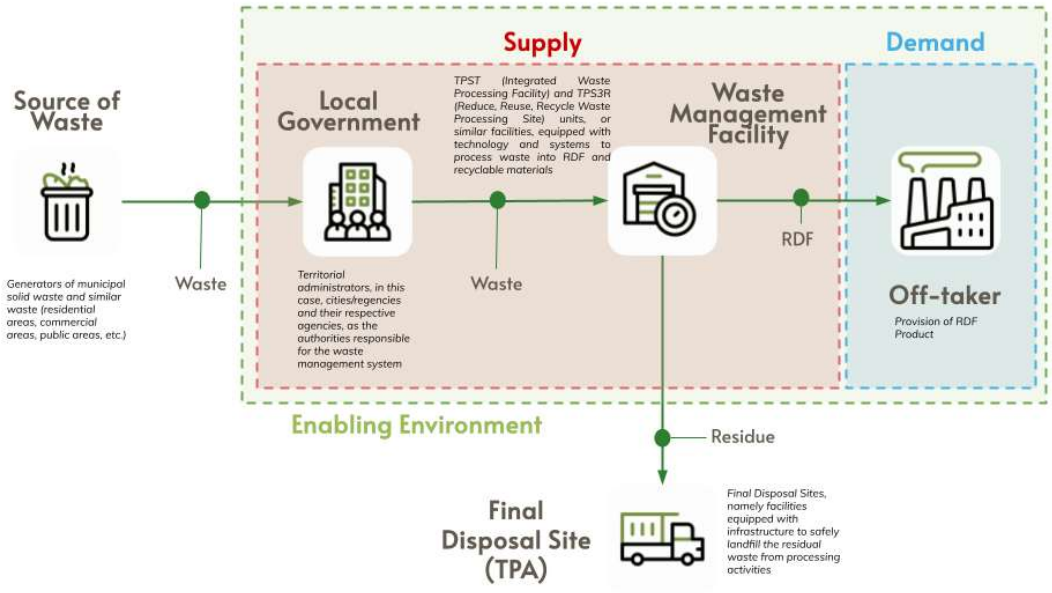

Figure 1.2 *Scope of Study*

1.4 Methodology

This gap analysis is conducted based on a structured analytical framework formulated from key aspects essential for developing effective planning and policy. The components included in this gap analysis are illustrated in **Figure 1.3**. The analysis using this framework is expected to produce outcomes that are aligned with the goals of the National Medium-Term Development Plan (RPJMN) 2025–2029 and the National Long-Term Development Plan (RPJPN) 2025–2045, which emphasize the importance of sustainable development through the processing and utilization of renewable energy.

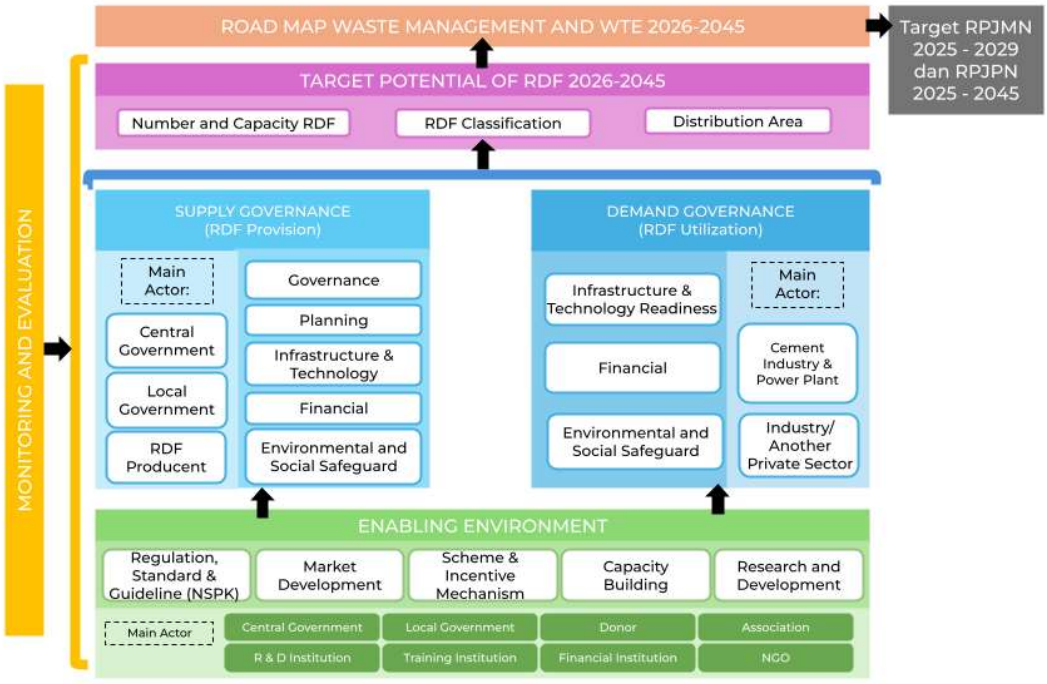

Figure 1.3 *Analytical Framework for Gap Analysis on RDF Expansion*

The methodology used in this gap analysis consists of several stages, as follows:

1. Literature Review.
   Initial data gathering from policy documents, technical reports, and previous studies related to RDF.
2. Stakeholder Discussions.
   Collection of in-depth information from key stakeholders, such as government institutions, industries (*offtakers*), and organizations/associations involved in RDF implementation.
3. Data and Information Analysis
   Assessment of data and information including the identification of *existing* conditions and ideal benchmarks, followed by gap analysis between these two conditions.
4. Focus Group Disccusion.
   Validation of initial findings and analysis, as well as collecting deeper insights from policy-makers (central and local governments), industry actors, donor institutions, associations, and waste sector stakeholders.
5. Strategic Recommendations.
   Formulation of recommendations based on analytical findings to address key challenges in RDF expansion.

02.

Urgency of RDF Implementation in Indonesia

2.1 The Role of RDF in Waste Management in Indonesia

In 2024, waste generation in Indonesia reached 68–70 million tons, with only 48.61% being properly managed. Under a *business-as-usual* (BaU) scenario, final processing sites (*tempat pembuangan akhir/TPA*) across the country are projected to exceed their maximum capacity by 2028—or sooner. Some TPAs are already over capacity, including those in DKI Jakarta, Bandung City, and several areas in Yogyakarta Province such as Sleman and Bantul Regencies.

According to data from the National Waste Management Information System (SIPSN) of the Ministry of Environment and Forestry as of June 4, 2024, waste management performance in 2023 stood at 62.34%, comprising 13.73% in waste reduction and 48.61% in waste handling. However, 37.66% of waste remains unmanaged. However, 37.66% of waste remains unmanaged. Furthermore, only 12.29% of waste was recorded as being processed in 2023 of which 10.89% was recycled and 1.40% was recovered for material use. The performance achievements in managing waste—specifically the reduction and handling of household waste and similar types—can be illustrated as follows.

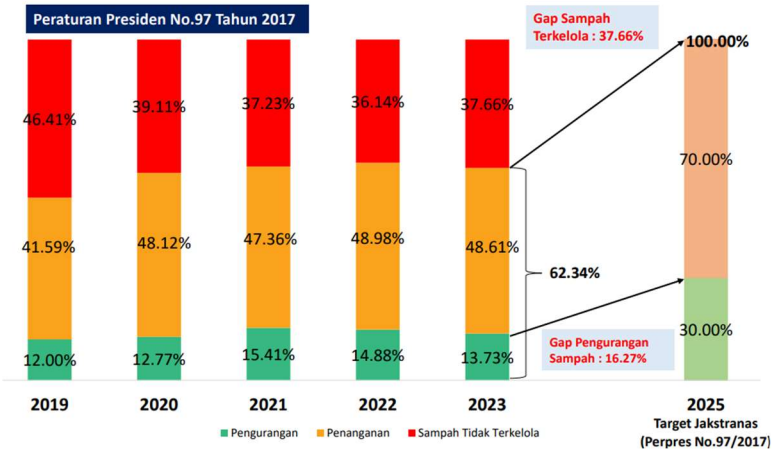

Figure 2.1 *Performance of Waste Reduction and Handling in Indonesia*
Source: Kementerian Lingkungan Hidup dan Kehutanan, 2024[11]

Generally, Indonesia's waste management system still shows suboptimal performance. Heavy reliance on TPAs and limited upstream processing efforts have resulted in consistently high volumes of waste being directed to landfills, making it difficult to achieve the national goal of zero new TPA development by 2030.

According to the waste management hierarchy (**Figure 2.2**), priority is given to prevention, reduction, reuse, recycling, and energy recovery before final disposal. Based on this hierarchy, RDF falls within the energy recovery stage—specifically, the conversion of non-recyclable waste into fuel.

[11] https://sipsn.menlhk.go.id/ accessed at 25 April 2024.

Based on this hierarchy, all available options to minimize waste must be considered in order of priority before selecting and implementing the most appropriate treatment technology.

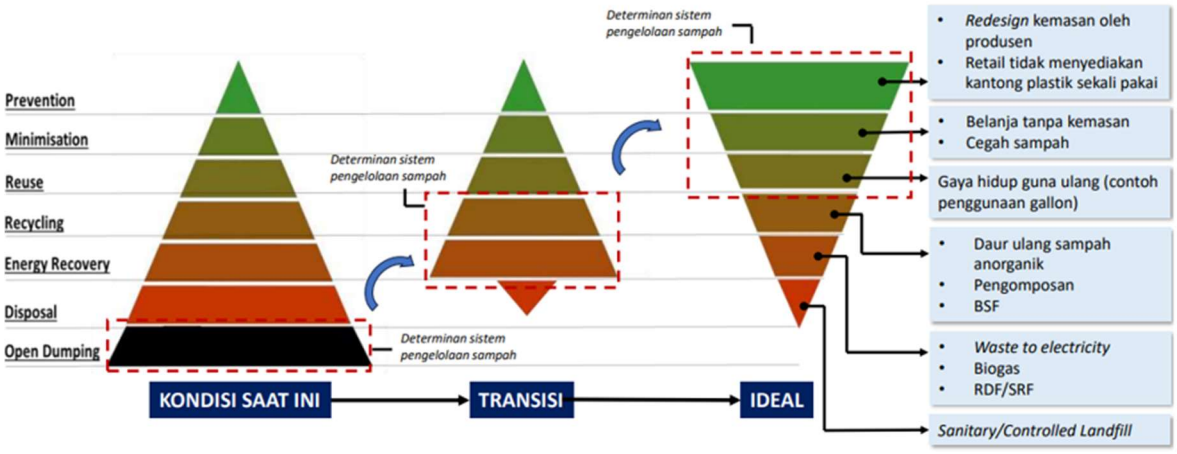

Figure 2.2 *Waste Management Hierarchy*
Source: Ministry of Environment and Forestry, 2024

The legal framework and principles for assessing the feasibility and sustainability of waste management technologies can be found in Law Number 18 of 2008, which mandates that waste management must comply with environmental quality and safety standards.

The Government of Indonesia has also set national waste management targets as outlined in the 2025–2045 National Long-Term Development Plan (RPJPN) and the 2025–2029 National Medium-Term Development Plan (RPJMN). In the RPJPN, the target for 2045 is for 100% of households to have full access to waste collection services, with 90% of waste processed at waste treatment facilities of which 35% is to be recycled. Meanwhile, the RPJMN targets for 2029 are 85% waste collection coverage and 38% of waste to be treated. Various actions are being encouraged to achieve these national waste management targets, including promoting waste-to-energy (WtE) solutions as part of climate change mitigation efforts one of which is processing waste into refuse-derived fuel (RDF). RDF is considered one of the sustainable options in waste management, and plays a vital role in resource efficiency, especially in energy recovery from waste. RDF has a relatively high and consistent calorific value and can partially substitute the thermal energy produced by conventional fuels used in industry, provided that the waste input for RDF production meets processing standards. By utilizing energy recovered from processed waste, RDF production also contributes to strengthening the circular economy.

Relevant regulations governing waste management are found in Minister of Public Works and Public Housing Regulation No. 3 of 2013. Although this regulation does not explicitly mention RDF, the principles and directives contained within support the development and use of RDF as part of a more comprehensive and sustainable waste management system in Indonesia. The regulation encourages the development of various waste treatment methods, including energy-producing technologies.

RDF can contribute significantly to improving national waste management, particularly in the context of the circular economy and reducing carbon emissions. RDF produced from waste is flammable and can be used as an alternative fuel across various industries. Its use can reduce dependence on fossil fuels, lower greenhouse gas (GHG) emissions, and minimize the volume of waste sent to final processing sites.

To achieve zero waste by 2050, the government is implementing a solid waste sub-sector strategy focused on 3R-based and circular economy approaches. The implementation of this strategy will begin in 2025 through landfill mining to optimize sustainable waste

management. By 2030, the volume of waste sent to TPAs is expected to decrease gradually, eliminating the need to construct new TPAs. In 2040, waste management will be enhanced through paper recycling, 3R practices for non-paper waste, WtE including RDF and the elimination of open burning.[12].

The RPJPN outlines a vision for 2045 of integrated and environmentally sound waste management, adhering to the principles of responsibility, utility, justice, awareness, disaster preparedness, safety, security, and economic value. The output targets for 2045 include: 100% of households receiving full waste collection services; 90% of waste processed at treatment facilities including 35% recycled; and the remaining 10% of residual waste disposed at residual landfill sites (Lahan Urug Residu/LUR).

Within the RPJPN, RDF-based waste processing is classified under material and energy recovery, with the corresponding processing targets presented in **Table 2.1**.

Table 2.1 *Detailed Targets for Processed Waste*

Target	(Baseline)	2029	2034	2039	2045
Percentage of Waste Processed at Facilities	15% [2023]	8%	54%	70%	90%
Waste Processing, consisting of:					
Percentage of Recycled Waste	13% [2023]	20%	-	-	35%
Percentage of Recovered Waste (*Material & energy recovery*)	2%	18%	-	-	55%

Source: Kementerian PPN/Bappenas, 2025.

The table above outlines the target percentages for waste processing at treatment facilities from 2023 to 2045. Using a baseline of 15% in 2023, the target is set to increase significantly—reaching 38% by 2029, 54% by 2034, 70% by 2039, and ultimately 90% by 2045. In this context, RDF falls under the category of processed waste for material and energy recovery, with a baseline of 2% in 2023, increasing to 18% by 2029, and rising further to 55% by 2045. Overall, **Table 2.1** reflects the Government's policy ambition in waste processing, aiming to improve long-term efficiency in treatment, recycling, and energy recovery—demonstrating a strong commitment to sustainability and resource efficiency.

According to the Ministry of Environment and Forestry, the potential use of RDF is estimated at 16,000 tons per day by coal-fired power plants (*PLTU*) and 8,000 tons per day by the cement industry. Together, these two sectors represent a combined processing potential of approximately 24,000 tons of waste per day.

In practice, however, the implementation of RDF in Indonesia's national waste management still faces several challenges. These include limited availability of processing infrastructure capable of producing high-quality RDF, underdeveloped RDF markets that hinder production sustainability, and weak coordination among central and local governments, RDF producers, and RDF-utilizing industries.

Nevertheless, RDF holds significant potential to contribute to more sustainable national waste management and to support the development of a circular economy in Indonesia. The successful implementation of RDF, guided by well-prepared planning, will become increasingly important in the future as waste generation continues to grow and awareness of environmental sustainability intensifies.

[12] Ministry of Environment and Forestry, "Operational Plan of Indonesia's Zero Waste Zero Emission 2050", 2024.

2.2 RDF in the National Policy Framework

2.2.1 Potential Contribution of RDF to Achieving the RPJPN 2025–2045 and RPJMN 2025–2029 Targets

Indonesia's development transformation has been laid out in the 2025–2045 National Long-Term Development Plan (RPJPN), which sets forth the vision of Indonesia Emas 2045. In the draft RPJPN 2025–2045, waste management is identified as one of the policy directions within the Economic Transformation Agenda, particularly under Goal 5: Implementation of a Green Economy.

To achieve the 2045 waste management vision—namely, integrated and environmentally sound waste management that adheres to the principles of responsibility, utility, fairness, awareness, disaster responsiveness, safety, security, and economic value—the RPJPN establishes several targets. By 2045, 100% of households are expected to receive full waste collection services, 90% of waste is to be processed in waste treatment facilities (including 35% recycled waste), and only 10% of residual waste will be sent to residual landfill (LUR). These outcomes are expected to contribute to improved public health, long-term environmental quality, and the transformation of waste into a sustainably managed resource.

In addition, the 2025–2029 National Medium-Term Development Plan (RPJMN) sets interim targets for waste management to be achieved within the five-year planning period. By 2029, the targets include processing 38% of waste at treatment facilities (with 24% from recycling) and providing waste collection services to 85% of households.

The potential contribution of RDF toward achieving these national waste management targets is calculated based on the projected national waste generation using a 2023 baseline, the 2045 waste projection from the Ministry of Environment and Forestry, and the material and energy recovery targets in the RPJPN for the 2029–2045 period. This approach considers the estimated volume of waste that can be converted into RDF, as well as the absorption potential of RDF based on demand from industrial users (*offtakers*).

Table 2.2 *Potential Contribution of RDF to National Waste Processing Through Material & Energy Recovery*

Year	Target for Waste Processing (*material & energy recovery*) (Source: Bappenas)	Total Estimated Waste Processing Based on Target	Total Estimated Waste Processed into RDF	Potential Contribution of RDF to National Waste Processing through Material & Energy Recovery
2029	18%	13.275.000 ton/year	3.111.000 ton/year	23,44%
2034	30%*	22.950.000 ton/year	5.457.000 ton/year	23,78%
2039	41%*	32.492.500 ton/year	6.630.000 ton/year	20,40%
2045	55%	45.100.000 ton/year	7.089.000 ton/year	15,72%

**) prognosa based on target 2029 and 2045.*

Looking at the projected contribution of RDF to national waste management targets as shown in the table above, it is evident that the application of RDF technology can serve as one of the key elements in achieving material and energy recovery goals through 2045. Therefore, further steps are needed to identify the potential regions, infrastructure, and capacity that support the sustainable implementation of RDF.

2.2.2 RDF in National CO_2 Emission Reduction Policies

In 2022, Indonesia submitted its Enhanced Nationally Determined Contribution (ENDC) document as part of its effort to increase its greenhouse gas (GHG) emission reduction ambition and update its national climate policy. Under the ENDC, Indonesia set a target to reduce GHG emissions by 31.89% by 2030 through domestic efforts (*Counter Measure 1*), and by 43.2% with the support of international cooperation (*Counter Measure 2*). In the waste sector mitigation scenario, the government aims to reduce emissions by 40 million tons of CO_2e by 2030 through domestic action (1.4% of BaU), and by 43.5 million tons of CO_2e with international support (1.5% of BaU).

RDF is identified as one of the GHG mitigation strategies in the waste sector—specifically in the domestic solid waste sub-sector—as outlined in the ENDC. Utilizing domestic solid waste by converting it into energy through RDF or using it as a renewable energy source in waste-to-energy (PLTSa) power plants is estimated to process up to 4.6 million tons of municipal solid waste (MSW) and avoid 1.9 million tons of CO_2e emissions.[12].

In addition, the Government of Indonesia has established a Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) 2050, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in July 2021. This document outlines Indonesia's ambitious vision under a low carbon scenario compatible (LCCP) with the Paris Agreement targets. Through this scenario, Indonesia commits to enhancing its GHG emission reduction efforts, with a projected peak in net national GHG emissions in 2030 at 1,244 million tons of CO_2e, or approximately 4.23 tons of CO_2e per capita. Following this peak, net emissions are expected to decline to 540 million tons of CO_2e by 2050, equivalent to 1.6 tons of CO_2e per capita. Indonesia will also continue to explore opportunities to accelerate the achievement of net zero emissions (NZE) by 2060 or earlier.

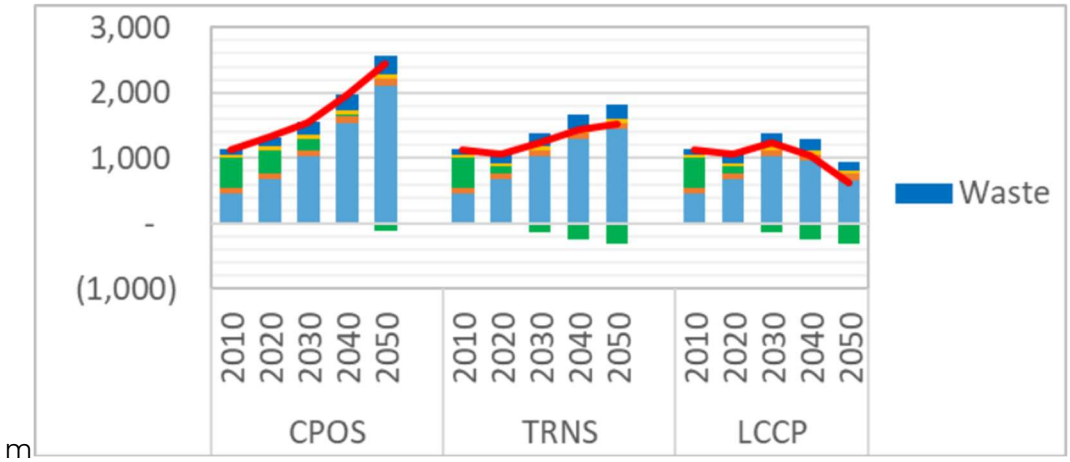

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Figure 2.3 *LTS-LCCR Strategies for the Waste Sector: a) CPOS (current policy scenario); b) TRNS (transition scenario); dan c) LCCP (low carbon scenario compatible with Paris Agreement target)*
Source: Ministry of Environment and Forestry , 2024[12]

In the LTS-LCCR strategy for the waste sector, GHG emissions are projected to decline after 2030, reaching 62 million tons of CO_2e by 2050. Achieving this reduction requires improved waste management to support GHG mitigation efforts, primarily through the strengthening of policy frameworks that regulate integrated waste management and the development of a circular economy ecosystem to reach zero waste by 2040.

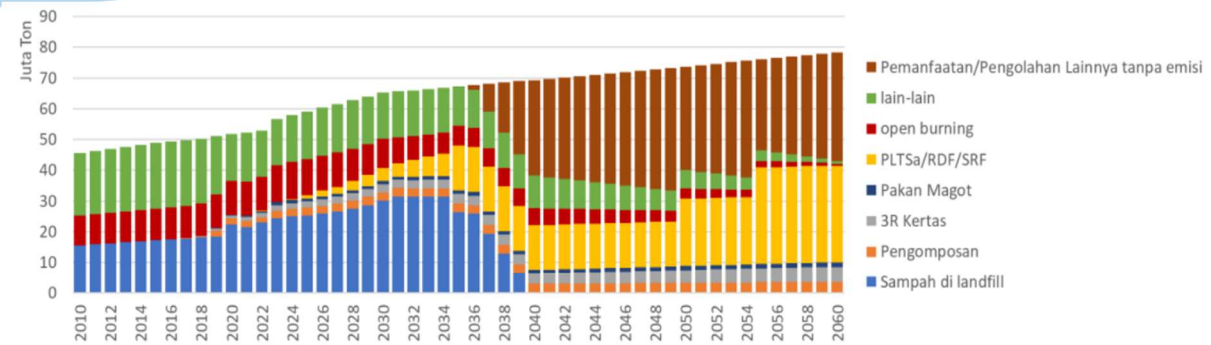

Figure 2.4 *Zero Waste, Zero Emission Strategy for 2050*
Source: Ministry of Environment and Forestry, 2024[12]

Achievement of the 2050 target will be pursued through the following actions:

a. Managing landfills (*TPA*) using sanitary or controlled landfill methods, equipped with methane gas capture and utilization systems.
b. Halting the construction of new landfills after 2030 by optimizing the use of existing landfill sites and initiating landfill mining.
c. Reducing the volume of waste sent to landfills, aiming for a "zero" waste to landfill target by 2040 (accepting only residual waste).
d. Achieving zero open burning by 2031.
e. By 2030, 50% of industries are expected to use domestically recycled paper, increasing to 100% by 2040.
f. Increasing the volume of waste processed outside of composting/3R, including waste-to-energy through PLTSa, RDF, SRF (solid recovered fuel), and other technologies such as organic fertilizer raw materials, biodigesters for organic waste, black soldier fly maggots for biomass waste, and landfills designated for inert materials.

2.2.3 RDF in the National Energy Policy

According to the draft National Energy Policy (KEN) outlined in Government Regulation No. 79 of 2014, Indonesia has set a target for the share of renewable energy in its primary energy supply at 19–21% by 2030 and 70–72% by 2060. One of the main objectives in achieving national energy resilience is the diversification of renewable energy sources. This objective is also reflected in the National Energy General Plan (RUEN), regulated under Presidential Regulation No. 22 of 2017, which sets renewable energy targets at 23% of primary energy supply by 2025 and 31% by 2050.

Referring to both KEN and RUEN, one of the goals of national energy management is to achieve a national energy mix comprised of four primary energy sources: petroleum, natural gas, coal, and new and renewable energy (EBT). The target shares for each energy type by 2025 are as follows: (i) renewable energy (EBT) at a minimum of 23%, (ii) petroleum at less than 25%, (iii) coal at a minimum of 30%, and (iv) natural gas at a minimum of 22%. Since 2016, the share of renewable energy in the national energy mix has shown a general upward trend. However, this increase has not yet reached the annual targets. For comparison, the share of EBT in 2021 was 11.7%, in 2022 it rose slightly to 11.9%, and in 2023 it reached 13.29%. **Figure 2.5** presents projections indicating that the renewable energy mix in 2024 is expected to reach 14.68%, an increase of 1.39 percentage points from the previous year.

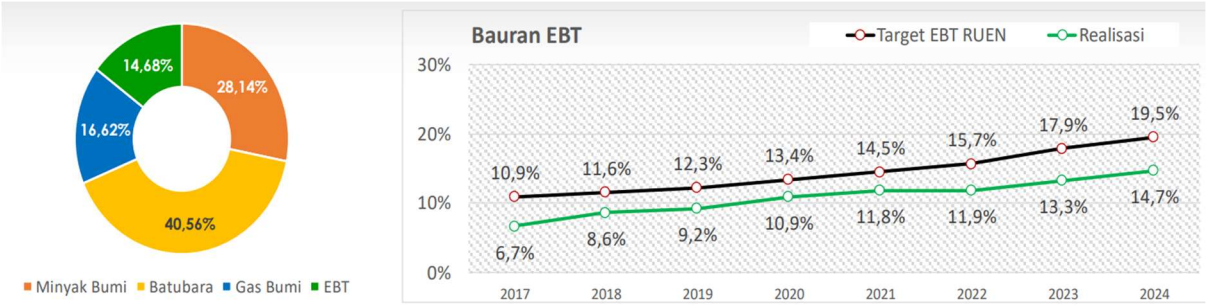

Figure 2.5 *Share of Renewable Energy (EBT) in the Primary Energy Mix*[13]
Source: Ministry of Energy and Mineral Resource, 2024

To achieve the 23% renewable energy target by 2025 while also reducing GHG emissions from the energy sector, the Government of Indonesia has outlined several action plans, including: (1) a moratorium on new coal-fired power plant (PLTU) investments, (2) a complete phase-out of coal-fired power plants by 2050, and (3) the implementation of co-firing, which involves blending waste-based fuels into the coal supply, ranging from 1% to 5%. The co-firing policy has also been included in the National Electricity General Plan (RUKN) 2019–2038, aiming to reduce dependence on fossil fuels and fulfill Indonesia's sustainable development goals. In line with this, the Ministry of Energy and Mineral Resources (ESDM) has introduced Ministerial Regulation No. 12 of 2023 on the Utilization of Biomass Fuel for Coal-Fired Power Plants (PLTU). This regulation includes a roadmap for biomass fuel utilization in co-firing from 2023 through 2030, detailed as follows:

Table 2.3 *Roadmap for Biomass Fuel Utilization in National Biomass Co-firing*

Year	2023	2024	2025	2026	2027	2028	2029	2030
Volume of Biomass Fuel (million tons/year)	1.05	2.83	10.20	10.11	9.08	9.11	9.14	8.91

Source: Peraturan Menteri ESDM Nomor 12 Tahun 2023

In 2023, Indonesia's total energy supply reached 1,843 million barrels of oil equivalent (MBOE), with coal being the largest contributor at 736 MBOE. The industrial and transportation sectors were the largest energy consumers, together accounting for nearly 90% of total final energy consumption.

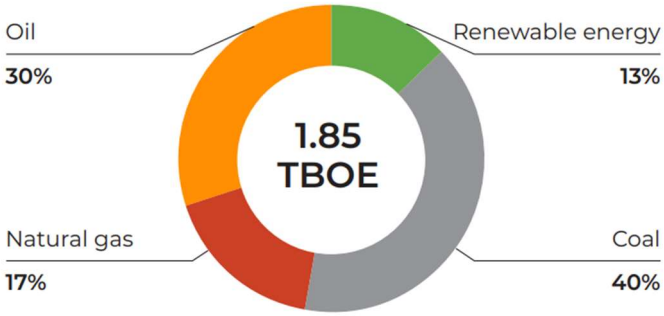

Figure 2.6 *Indonesia's Primary Energy Supply Mix*
Source: Institute for Essential Services Reform, 2025

The industrial sector alone generated approximately 460 million tons of CO_2e emissions in 2023, marking an increase of nearly 5% compared to 2022. Around 73% of these emissions

[13] Laporan Kinerja Kementrian ESDM, 2024

were attributable to energy consumption, particularly the combustion of fossil fuels. The high emissions from industry raise concerns about the effectiveness of Indonesia's emission reduction efforts and their alignment with its Nationally Determined Contribution (NDC) and Net Zero Emission (NZE) commitments. Contributing factors include the extended fossil fuel subsidies for natural gas under the Specific Natural Gas Price (HGBT) policy, as stipulated in Ministerial Decree of Energy and Mineral Resources No. 255 of 2024, and the continuation of Domestic Market Obligation (DMO) coal pricing, which remains in effect indefinitely.

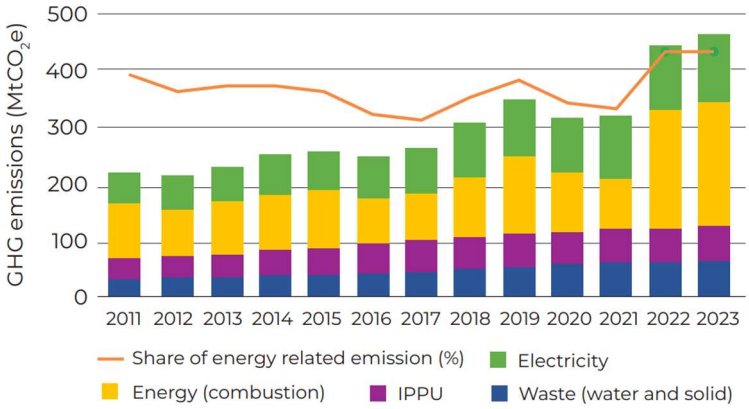

Figure 2.7 *Historical GHG Emissions from Industrial Activities*
Source: Ministry of Environment and Forestry (2023); Ministry of Energy and Mineral Resource(2024)

The rising energy consumption within the industrial sector has prompted the Government to encourage a transition to alternative energy sources shifting from fossil fuels to lower-carbon alternatives, such as biomass and RDF.

2.2.4 Industrial Decarbonization

RDF, alongside other waste-derived energy sources such as solid recovered fuel (SRF), biomass, and refuse-based solid fuel (BBJP), is classified as a form of bioenergy, and is part of Indonesia's new and renewable energy (EBT)[14] development policy. Transitioning toward renewable energy through bioenergy represents an initial step aligned with the national industrial decarbonization agenda.

The Ministry of Industry is currently developing a decarbonization roadmap and carbon pricing mechanisms for nine priority industrial sub-sectors, which are expected to be finalized in early 2025. As of mid-2024, there are 103 certified green industries and 37 officially recognized standards, reflecting a growing green industrial ecosystem[15]. This development marks a significant policy direction by the Indonesian government toward achieving net-zero emissions (NZE) in the industrial sector by 2060 or earlier.

In 2023, energy consumption in the industrial sector increased by nearly 9%, reaching 556 million barrels of oil equivalent (MBOE)[14], driven by a year-on-year growth rate of 4.6%[16]. The majority of energy consumption came from fossil fuels, with coal accounting for 56.9%, natural gas and LPG 21.6%, and petroleum-based fuels 5.1%. Meanwhile, the share of renewable energy in industrial energy use rose from 3.82% in 2022 to 6.52% in 2023.

[14] Kementerian Energi dan Sumber Daya Mineral, 2024
[15] Pusat Industri Hijau Kementerian Perindustrian, 2024.
[16] GoI, 2024a

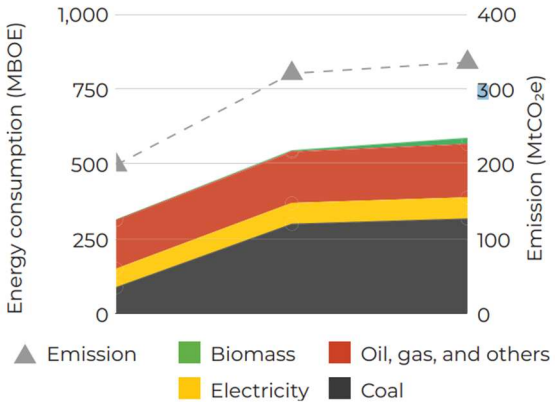

Figure 2.8 *Industrial Energy Demand and Related Emissions*
Source: Institute for Essential Services Reform, 2025

Coal consumption in industry rose 5% from 2022 to 2023, with a compound annual growth rate (CAGR) of 32.4% since 2017. In the iron, steel, and metallurgy sub-sector, coal consumption increased by 20%, reaching 60.1 million tons in 2023, supported by 14.2% year-on-year growth[17].

In contrast, coal consumption declined in the cement, textile, and fertilizer sub-sectors by 25%, and in the pulp and paper sub-sector by 16%. These reductions are attributed to decarbonization efforts, including the use of alternative fuels such as RDF, industrial waste, and biomass, as well as market demand slowdowns[18,19,20]. Despite these shifts, the industrial sector remains heavily reliant on coal, with only limited transition toward renewable energy and sustainable fuels. The manufacturing industry in particular must be prioritized for further decarbonization by adopting low-carbon fuels such as bioenergy, low-carbon hydrogen, and RDF.

Industries face several barriers to adopting RDF, including limited availability, inconsistent quality, and technical risks during combustion. In particular, hydrogen and ammonia, which are being evaluated for their feasibility, affordability, and availability, are not expected to be widely deployed before 2030. On the other hand, waste—used as the raw material for RDF—is abundantly available and can be promoted as a sustainable fuel source for industrial use.

Although the industrial sector continues to rely on fossil fuels, it has begun exploring biomass and biofuel utilization. According to the Handbook of Energy & Economic Statistics of Indonesia (HEESI) issued by the Ministry of Energy and Mineral Resources, the industrial sector consumes 6.9% of the nation's biofuel, excluding use in transportation and logistics. Biomass and biofuel currently account for approximately 6.5% of total industrial energy consumption[21]. The use or combustion of RDF as a substitute for fossil fuels has significant potential to reduce greenhouse gas (GHG) emissions and other pollutants. Due to its lower sulfur content compared to coal, RDF produces lower sulfur dioxide (SO_2) emissions.

According to the tier 1 emission factor methodology by the World Business Council for Sustainable Development (WBCSD), RDF has a lower carbon emission factor than coal, leading to reduced CO_2 emissions during combustion. Moreover, since RDF is derived from

[17] Nurdifa, A. R., "Basic Metal Industry Grows Rapidly by 14.17%, Driven by Demand from China?", 2024.
[18] Ember, "The Risk of Ignoring Methane Emissions in Coal Mining", 2024.
[19] Atmoko, C., "Semen Indonesia Innovates to Support Low-Carbon Development", 2024.
[20] Sayekti, I. M. S., "SIG Accelerates Decarbonization Initiatives to Produce Green Cement & Environmentally Friendly Development", 2024.
[21] Ministry of Energy and Mineral Resources (MEMR) RI, 2024.

waste, its use in industry can reduce the volume of waste sent to final disposal sites (TPA), thereby supporting improved waste management practices.

Nonetheless, a key barrier to RDF adoption in industry remains its cost—high-quality RDF tends to be more expensive than other alternative fuels and may approach the cost of coal. With coal prices still subsidized, RDF is less financially attractive to industrial actors.

On the supply side, the Ministry of Energy and Mineral Resources estimates that the industrial sector consumes around 85 million tons of coal per year, equivalent to roughly 500 million tons of biomass. This volume is difficult to achieve, given the limited domestic biomass production capacity in Indonesia. Therefore, it is crucial to prioritize electrification, the use of sustainable alternative fuels such as RDF, and the adoption of carbon capture storage (CCS) or carbon capture utilization and storage (CCUS) technologies to minimize GHG emissions in the industrial sector.

2.3 Current Implementation of RDF in Indonesia

Refuse-Derived Fuel (RDF) is a product generated through the separation process of waste into two fractions: combustible and non-combustible components, such as metals and glass. There are two types of combustible materials in waste that contribute to RDF's calorific value: high-calorific materials such as paper, plastic, rubber, textiles, and wood; and low-calorific materials such as easily biodegradable waste like wet organic matter.

High-quality RDF is characterized by high calorific value, low moisture content, and low concentrations of contaminants, such as stones and toxic compounds (e.g., heavy metals and chlorine). Factors influencing RDF quality include the waste source, waste composition, and pre-processing treatment.

According to the American Standard Testing and Material (ASTM E856-83), RDF is classified into seven types based on its form and initial separation process:

1. RDF-1 is an unprocessed derived fuel from municipal solid waste (MSW), used after removing large and bulky waste.
2. RDF-2 is MSW processed into coarse particles, with or without ferrous metals. A subcategory of RDF-2 consists of shredded RDF that passes 95% by weight through a mesh size 6 screen and is compacted (about 300 kg/m^3), also known as coarse RDF (c-RDF).
3. RDF-3 is shredded fuel derived from MSW, processed to remove metals, glass, and other inorganic materials, with 95% of the material passing through a 2-inch square screen, commonly referred to as fluff RDF.
4. RDF-4 is a combustible fraction processed into powder, with 95% of the weight passing through a mesh size 10 screen, also called dust RDF (p-RDF).
5. RDF-5 is compacted RDF in the form of granules, slags, cubes, or briquettes, with a density of approximately 600 kg/m^3, also known as densified RDF (d-RDF).
6. RDF-6 is MSW processed into liquid fuel.
7. RDF-7 is MSW processed into gaseous fuel.

2.3.1 RDF Standards

In Europe, RDF classification is regulated under UNI CEN/TS 15359, which uses three parameters: net calorific value (as an economic indicator), chlorine content (as a technical indicator), and mercury content (as an environmental parameter). These classifications are intended to define RDF quality and ensure the material is not misused when sold as fuel. A more recent reference standard for SRF (Solid Recovered Fuel) is ISO 21640, available at https://www.iso.org/standard/71309.html.

Indonesia has already developed Indonesian National Standard (SNI) 8966:2021 for BBJP (Refuse-Based Solid Fuel) used in power plants. This standard, initiated by the Ministry of Energy and Mineral Resources and PLN, is designed for RDF-like fuels in co-firing applications with coal in coal-fired power plants (PLTU).

For industrial use, SNI 9313:2024 is currently in draft form under the title "Waste Shredded Fuel for the Cement Industry." This standard aims to protect RDF users by ensuring that the fuel meets technical requirements and provides certainty for investors and producers in supporting the development of RDF-based fuel industries.

At present, no universal international standard for RDF exists, unlike SRF, which is already regulated under ISO 21640. The SRF standard is more relevant for advanced-processed fuels with strict specifications, whereas RDF characteristics vary widely across countries, depending on waste sources and processing technologies. In Indonesia, national standards such as SNI 8966:2021 for power plant co-firing and SNI 9313:2024 for cement industries have been tailored to the country's local conditions and industrial needs.

2.3.2 RDF Supply in Indonesia

In terms of supply, Indonesia began constructing RDF facilities in 2017. The RDF TPST facility in Desa Tritih Lor, Kabupaten Jeruklegi, Kabupaten Cilacap, located on a 3-hectare site, was the first to adopt RDF technology in the country. This initiative was made possible through multi-stakeholder collaboration: the Ministry of Public Works and Housing provided the main building; the Ministry of Environment and Forestry supplied mechanical and electrical equipment made in Germany (a grant from the Government of Denmark through DANIDA); the Jawa Tengah Provincial Government provided supporting infrastructure; and the Kabupaten Cilacap Government contributed land and access roads. The RDF facility is operated by and supplies RDF to PT Solusi Bangun Indonesia (SBI) in Cilacap.

Another RDF facility was initiated at the regional level using local government funding (APBD), such as the BLE RDF TPST in Kabupaten Banyumas, Jawa Tengah Province. Managed by a Community-Based Organization (KSM), this facility operates under an MoU between the Kabupaten Banyumas Government and two offtakers: PT Solusi Bangunan Indonesia and PLTU Cilacap Greenprosa.

An additional RDF processing facility is located at TPST Bantar Gebang, built by the DKI Jakarta Provincial Governance, with a daily capacity of 2,000 tons of waste (1,000 tons of fresh waste and 1,000 tons of landfill mining waste). This facility applies thermal drying technology. Its target output is 700 tons of RDF per day in fluff form, with a calorific value of over 3,200 kcal/kg, a maximum moisture content of 20%, and a maximum chlorine content of 1%. The process equipment requires less than 2 hectares of land.

Figure 2.9 *RDF Plant Facility in Bantar Gebang*
Source: Dinas Lingkungan Hidup DKI Jakarta, 2023

The offtakers utilizing RDF products from this facility are two cement plants in Jawa Barat: PT Indocement and PT SBI. Indocement is planned to receive a minimum of 625 tons of RDF per day, while SBI is projected to receive up to 75 tons per day. The facility was built with a total investment of approximately IDR 1.1 trillion, sourced from regional loan funds allocated under the National Economic Recovery (PEN) program amounting to IDR 456.3 billion, and regional budget (APBD) funding in 2022 of IDR 613.9 billion. According to the DKI Jakarta Environmental Agency, the RDF facility in Bantar Gebang is expected to generate annual revenue of IDR 59.4 billion for the Provincial Government of DKI Jakarta, based on a daily production target of 700 tons of waste[22].

The Ministry of Public Works initiated the development of TPST (Integrated Waste Processing Facilities) under the ISWMP (Indonesia Solid Waste Management Program), with project locations in several regions including Kota Bandung, Kabupaten Indramayu, Kota Depok, Kabupaten Gianyar, Kota Padang, Kabupaten Tuban, and Kota Cilegon. However, it should be noted that not all of these TPSTs have incorporated RDF processing. Given the number of RDF facilities developed by the central government, further studies and analyses are required to assess the potential for implementing RDF technology.

This study has mapped 22 RDF facilities, as presented in **Table 2.4**, along with their geographic distribution shown in the accompanying figure. Updated information regarding the development status in these regions can be found in the **Appendix**..

***Table** 2.4 Reported RDF Facilities*

No.	RDF Facility Name	Regency/City, Province	Year Built	Processing Capacity (tpd)	RDF Capacity (tpd)
1	TPA Jeruk Legi	Kab. Cilacap, Jawa Tengah	2020	160	60
2	RDF Bantar Gebang	Kota Bekasi, Jawa Barat	2020	2000	700
3	RDF Rorotan	Daerah Khusus Jakarta	2024	2500	875
4	RDF TOSS Klungkung	Kab. Klungkung, Bali	2017	50	20
5	RDF TPA Jabon	Kab. Sidoarjo, Jawa Timur	2021	60	20
6	RDF TPA Ngipik	Kab. Gresik, Jawa Timur	2015	20	3.5
7	TPST Belahanrejo	Kab. Gresik, Jawa Timur	2023	20	8
8	RDF Indocement Palimanan	Kab. Cirebon, Jawa Barat	2008	10	4
9	RDF TPST Samtaku	Kab. Badung, Bali	2021	120	48
10	RDF TPST Kertalangu	Kota Denpasar, Bali	2023	450	240
11	TPST Padangsambian	Kota Denpasar, Bali	2023	120	
12	RDF TPST Cicukang Holis	Kota Bandung, Jawa Barat	2022	10	4
13	RDF TPST Cicukang Oxbow	Kota Bandung, Jawa Barat	2022	20	8
14	TPST RDF Cimenteng	Kota Sukabumi	2024	330	100
15	RDF TPST BLE Banyumas	Kab. Banyumas, Jawa Tengah	2023	75	<10
16	RDF TPST Tegalsari	Kab. Purwakarta, Jawa Barat	2022	15	6

[22] Environmental Agency of DKI Jakarta, 2022.

No.	RDF Facility Name	Regency/City, Province	Year Built	Processing Capacity (tpd)	RDF Capacity (tpd)
17	RDF TPST Jayakerta	Kab. Karawang, Jawa Barat	2023	25	10
18	RDF TPST Sentiong	Kota Cimahi, Jawa Barat	2024	50	20
19	RDF TSPST Kebun Kongok	Kab. Lombok Barat, NTB	2023	120	20
20	RDF TPST3R Argodadi	Kab. Bantul, Yogyakarta	2024	49	15-30
21	RDF TPST Sendangsari	Kab. Sleman, Yogyakarta	2024	45	15-30
22	TPST RDF Rawa Kucing	Kota Tangerang, Banten	2024	50	15

Sumber: Kementerian PPN/Bappenas, 2023; Kementerian Pekerjaan Umum, 2024; Analisis Konsultan, 2025

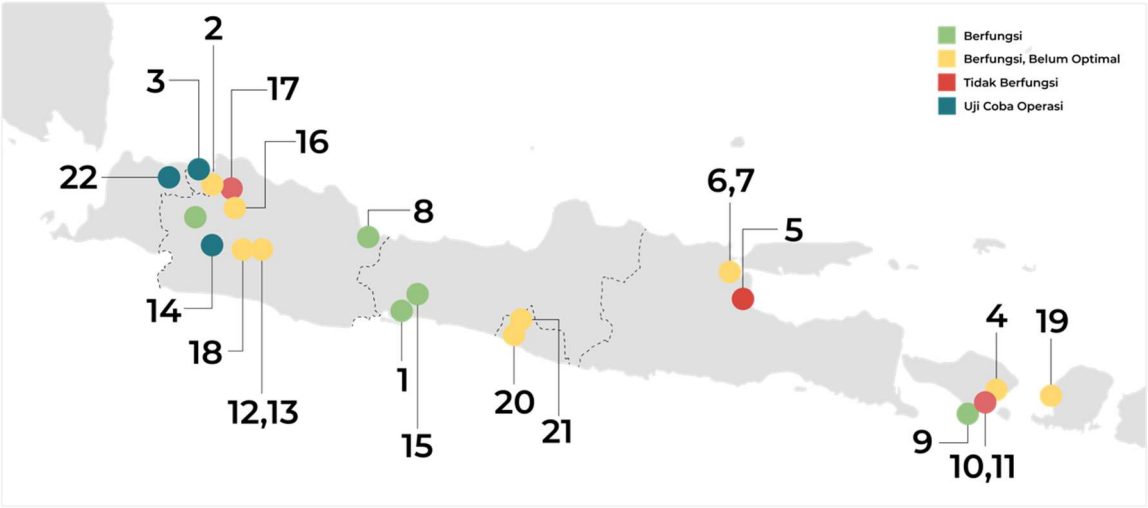

Figure 2.10 *Mapped RDF Facility Distribution and Their Operational Status*

Figure 2.11 *RDF Plant Rorotan*
Source: diakses melalui https://konstruksimedia.com

The DK Jakarta Provincial Government is also developing the Rorotan RDF Plant, which is targeted to begin operations in early 2025 and is expected to serve 16 sub-districts across North Jakarta, Central Jakarta, and East Jakarta. With a waste processing capacity reaching 2,500 tons per day, the Rorotan RDF Plant is designed to produce RDF measuring 5x5 cm at a rate of 875 tons per day. This facility will become the largest waste processing project in Indonesia.

Another RDF facility is being constructed at the Cimenteng landfill area (TPA Cimenteng), under a Cooperation Agreement (PKS) between the Siam Cement Group (SCG) and the Sukabumi

Regency Government. The RDF produced will be used as an alternative fuel by SCG's cement plant, Semen Jawa, located approximately 15 kilometers from the landfill.

The RDF concept and technology design was developed by SCG, while the contractor and operator of the project is Cahaya Yasa Cipta (CYC), a subsidiary of UAC Global Plc (UAC), a Thai company involved in chemical distribution and renewable energy operations. According to published information, UAC, through CYC, has allocated 200 million baht to the project, covering 70% of the total cost, while the remaining 30% is financed by PT Terang Hidup Energi. CYC shares are jointly owned by UAC, SCG, and Indonesian nationals.

Cimenteng RDF project, with an estimated processing capacity of 330 tons per day, will handle 200 tons per day of fresh waste from 27 sub-districts and 130 tons per day of landfill mining waste. The RDF facility is built on a 5,000 m² landfill site and includes a weighbridge, equipment hangar, office, and control room. The main equipment of the facility consists of two grab cranes, one primary shredder, one disc screen, one wind shifter, and one secondary shredder. Major equipment such as the shredders, screen, and wind shifter are imported from the United States and the Netherlands, while the belt conveyor is sourced from Thailand, and only the grab cranes are domestically procured in Indonesia. The facility plans to employ 15 personnel. Groundbreaking was held in August 2023, and commissioning was completed in December 2024. However, the facility is not yet operational due to pending environmental permitting issues.

2.3.3 RDF Utilization

The cement industry is the main user of RDF in Indonesia. This is due to the fact that cement plants require a substantial amount of energy in their production processes, and the use of RDF helps reduce dependence on traditional fossil fuels such as coal. The utilization of RDF in the cement industry not only helps to lower operational costs but also supports environmental initiatives by making use of waste.

Several cement companies have implemented co-processing of alternative fuels in clinker production, with thermal substitution rates reaching up to 30%. Commonly used alternative fuels in Indonesian cement plants include agricultural waste such as rice husks and palm shells, industrial waste, and RDF. In 2023, the average thermal substitution rate across the national cement industry was 9.1%, with biomass, including RDF, accounting for only about 5%.

In support of achieving the 23% renewable energy mix (EBT) target by 2025, the Government of Indonesia has set a target for biomass utilization including RDF at 8.4 million tons in 2025. The use of biomass and RDF-based fuels in coal-fired power plants (PLTU) can be implemented without constructing new plants, through co-firing. The application of RDF as co-firing fuel in coal-fired power plants is still in the trial phase by PLN subsidiaries PT PLN Indonesia Power (IP) and PT Pembangkitan Jawa Bali (PJB), and is not yet a standard practice across all PLTUs. In Indonesia, co-firing fuels in pellet form are referred to as BBJP. A complete list of PLTUs with potential to serve as offtakers of RDF-based fuels can be found in the appendix.

Currently, PLN subsidiaries PT PJB and PT PLN IP have conducted co-firing trials in 30 PLTUs located in and outside of Java, with the smallest capacity at the Tembilahan PLTU (2 × 7 MW) and the largest at Paiton 9 PLTU (1 × 660 MW).

PT PJB has conducted co-firing trials using 5% biomass pellets and 1% RDF waste with 10 different biomass types: wood pellets, palm kernel shells, sawdust, organic pellets, lamtoro wood chips, sago wood chips, rabasan wood chips, gamal wood chips, and rice husks. Meanwhile, IP has carried out co-firing trials using RDF pellets derived from waste. The PLTUs that have trialed co-firing with RDF from household waste include PLTU Jeranjang

in NTB (2 × 25 MW), PLTU Lontar in Banten (3 × 315 MW), and PLTU Ropa in Ende, NTT (2 × 7 MW). Other PLTUs have tested co-firing using biomass waste. PLTU Jeranjang utilized RDF from garden waste and felled trees, while PLTU Lontar's trial used RDF from the Cilacap TPST facility and waste from Saguling.

The Ministry of Energy and Mineral Resources estimates that RDF utilization potential in the cement industry reaches 3,425 tons per day. This figure could increase, as some cement factories in Indonesia have set thermal substitution rate (TSR) targets of over 10% by 2030. Assuming only 5% TSR from RDF, approximately 938,182 tons of RDF would be needed annually by 2030 or about 3,127 tons per day.

Beyond the cement industry, other companies are also planning to utilize RDF. One such example is paper producer PT Tjiwi Kimia, part of the APP Group, located in Sidoarjo, Jawa Timur. The company is currently building an RDF-fueled boiler with a capacity of 200 tons per day to serve as an energy source for its paper production. Around 50% of the RDF feedstock is expected to come from the company's internal recycling impurities from paperboard raw material processing, while the remaining 50% could be sourced from municipal RDF processing or RDF from other nearby industrial solid waste. In addition, in 2024, fertilizer producer Pupuk Sriwijaya in Palembang and Petrokimia Gresik have conducted trials using BBJP from biomass waste as part of their steam generation energy mix. A full list of registered steam power plants with potential as offtakers in the coal-fired PLTU co-firing with biomass program is provided in the document annex.

2.4 RDF Governance Outside Indonesia

The following are examples of RDF governance practices implemented outside Indonesia

2.4.1 RDF Implementation in India

Legal Framework Reference

In the context of waste management in India, the primary legal reference framework is the Solid Waste Management (SWM) Rules, 2016. This regulation outlines the responsibilities of local governments in facilitating the development, operation, and maintenance of waste processing facilities by adopting appropriate technologies, including Refuse-Derived Fuel (RDF). The SWM Rules serve as the only legal document that establishes emission standards for incineration in India. However, specific emission standards for boilers utilizing RDF are not explicitly defined. Therefore, until such standards are officially established, emission standards for chimneys used in the treatment or utilization of municipal solid waste (MSW) through incinerators and thermal technologies, as prescribed in the SWM Rules, must be followed.

Priority is given to decentralized waste processing in order to reduce transportation costs and environmental impact. Additionally, the Solid Waste Management (SWM) Rules mandate that industrial units located within a 100-kilometer radius of an RDF or Waste-to-Energy (WtE) facility must replace at least five percent of their fuel requirement with RDF within six months of the regulation's issuance. The rules also include a specific provision that prohibits the disposal of waste with a calorific value greater than 1,500 Kcal/kg at landfills. Such waste must be utilized for energy recovery through RDF or co-processing in cement industries and thermal power plants.

Furthermore, the establishment of RDF facilities with a capacity exceeding five tons per day requires approval from the State Pollution Control Board or the Pollution Control Committee, which is obligated to issue a decision within 60 days of receiving the application. These policies reflect India's efforts to expand the use of RDF as a more

sustainable waste management solution and may serve as a valuable reference for RDF development in Indonesia.

Overview of RDF Infrastructure and Technology

Furthermore, one subsection of the waste management regulation emphasizes that residual waste (rejects) from the processing stages both before and after the main treatment process must be removed regularly from waste processing facilities and must not accumulate on-site. Waste that still holds recycling potential must be directed to appropriate vendors, while high-calorific non-recyclable fractions must be sent to Waste-to-Energy (WtE) facilities, processed into RDF, utilized in co-processing in cement plants, or supplied to thermal power plants. Only the final residual waste from all these processes may be disposed of at sanitary-compliant landfill sites. Large cities generating more than 1,000 tons of waste per day are required to implement a combination of waste processing technologies, including composting, RDF, and WtE methods either anaerobic or thermal-based. These processing facilities must be designed using advanced technologies that comply with stricter environmental standards. To ensure the sustainable operation of such facilities, local governments are mandated to provide adequate incentives to support the technical and economic viability of these plants. These provisions reflect India's approach to more efficient waste management by reducing reliance on landfilling and promoting the use of RDF as a sustainable solution. Such measures may serve as a reference for Indonesia in designing its own RDF expansion strategies to enhance national waste management efficiency.

Overview of Incentive Schemes and Mechanisms

The Ministry of Environment, Forest and Climate Change (MoEFCC) promotes the utilization of Refuse-Derived Fuel (RDF) through the implementation of the Swachh Bharat Mission, launched in 2014. This national program has served as a key catalyst for the development of waste management infrastructure, including RDF facilities, by providing a policy framework and financial support for related projects. MoEFCC also sets emission standards and operational parameters that RDF facilities must comply with to minimize environmental impacts. The Ministry of Finance supports private sector participation by offering a range of fiscal incentives, including tax reductions, capital subsidies, and accessible financing mechanisms for investors developing RDF facilities. These incentives have played a crucial role in encouraging private investment in waste-to-energy technologies in India.

The Ministry of New and Renewable Energy (MNRE) plays a significant role in the technical and energy-related aspects of RDF development. MNRE has established technical standards for RDF quality and introduced tradable Renewable Energy Certificates (RECs). The ministry also provides direct subsidies for power plants using RDF as fuel and has established Renewable Purchase Obligations (RPOs), which require electricity producers to source a portion of their energy from renewable sources, including energy generated from RDF. MNRE actively promotes waste-to-energy projects such as RDF, biomethanation, biogas, and gasification by providing financial incentives to stakeholders. Incentives are extended to both public and private sector entrepreneurs and investors. Subsidies range from Rs. 15 million to Rs. 30 million per megawatt (MW). For commercial projects, financial assistance is also provided through interest subsidies, lowering the interest rate to 7.5%, capitalized at a discount rate of 12% per annum.

Subsidy disbursement is carried out through:

a) Financial assistance of up to 50% of the project's capital cost, capped at ₹3.00 crore per MW, is provided to project proponents for pilot projects.

b) In addition, a financial incentive of ₹15.00 lakh per MW is granted to municipal corporations or Urban Local Bodies (ULBs) for supplying waste free of charge at the project site and for providing land on long-term lease (over 30 years) at nominal rental rates.
c) State agencies are incentivized with ₹5.00 lakh per MW of electricity generated for activities related to project promotion, coordination, and monitoring.

2.4.2 RDF Implementation China

China has adopted Refuse-Derived Fuel (RDF) as part of its waste management and energy utilization strategy. With the increasing volume of waste, both the government and industrial sectors have developed RDF to reduce reliance on landfills and provide an alternative fuel source. Since 2004, China has been one of the world's largest waste producers, with waste generation projected to reach 480 million tons per year by 2030. RDF-based waste management has emerged as one of the approaches implemented in several regions to address this growing challenge.

Legal Framework Reference

The Chinese government has issued various regulations related to RDF management. The Standard for Pollution Control on the Municipal Solid Waste Incineration (2014) establishes emission and operational standards for facilities utilizing RDF. The National Sword Policy (2018) plays a critical role in restricting waste imports and encouraging the utilization of domestic waste as feedstock for RDF production.

The regulatory framework has been further strengthened through the 14th Five-Year Plan for Circular Economy Development (2021–2025). This strategic document explicitly prioritizes the development of waste-to-energy conversion technologies, including the enhancement of RDF production capacity from domestic waste sources. These policies form an integral part of China's broader strategy to reduce dependence on fossil fuels and to strengthen national energy security.

The implementation of RDF in China is supported by a series of strategic policies aimed at enhancing the use of waste as an alternative energy source. One key policy mandates cement plants to co-process waste through combustion as part of the cement production process. This regulation forms part of China's national effort to reduce the volume of waste sent to landfills, while harnessing the energy potential embedded in waste materials for energy-intensive industrial applications.

As part of its broader energy transition agenda, the Chinese government has also introduced restrictions on coal supply for the cement industry. This policy strategically compels cement plants to seek and develop alternative energy sources, particularly those derived from the treatment of hazardous waste (B3) and RDF. These coal restrictions not only help reduce dependence on fossil fuels but also establish a stable market for RDF as an alternative fuel, considering the cement industry's need for a continuous and reliable energy supply.

To ensure the effective utilization of RDF with varying quality levels, China promotes the development of appropriate technical infrastructure within cement plants. These plants are equipped with specialized combustion chambers integrated into the feeding system. This technical modification enables cement plants to burn all grades of RDF, including both low- and high-calorific value types. Such technological adaptation is critical, as the quality of RDF derived from municipal solid waste in China varies significantly. Therefore, flexibility in processing different RDF qualities is a key factor in the successful nationwide implementation of the program.

Overview of RDF Infrastructure and Technology

RDF facilities in China have expanded in line with the need for more efficient waste management systems. As of 2020, more than 500 facilities were utilizing RDF for energy production, including in industrial sectors such as power generation and cement manufacturing. Shanghai is among the cities implementing RDF to treat low-value industrial solid waste (LISW). The technologies employed include RDF pretreatment, comprising processes such as shredding, separation, drying, and pelletizing, which aim to enhance the calorific value and fuel stability of RDF. Additional technologies such as moving grate incineration and circulating fluidized bed (CFB) combustion have also been adopted in several facilities to improve energy conversion efficiency. RDF utilization is regulated through emission control standards to manage pollutants such as heavy metals, SO_2, NOx, and dioxins, ensuring environmental compliance and public health protection.

Overview of Incentive Schemes and Mechanisms

The National Development Reform Commission (NDRC) plays a fundamental role in establishing the regulatory framework governing the implementation of RDF, both through circular economy policies and solid waste management regulations. The NDRC issues national-level regulations, which are subsequently translated into regional regulations by local governments, thereby creating a legal framework tailored to regional conditions. The Ministry of Finance provides financial support in the form of incentives and subsidies to the private sector or industry to encourage participation in the RDF ecosystem, helping to reduce the initial investment burden that often poses a barrier to the development of environmental infrastructure.

The Ministry of Ecology and Environment exercises comprehensive environmental oversight, not only over the private and industrial sectors but also directly monitors RDF facilities to ensure compliance with emission standards and other environmental parameters. This oversight function includes periodic monitoring, inspections, and the enforcement of sanctions for regulatory violations. The relationship between local governments and RDF facilities is characterized by a public-private partnership (PPP) model, in which local authorities provide land, licensing, and guarantees for waste supply, while the private sector contributes investment and handles operations. Private sector entities or industries act as investors and operators of RDF facilities, leveraging their technical expertise and management capacity to optimize operational efficiency.

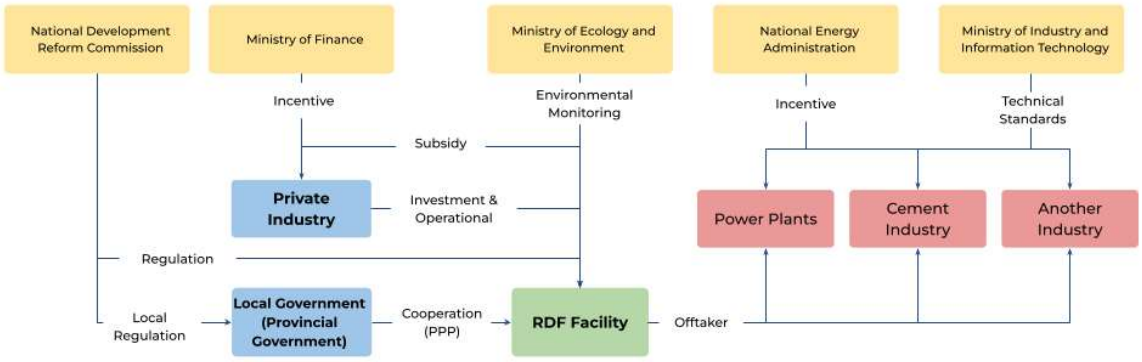

Figure 2.12 *Financial Scheme of RDF Facilities in China*

The National Energy Administration (NEA) provides energy-related incentives, such as feed-in tariffs and energy quotas, to power plants, cement factories, and other industries that utilize RDF as an alternative fuel. Meanwhile, the Ministry of Industry and Information Technology (MIIT) establishes technical standards that end-user industries must comply with, ensuring that RDF usage meets both safety and efficiency requirements. RDF facilities serve as a critical link between waste sources and end-users, processing waste into high-quality fuel consumed by power plants, cement factories, and other industries as

offtakers. This integrated system enables China to effectively implement circular economy strategies in waste management while reducing dependence on conventional fossil fuels.

The Chinese government provides a variety of incentive mechanisms to support the development of RDF, such as electricity subsidies for facilities that generate energy from RDF and policies limiting the use of landfills. Various international institutions have also supported financing and investment for the development of RDF technologies. RDF is regarded as one of the methods capable of reducing reliance on fossil fuels in several industrial sectors. **Table 2.5** presents a comparative overview of RDF implementation conditions in India, China, and Indonesia.

Tabel 2.5 *RDF Implementation in India, China and Indonesia*

No	RDF Implementation in India	RDF Implementation in China	RDF Implementation in Indonesia
1	**Reference Legal Framework** The Solid Waste Management (SWM) Rules, 2016 serve as the legal basis for RDF implementation. The regulation sets emission standards for incineration, imposes an obligation on industries within a 100-kilometer radius to utilize RDF, and prohibits the disposal of high-calorific-value waste in landfills.	**Reference Legal Framework** Standard for Pollution Control on MSW Incineration (2014), National Sword Policy (2018), dan 14th Five-Year Plan for Circular Economy: The policy mandates the use of RDF by cement industries and imposes restrictions on coal usage as an indirect incentive to encourage the adoption of alternative fuels.	**Reference Legal Framework** There is currently no specific regulation governing RDF. Emission standards for RDF usage still refer to the general standards applied to coal-fired power plants (CFPPs) or incinerators.
2	**Overview of RDF Infrastructure and Technology** • Decentralization of RDF facilities is encouraged to reduce transportation costs. • Industries are required to utilize at least 5% RDF within six months of regulation enforcement. • Establishing facilities with a capacity exceeding 5 tons per day requires approval from the environmental authority. • The technologies employed include thermal and anaerobic processing, with a mandatory separation of high-calorific waste fractions.	**Overview of RDF Infrastructure and Technology** More than 500 RDF facilities are in operation, utilizing technologies such as pretreatment, circulating fluidized bed (CFB), and moving grate incineration. Cement plants are equipped with dedicated combustion chambers designed specifically for RDF usage. In several regions, low-value industrial waste is processed into RDF as part of local waste management strategies.	**Overview of RDF Infrastructure and Technology** • RDF facilities remain limited in number. • The technologies used vary and are not yet fully standardized. • Coal-fired power plants (CFPPs) utilizing RDF are still in the pilot or testing phase.
3	**Overview of Incentive Schemes and Mechanisms** • The Ministry of Environment, Forest and Climate Change (MoEFCC) supports RDF through the Swachh Bharat Mission and the establishment of environmental standards. • The Ministry of Finance provides fiscal incentives, including subsidies and tax reductions. • The Ministry of New and Renewable Energy (MNRE) offers energy subsidies, Renewable Purchase Obligation (RPO) incentives, and capital assistance of up to 50% per project, with incentive schemes ranging from Rs. 15–30 million per MW.	**Overview of Incentive Schemes and Mechanisms** • National policies are in place to regulate RDF implementation. • The Ministry of Finance and the National Energy Administration provide subsidies and feed-in tariffs. • A public-private partnership (PPP) model is adopted, where local governments provide land, permits, and waste supply guarantees, while the private sector acts as the operator and investor. • RDF facilities serve as the link between waste sources and end-user industries.	**Overview of Incentive Schemes and Mechanisms** • Incentives remain sporadic and are not yet centralized. • There is no specific feed-in tariff for RDF at this time. • While local governments provide support in the form of land allocation or waste supply, a comprehensive national scheme to significantly attract private investment in RDF is still lacking.

03.

Gap Analysis

The issue of waste management in Indonesia is becoming increasingly complex due to the rising volume of waste generation and the limited capacity of existing landfills. One approach currently being implemented to help reduce the burden on landfills is the processing of waste into Refuse-Derived Fuel (RDF), which is considered effective, particularly in areas with high waste volumes but limited land, budget, and waste management investment. However, the implementation of RDF continues to face challenges related to regulation, infrastructure, investment, and market acceptance. Therefore, a gap analysis is necessary to identify the barriers and opportunities that can support the optimization of RDF utilization in Indonesia.

Based on the results of the gap analysis, several key issues have been identified as critical factors influencing the successful implementation of RDF in Indonesia. These issues span across the supply, demand, and enabling environment aspects, which are interrelated and must be addressed in a systematic and integrated manner to ensure the optimal development of RDF. Without a strategic approach, RDF implementation efforts are likely to face greater challenges and risk falling short of the expected outcomes.

From the supply side, the main challenges include the absence of specific policies and technical guidelines related to institutional arrangements, processing workflows, and RDF product standardization. The capacity of RDF processing facilities and their distribution networks remains limited and uneven across regions, while workforce competency in RDF project planning and implementation still needs substantial improvement. In addition, from a planning perspective, many local governments have yet to integrate RDF into their waste management planning documents, and RDF funding is still primarily reliant on government sources, with minimal private sector participation.

On the demand side, industries as potential offtakers face significant challenges, particularly related to the investment required to modify existing equipment and the lack of attractive fiscal incentive schemes. In addition, emission standards for various industrial sectors that may use RDF are not yet established, further hindering its widespread adoption.

In terms of the enabling environment, no dedicated incentive mechanisms are currently in place to promote RDF technologies, which remain limited in development. Collaboration among government, academia, and industry in advancing RDF remains suboptimal, while the role of Regional Research and Innovation Agencies (BRIDA) in supporting applied research at the local level also requires further strengthening. Therefore, to accelerate the expansion and utilization of RDF in Indonesia, a comprehensive reform is needed covering regulatory and institutional frameworks, financing schemes, technical capacity building, and the development of industry-driven innovations.

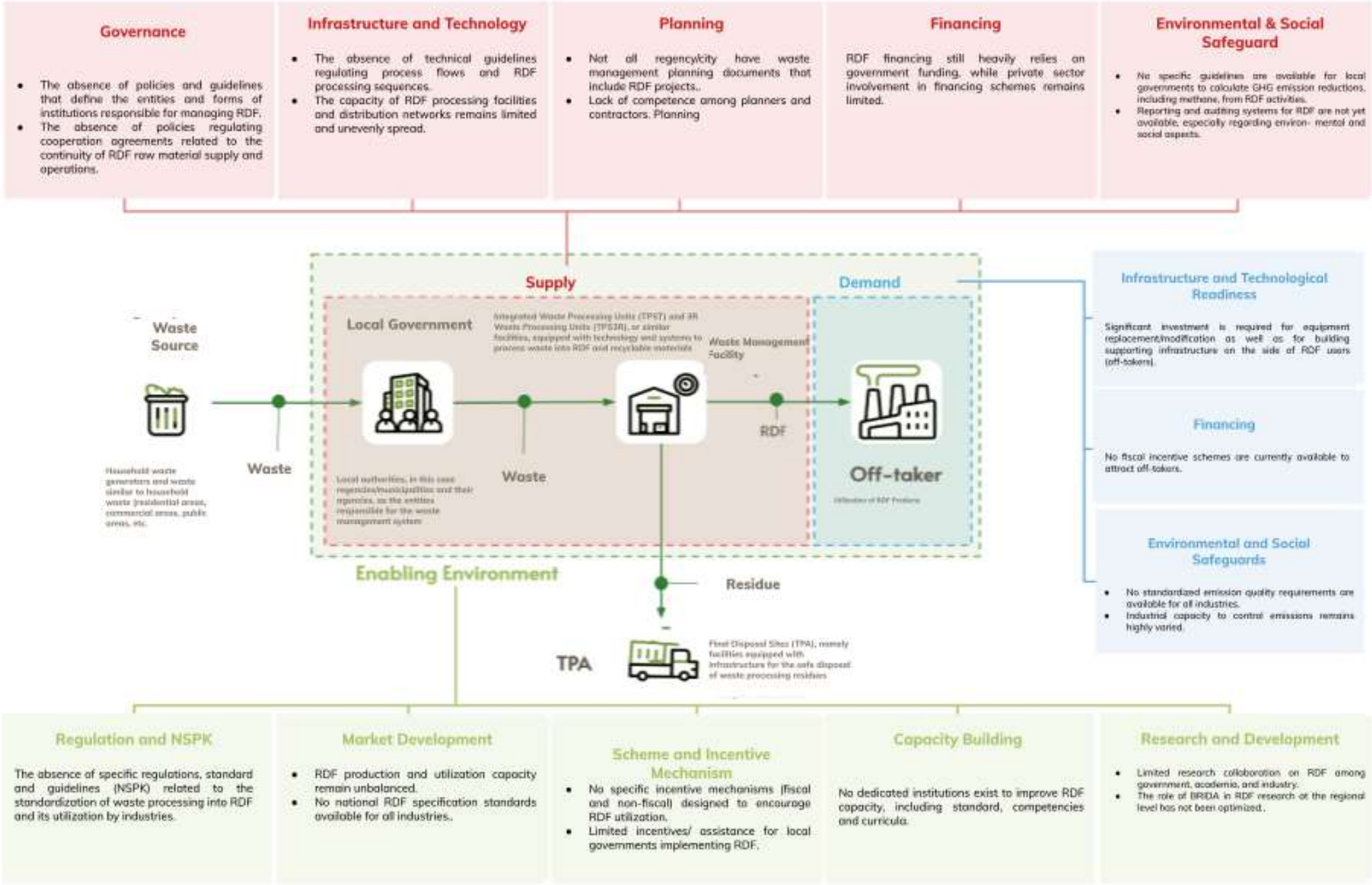

Figure 3.1 *Key Issue of RDF*

3.1 Gaps in RDF Supply

The use of RDF in waste management in Indonesia began with the RDF processing facility at the Jeruklegi landfill in Cilacap Regency, which became operational in July 2020. This RDF facility, with a capacity of 160 tons per day, was constructed with an investment cost of approximately IDR 90 billion. Since then, various RDF facilities have been established across several districts and cities in Indonesia. By mid-2024, more than 20 RDF facilities had been built through a range of initiatives and programs. The majority of RDF facility development has been initiated and funded by the Ministry of Public Works and Housing (MPWH) through the Indonesia Solid Waste Management Project (ISWMP), financed by a World Bank loan. Some RDF facilities have also been developed through Public-Private Partnership (PPP) schemes, although the largest share of investment has still come from the Government. A smaller number of facilities have been funded by local governments through regional budgets (APBD), such as in Sleman Regency and Bantul Regency. The following presents an overview of RDF facility provision in Indonesia as of mid-2024:

1. The first RDF facility at the Jeruklegi Landfill in Cilacap Regency was developed through multi-stakeholder financing, including the State Budget (APBN) via the Ministry of Public Works, a grant from the Government of Denmark through DANIDA, and PT Solusi Bangun Indonesia (SBI).
2. Twenty-two RDF facilities have been constructed through foreign loan financing from the World Bank, under the Indonesia Solid Waste Management Project (ISWMP) implemented by the Ministry of Public Works and Housing.
3. One RDF facility is planned to be developed through a Public-Private Partnership (PPP) scheme, namely the RDF Nambo project.
4. A small number of RDF facilities have been developed through regional government financing (APBD) [23].
5. The operational condition of RDF facilities in Indonesia is currently suboptimal. Of the 22 mapped facilities, 4 are non-operational, and 11 are either not functioning or not operating optimally. This situation is driven by several factors, including equipment issues and/or design capacity limitations, logistical costs, incomplete documentation such as Environmental Impact Assessments (AMDAL) and tariff regulations, as well as other operational constraints.

The use of RDF technology is beginning to grow in Indonesia; however, challenges and failures have also been experienced by several local governments that have adopted RDF for waste management. This section specifically highlights the challenges and gaps in RDF supply. A summary of the supply-side gaps in RDF provision is presented in **Figure 3.2.**

[23] The exact number of local governments that have independently constructed RDF facilities using regional budget (APBD) funds is not yet known. The study team has identified at least three local governments that have undertaken such construction using APBD funds, namely Kabupaten Sleman, Kabupaten Bantul, and Kota Tangerang..

Governance

- There is no policy or guideline to determine the entity and institutional form of RDF management bodies.
- There is a lack of performance monitoring tools for RDF management institutions.
- There are no guidelines for cooperation agreements regulating the management and governance of RDF partnerships, to support the utilization of the produced RDF.
- Typically, local governments only have an MoU during the planning phase, without progressing to operational agreements..

Planning

Waste management planning documents that incorporate RDF projects are not yet available in all regencies/ municipalities.

Infrastructure & Technology

- The wide variation in configurations and equipment types can foster innovation, but also increases the uncertainty of design outcomes.
- Lack of certainty regarding the competency of designers in configuring RDF systems poses a risk of failure in achieving operational targets.
- The sustainability of RDF supply is not yet guaranteed, and TPST facilities remain insufficient to meet the needs of potential offtakers.
- Potential industrial users exist in several regions, but RDF facilities are either unavailable, not operating optimally, or lack sufficient capacity.
- The connectivity of the RDF distribution network remains suboptimal.
- Facilities designed to produce RDF for specific industries lack flexibility to adjust specifications for other industrial applications.

Financial

- The operational and maintenance costs for RDF production per ton have not yet achieved full cost recovery (FCR) or break-even point (BEP), jeopardizing the sustainability of RDF plant operations.
- RDF funding still heavily relies on government sources, while private sector involvement in financing schemes remains limited.
- Budget allocation for waste treatment remains low. Only five cities allocate more than 2% of their budget, while 50 regions have been identified to allocate only around 0.7%.
- The absence of tipping fee support adds uncertainty to the sustainability of RDF operations, as revenue primarily depends on RDF sales, which are subject to market fluctuations

Environmental and Social Safeguard

- There is currently no specific guideline available for local governments to calculate greenhouse gas (GHG) emission reductions, including methane emissions, from waste processing activities into RDF.
- A standardized and periodic reporting and auditing system for environmental and social aspects has yet to be established.
- Formal community involvement remains limited, and public education on the benefits of RDF is still insufficient.

Figure 3.2 *Gap Implementation in Supply Side*

3.1.1 Governance Aspects

This aspect highlights RDF management institutions, waste supply continuity, and cooperation agreements.

Institutional Framework for RDF Management

Based on the mapping of approximately 22 RDF facilities[24], institutional typologies show that 67% are managed by local governments, 28% by private sector actors (offtakers or third parties), and 5% by Village-Owned Enterprises (BUMDes).

Out of the 22 existing RDF facilities, most are not running well (45.4%). Only 22.7% are working properly. Around 18.1% are not working at all, and 13.6% are still being tested. The RDF facilities that are not running well are mostly managed by local governments. Among the ones that are not working, 75% are run by private companies and 25% by local governments.

This indicates that the type of entity and institutional form of the RDF operator are not determining factors affecting the functionality and sustainability of RDF facilities. Rather, these are influenced by other management aspects such as the fulfillment of operational costs, availability of offtakers and absorption of RDF products, standardization of technology and equipment, and other related factors.

While not a determining factor in itself, the type of managing entity and institutional arrangement for RDF facilities should still be carefully assessed, as different models entail distinct strengths and constraints that can influence operational continuity and effectiveness. **Currently, there is no reference or guideline available for Regional Governments planning to develop RDF facilities, particularly concerning the selection of the appropriate institutional model for RDF management.** This reference will serve as a useful guide for Regional Governments in selecting and determining the appropriate institutional arrangement for sustainable RDF management. **Furthermore, there is a lack of tools or mechanisms to monitor and measure the effectiveness of RDF operators.** Ministry of Environment and Forestry has issued a Waste Management Performance Index (Indeks Kinerja Pengelolaan Sampah/IKPS), which includes 10 parameters. However, the performance of waste management operators is not assessed as a specific parameter. A set of performance parameters or an index for RDF management entities would provide stakeholders with a clear picture of the current state of RDF operations and help identify necessary interventions in cases where performance does not meet the established standards.

Continuity of Waste Supply and Cooperation Agreement

The continuity of raw materials or waste supply determines the continuity of RDF production. Based on discussions with the Center for Green Industry, the Ministry of Industry, and various industrial actors with potential interest in utilizing RDF, it was found that one of the key factors influencing industries to use RDF is the continuity of supply. In RDF management under a PPP scheme, the continuity of waste supply to the RDF facility, guaranteed by the local government is stipulated in the contract. The contract specifies the minimum supply of raw materials, which is linked to the tipping fee or the cost that the local government must pay for waste processing. **For schemes other than Public-Private Partnerships (PPP), there is currently no information indicating that the supply of raw materials (waste) and their quality (organic/inorganic) are regulated in cooperation agreements (if any) between the RDF operator and the raw material supplier (Local**

[24] The exact number of local governments that independently construct RDF facilities using regional budget (APBD) funds is not yet known. The study team has identified at least three local governments that have built such facilities with APBD funding, namely Sleman Regency, Bantul Regency, and Tangerang City.

Government). According to information obtained from the Indonesian Cement Association, the raw materials delivered to RDF facilities fluctuate depending on waste availability and collection, and their quality cannot be regulated due to the lack of waste segregation practices in Indonesia. Therefore, not only the volume of supply but also the quality of inputs particularly the type and composition of waste, is a key factor in producing RDF that meets industrial standards. At the Jeruklegi RDF facility in Cilacap Regency, waste sorting is carried out prior to further processing.

Figure 3.3 *Waste Segregation as Part of the RDF Process in Kabupaten Cilacap*
Source: Environmental Agency of Kabupaten Cilacap

The continuity and quality of RDF are among the key factors that determine the demand from offtakers. Discussions with the Directorate of Bioenergy under the Directorate General of New, Renewable Energy, and Energy Conservation, Ministry of Energy and Mineral Resources, indicated that the energy sector (particularly coal-fired power plants) utilizes fuels subsidized by the government. Therefore, the use of RDF (or alternative fuels) may be considered feasible if it meets the following requirements and conditions:

a) The price is regulated,
b) The RDF specifications are clearly defined, and
c) The RDF supply is continuously available.

A cooperation agreement provides certainty for the management and production of RDF, making it necessary and advisable to implement in RDF operations. However, such agreements do not guarantee sustainability if critical aspects of RDF management are not well-planned and implemented. An example of this is found in the RDF facility in Kertalangu, Denpasar City, where a cooperation agreement existed, but important management aspects were not adequately addressed. The RDF facility was managed under a PPP (Public-Private Partnership) scheme through a contract between the local government and a private third party. However, during implementation, several issues arose, including the failure to reach the agreed 60 percent target, ongoing feasibility tests, reliability tests, machinery trials, and emission testing. After two years of operation, the

private partner had not received any tipping fee and only earned revenue from RDF sales. Moreover, they had to sell RDF outside the region, which incurred significant transportation costs, further increasing operational expenses. As a result, in October 2024, the contract between the local government and the private party was officially terminated.

Out of the 22 RDF operators that have been mapped, the majority already have cooperation agreements in place either between the local government and the operator (if privately managed) or between the operator (if managed by the local government) and the offtaker. There is no information indicating the existence of cooperation agreements with equipment providers, except in cases where the operator also acts as the technology and equipment provider, such as at the RDF facility in Kertalangu, Kota Denpasar.

However, there are currently no regulations or guidelines (NSPK) governing the establishment and management of cooperation in RDF operations, which regulate:

a) Which parties are required to have a cooperation agreement;
b) Minimum duration of the cooperation agreement;
c) Type or scheme of cooperation;
d) Key elements that must be included in the cooperation agreement.

The duration of cooperation agreements, particularly between RDF operators and industries or offtakers, typically averages five years. This duration is considered short and does not provide long-term certainty for RDF absorption relative to the investment already made. Moreover, there is currently no national standard, procedure, and criteria (NSPK) governing cooperation schemes for RDF management, resulting in frequent implementation challenges under existing conditions.

3.1.2 Planning Aspects

Comprehensive planning is a key factor in the success of waste-to-RDF facility development projects. However, field realities indicate that there are still various gaps in the preparation and implementation of RDF project planning documents in Indonesia. RDF projects must be integrated into each region's waste management masterplan. **Many regions plan to develop RDF infrastructure; however, their regional masterplans are not yet aligned with the substance of the Ministry of Public Works and Housing Regulation Number 3 of 2013, which outlines waste management infrastructure development, including RDF. In some cases, RDF infrastructure is included in the plan but lacks sufficient detail and does not reflect the region's specific needs.** Before the development of RDF infrastructure, local governments were required to prepare comprehensive planning documents, including a detailed feasibility study that encompassed technical, financial, environmental, and economic assessments. Additionally, preparing a complete set of Detailed Engineering Design (DED) documents is essential, which includes design briefs, technical drawings, cost estimates, technical specifications, and standard operating procedures.

The main gap in this phase is the lack of high-quality and detailed planning documents for RDF projects in Indonesia. Planning documents that do not align with the substance regulated under the relevant Ministerial Regulations, lack comprehensiveness and technical depth, or fail to reflect the specific conditions of each region pose significant risks to the success of RDF project planning and implementation.

Secondly, the quality of planning documents is often inadequate. Many RDF project planning documents adopt a uniform substance and design across various regions, without due consideration of the waste characteristics and specific needs of each locality. This uniformity risks inefficiency and even project failure due to designs that are misaligned with on-the-ground conditions. Insufficiently detailed feasibility studies further weaken risk

analysis and mitigation planning. As a result, RDF projects frequently encounter implementation challenges and may incur significant financial losses. This issue also reflects a lack of compliance with prevailing legal frameworks, such as the Minister of Public Works and Public Housing Regulation Number 3 of 2013.

Thirdly, the evaluation and monitoring processes for planning documents remain weak. The lack of adequate supervision and periodic assessments hampers local governments' ability to identify and rectify errors or deficiencies promptly, thereby increasing the risk of deviations and project failure.

Fourth, the involvement of various stakeholders in the planning process needs to be further strengthened. Effective planning of RDF projects requires active participation from multiple parties, including the central and local governments, business entities, and the community. Inadequate stakeholder engagement may result in planning that is not comprehensive and fails to accommodate the interests of all relevant parties.

Without strong integration with the regional masterplan and other planning documents, the development of RDF facilities may become unfocused and deprioritized, leading to resource inefficiencies. RDF projects may proceed without adequate consideration of the region's long-term waste management strategies.

The lack of detail in the masterplan regarding the ideal location for RDF facility development may lead to difficulties in land acquisition and permitting processes, potentially causing project delays or even failure. If not aligned with a specific feasibility study and detailed engineering design (DED), the planned capacity and technology of the RDF facility may not correspond to the actual needs of the region. This could result in the construction of an RDF facility that is ineffective and unable to meet local waste management requirements.

It is important to note that in this study, the analysis of the planning aspect does not cover the entire RDF cycle. Rather, it is limited to the scope of RDF supply facilities and the utilization of RDF in industry. A more comprehensive analysis covering the full upstream-to-downstream RDF cycle is recommended as a continuation of this study.

3.1.3 Infrastructure and Technology Aspects

Technology Design and Operational Reliability

The design of RDF processing technology in Indonesia remains largely unstandardized and is generally adapted to the specific needs and conditions of each region. An evaluation of 22 existing RDF processing facilities across the country reveals significant variation in technological design, equipment configuration, and process flow.

The *General Guidelines for the Utilization of Household Waste and Similar Waste as Alternative Fuel*, published by the Ministry of Environment and Forestry, provide overarching guidance but do not offer detailed regulations regarding process stages or equipment sequencing in RDF system configurations. The configuration of equipment within RDF technologies is highly flexible, allowing designers the freedom to select appropriate machinery and introduce innovations. However, this flexibility also carries the risk of design failure if not accompanied by established competency standards for designers and thorough evaluation of the selected technologies.

The wide variation in technological designs without guarantees of operational success has led to low efficiency and effectiveness in several established RDF facilities. The gap between the planned and actual processing capacities is primarily due to limited competencies in technology design, inadequate evaluation systems for proposed designs, and constraints in selecting reliable and appropriate equipment.

The operational performance of RDF facilities in Indonesia remains low, as indicated by limited waste processing capacity, high operational and maintenance costs, and uncertainty in achieving production targets. Based on operational data from 18 RDF facilities developed by the government, only 21% demonstrated good operational performance, while more than 76% operated below their design capacity. Operational reliability issues are indicated by the low actual processing capacity achieved and the high percentage of idle capacity due to frequent equipment failures. These issues stem from various factors, including equipment inability to handle waste in certain conditions, limited maintenance performance, and inadequate supply of spare parts. In several facilities, the RDF processing also generates a large amount of residue, indicating a failure in waste reduction. The competence of operators and the availability of sufficient spare parts are also critical factors that must be addressed. Most RDF facilities in Indonesia still require significant improvements in operational management, as well as in the selection of more reliable equipment and technology.

Technology Innovation

Although RDF technology continues to develop, the variety of RDF products produced in Indonesia remains limited, with the majority primarily focused on meeting the needs of the cement industry. Only a small number of facilities produce alternative fuel products (BBJP) for other industries, such as coal-fired power plants (PLTU). This indicates **a lack of technological innovation and limited flexibility in adapting the type and specifications of RDF to meet the diverse needs of different industries.** Mechanical drying technology is the most widely used, while biological processing technology (mechanical biological treatment or MBT) is still rarely implemented.

There is a significant gap between RDF technology innovation in Indonesia and future implementation needs. The range of RDF products remains limited, and the technologies used are mostly conventional. More advanced technologies, such as gasification, pyrolysis, and sophisticated biological processing methods, are still rarely adopted. This reflects a low level of innovation and limited adoption of modern technologies in Indonesia's waste processing sector. As a result, there is a lack of flexibility in meeting the diverse needs of industries and a low added value of RDF products.

The evaluation of Technology Readiness Levels (TRL) for advanced RDF technologies, such as gasification and pyrolysis, indicates that the development of more complex RDF forms such as gas and liquid fuels remains limited domestically, with few examples of implementation internationally. This suggests that such technologies are not yet fully mature and still require further development before they can be widely implemented in Indonesia.

Infrastructure

The number and capacity of RDF infrastructures in Indonesia remain insufficient to meet the demands of potential offtakers. **More regions have potential RDF markets but do not yet have RDF facilities.** The facilities that have already been built often operate below their design capacity. The gap between the available number and capacity of RDF infrastructure and the needs of offtakers poses a potential barrier to RDF market development. This situation is caused by various factors, including inadequate planning, limited funding, and the readiness of technology. RDF infrastructure development must consider the potential demand from offtakers, resource availability, and sustainability aspects, and it must be supported by adequate financing and enabling policies.

The planning of RDF infrastructure development should take into account the potential demand from offtakers in each region, ensure the availability of sufficient land and resources, and be supported by adequate funding. Infrastructure development must also

consider sustainability aspects and cover the entire waste management value chain, from collection and sorting to the utilization of RDF.

Various regions in Indonesia have developed RDF facilities, primarily within waste management infrastructure such as Integrated Waste Processing Sites (TPST). Typically, TPSTs manage waste at the regency or city level and utilize technologies such as RDF, composting, black soldier fly (BSF), and thermal processing. Between 2022 and 2024, the Ministry of Public Works completed the construction of 31 TPST units, with an additional 14 units planned for 2025 under various financing schemes. Differences in the number, scale, technology, and capacity of TPSTs highlight disparities in waste management infrastructure across regions in Indonesia. The gap between the number of RDF-based TPSTs and the capacity needs of each region may hinder the sustainability of RDF implementation efforts and impede regional targets for effective and sustainable waste management.

Distribution Network

The connectivity of the RDF distribution network in Indonesia remains suboptimal and poses a barrier to enhancing the competitiveness of RDF as an alternative fuel. An efficient and integrated transportation and distribution system is not yet fully available, particularly in remote areas. The lack of supporting facilities and the high logistics costs are key barriers to improving the competitiveness and utilization of RDF. Transfer facilities that function as consolidation points to optimize transport routes and logistics efficiency remain limited, making them not yet a viable option for RDF implementation.

Domestic Content Level (Tingkat Komponen Dalam Negeri, TKDN)

The implementation of the Domestic Content Level (TKDN) in RDF facility development projects still faces several challenges. Most of the core equipment used in RDF facilities is still imported. This limits the involvement of domestic industries in technology development and local economic growth.

There is a gap between the implementation of Domestic Content Level (TKDN) in RDF facility development projects and the targeted expectations. This gap is primarily due to dependency on imported technology and equipment, limited domestic technological innovation, and insufficient support from the government. RDF facilities require regular maintenance, with most equipment needing daily inspections and upkeep. To ensure smooth operations, RDF facilities must have an adequate supply of spare parts. If the required spare parts need to be imported, procurement lead times become a challenge, thus requiring effective inventory management. Delays caused by the unavailability of spare parts during maintenance or repairs can hinder RDF production and impact the achievement of waste processing targets.

3.1.4 Financial Aspect

Currently, the development of RDF plants in Indonesia still relies on funding from the government budget. The majority of RDF projects approximately 68% are funded through the national budget (APBN) or government loans, while allocations from provincial and municipal/regency budgets (APBD) account for only around 10%. Additionally, 5% of the funding originates from foreign grants, and another 5% is provided by non-governmental organizations (NGOs). However, 11% of RDF funding sources remain unidentified. Based on data from 20 cities/regencies currently developing RDF plants, only two are utilizing non-public financing schemes. The low level of private sector participation in these projects indicates that alternative financing mechanisms such as bank loans, Sustainability Linked Loans (SLL), Public-Private Partnerships (PPP), or Government Cooperation with Third Parties (KSDPK) have not been fully optimized, **The lack of tipping fee support increases**

uncertainty about the sustainability of RDF operations. Currently, revenue relies heavily on RDF sales, which are volatile and insufficient to fully cover OPEX.

OPEX Financing

Operational financing (OPEX) of RDF plants is a critical aspect in ensuring the sustainability of RDF-based waste management. Currently, the operational financing of RDF plants faces several significant challenges, including **Revenue from RDF sales has not been sufficient to cover the full operational and maintenance costs. The cost of operating and maintaining RDF production per ton has not yet reached the level required for Full Cost Recovery (FCR) or even Break Even Point (BEP).** This means that the cost of producing one ton of RDF which includes waste collection, sorting, drying, and shredding remains higher than the economic value that can be obtained from the RDF itself. This condition makes RDF projects non-bankable without the support of subsidies, incentives, or long-term market guarantees from offtakers such as cement industries or power plants.

Based on current conditions, most RDF Plants still rely on a cost-sharing scheme between local governments and the private sector. For example, the Cilacap RDF Plant is funded 45% by the Regency Government and 55% by PT SBI[25], while the Bantargebang RDF Plant receives funding from the regional budget (APBD) and RDF service revenue. However, not all RDF Plants have stable financing mechanisms. The Kertalangu RDF Plant, for instance, ceased operations due to unmet targets in the cooperation agreement and the absence of an adequate tipping fee. The limited budget allocation for waste management in most regions, averaging only around 0.64%[26], has further hindered the sustainability of RDF Plants.

This issue is further exacerbated by the low budget allocation for the waste management sector in most regions. Data shows that only five cities allocate more than 2% of their total regional budgets for waste management, while more than 50 regions allocate only around 0.7%.[23]. This disparity reflects the lack of adequate prioritization of waste management in regional budget policies. As a result, RDF Plants that heavily rely on regional government (APBD) funding are vulnerable to operational disruptions, especially when financing is unsustainable and not integrated into long-term planning.

3.1.5 Environmental and Social Safeguard Aspects

Potential for GHG Emission Reduction and Other Pollutants

The large volume of unmanaged waste requires effective solutions, as it contributes to increased greenhouse gas (GHG) emissions and environmental pollution. One major source of GHG emissions is methane gas released from decomposing waste in landfills. It is estimated that one ton of waste generates approximately 50 kg of methane[27], where one ton of methane is equivalent to 28 tons of CO_2. In addition, waste piles in landfills also produce leachate, which can contaminate soil and groundwater.

Waste processing through RDF (Refuse-Derived Fuel) holds significant potential in reducing both greenhouse gas (GHG) emissions and leachate production. By 2030, GHG emissions from Indonesia's 514 landfills are projected to reach approximately 58.22 million tons of CO_2e. Field case studies show that RDF implementation in Cilacap has reduced emissions by 49,632 tons of CO_2e, while RDF operations in Bantargebang have achieved a

[25] Environmental Agency of Kabupaten Cilacap, 2023
[26] Allocation Data for Local State in Ministry of Home Affairs 2024
[27] https://katadata.co.id/ekonomi-hijau/ekonomi-sirkular/648c416e22567/pangkas-emisi-gas-metana-klhk-akan-hentikan-pembangunan-tpa-di-2030.

reduction of 446,497 tons of CO_2e[28]. These examples demonstrate the substantial mitigation potential of RDF. If RDF development is scaled up, it could significantly reduce landfill leachate and GHG emissions from domestic solid waste, supporting the achievement of Indonesia's Enhanced Nationally Determined Contribution (ENDC) 2022 target, which aims to avoid 1.9 million tons of CO_2e through RDF processing by 2030.

In addition, the transportation of RDF to offtakers also contributes to GHG emissions. The distribution process from TPST to offtakers requires careful planning to minimize emissions from transport activities. While existing landfill distribution maps already cover several areas located near coal-fired power plants and cement factories, there is still a lack of comprehensive mapping to ensure efficient RDF distribution to all potential offtakers, especially those outside the cement and PLTU sectors.

Although RDF has significant potential to reduce greenhouse gas (GHG) and methane emissions as well as leachate production, several gaps still hinder its optimal implementation. Currently, **there are no specific guidelines available for local governments to calculate GHG emission reductions, including methane emissions, resulting from waste-to-RDF processing activities**. These guidelines can serve as a reference for local governments to identify and understand the potential within their respective regions. Moreover, achieving optimal and sustainable RDF plant capacity remains a challenge, primarily due to the absence of mechanisms that ensure continuous operations. In fact, several facilities, such as the RDF plant in Kertalangu, have ceased operations. In terms of transportation, the current mapping of RDF distribution to various offtakers remains limited, resulting in suboptimal logistical efficiency.

Potential for Air Pollution and Other Environmental Contaminations

Although RDF offers a promising solution for waste management, its processing activities still pose potential environmental risks. The conversion of waste into RDF through steps such as drying, shredding, and screening can generate dust and fine particulate matter (PM10, PM2.5), which may contribute to air pollution. Furthermore, if thermal technologies are applied during the drying process, emissions such as carbon dioxide (CO_2), volatile organic compounds (VOCs), nitrogen oxides (NOx), and sulfur oxides (SOx) may be released into the atmosphere**Error! Bookmark not defined.**. The combustion of plastic waste during the RDF process can also produce hazardous pollutants such as dioxins, furans, and heavy metals. Additionally, the risk of leachate pollution remains if waste is not promptly processed at the TPST. Therefore, environmental assessments must be conducted prior to the construction of RDF facilities, as mandated by the Regulation of the Minister of Public Works and Public Housing No. 3 of 2013.

However, several gaps remain that require attention. A standardized and regular reporting and auditing system for RDF facilities is currently not available. In fact, the effectiveness of dust and pollutant control systems at existing TPST facilities still needs to be further reviewed. Leachate treatment installations also require evaluation to ensure their capacity to manage the resulting liquid waste effectively. Regular monitoring is essential to ensure that waste processing into RDF remains environmentally friendly and sustainable.

Impact of RDF Implementation for Public

Beyond environmental aspects, waste processing into RDF also holds potential for generating socio-economic benefits. According to studies, the implementation of RDF can create up to 4.4 million new jobs[29]. A concrete example can be seen at the Jeruklegi TPST in Cilacap, where 130 waste pickers have been integrated into the RDF processing

[28] RDI, "Presentation Material at Bioshare Series #14 RDFact", October 2024.
[29] Bappenas, "Institutional Analysis, Planning, and Funding & Financing Options for Waste Management Report", 2022.

activities[Error! Bookmark not defined.]. They are provided with a designated workplace and standard operating procedures (SOPs) to sort high-value materials such as PET, HDPE, LDPE, metals, and glass. This not only increases economic value but also reduces materials that lower the calorific value of RDF.

More than just conventional employment, RDF also holds significant potential for creating green jobs in Indonesia. According to the ILO, green jobs are those aimed at reducing environmental impacts while preserving the natural environment, including protecting ecosystems, reducing energy and material consumption, and decarbonizing the economy[30]. In the context of RDF, green jobs can be created across various stages of its value chain, such as waste collection and sorting, operation of shredding and drying machines, equipment maintenance, and the distribution and utilization of RDF by end-user industries.

However, despite its significant potential, the creation of green jobs through RDF implementation in Indonesia still faces various challenges. One of the key issues is related to **the equitable distribution of local workforce capacity and the inclusion of women and vulnerable groups involved in the RDF value chain.**

In addition to employment-related challenges, waste processing facilities often face social issues, both during construction and operational phases. Social conflicts frequently arise due to environmental impacts such as noise or odor caused by suboptimal waste management. According to the Directorate General of Sanitation at the Ministry of Public Works and Housing, social tensions are a common obstacle in the development of waste treatment facilities. Furthermore, many members of the public still lack understanding of the benefits of RDF as a waste management solution and alternative fuel.

Ideally, the expansion of RDF implementation should be supported by communities and other stakeholders without conflict. The operation of waste processing into RDF is also expected to run smoothly without causing negative environmental impacts that could trigger protests from surrounding residents. In addition, the expansion of RDF should create new employment opportunities and open up business prospects, particularly for local communities. RDF projects should be designed fairly by ensuring community involvement at every stage, both as workers and business partners. This approach not only supports local economic growth but also strengthens public support for RDF programs.

However, to this day, **public education regarding the benefits of RDF and its potential as an alternative fuel remains limited**. Moreover, there is still no clear scheme established to formally involve communities in the waste-to-RDF process. In fact, the presence of such a scheme could provide a structured framework to maximize the socio-economic benefits of RDF while ensuring the sustainability of the program through strong local community support. On the other hand, conflicts often arise when RDF facilities do not operate optimally—for example, unmanaged piles of waste that produce unpleasant odors. Although the identification and mitigation of potential social conflicts are mandated in social assessment documents, as stipulated in the Minister of Public Works and Housing Regulation No. 3 of 2013, its implementation in the field has not yet been fully effective. Similarly, as with environmental aspects, the social dimension also lacks a reporting and regular audit system to monitor the implementation of conflict mitigation efforts.

3.2 Challenges in the Utilization of RDF

The demand for Refuse-Derived Fuel (RDF) in Indonesia largely depends on industrial sectors capable of utilizing it as an alternative energy source—primarily the cement

[30] International Labour Organization, “Fact Sheet on Decent and Environmentally Friendly Work (Green Jobs) in Indonesia”, 2010

industry, power generation facilities, and several other industries that use solid fuels. The cement industry has emerged as the main sector for RDF utilization, given that its fuel characteristics are well-suited for the co-firing process in cement kilns. Several major cement producers in Indonesia, such as PT Solusi Bangun Indonesia (SBI) and PT Semen Indonesia, have begun adopting RDF as part of their decarbonization and energy efficiency strategies.

Despite growing interest in the use of RDF, actual demand continues to face various challenges. One of the primary obstacles is the need for industries to modify their existing technologies to accommodate the shift in fuel type. These modifications often require substantial investments. In general, industries are reluctant to initiate such high-risk investments without certainty. This section highlights the key factors influencing RDF demand in Indonesia. A summary of the gaps in RDF utilization is presented in **Figure 3.4**.

Infrastructure & Technological Readiness

- The cement industry has not yet reached its optimal capacity in utilizing RDF but holds significant potential to increase RDF uptake under certain conditions. Meanwhile, other industries such as fertilizer, chemical, and paper have the potential to utilize RDF but are currently still in the study or pilot testing phase.
- The transition to alternative fuels requires innovative technology, which entails difficult initial implementation and substantial investment. As a result, industries are often reluctant to invest due to the high associated risks.

Financial

- There is currently no available fiscal incentive scheme to attract potential offtakers.
- RDF infrastructure requires substantial investment, including modifications to combustion technology, flue gas treatment systems, and waste handling and processing facilities.

Environmental and Social Safeguard

- According to Annex 3 of the Regulation of the Minister of Environment and Forestry Number 19 of 2017, the emission standards for RDF are stricter than those for hazardous waste (B3), even though RDF is classified as non-hazardous waste. Moreover, the regulation only applies to cement industries that utilize RDF exclusively.
- Emission control and monitoring systems in industries other than coal-fired power plants (PLTU) and cement industries are, in some cases, inadequate for RDF utilization.
- There is currently no standardized methodology for offtakers to calculate greenhouse gas (GHG) emissions resulting from RDF combustion as an alternative fuel.

Figure 3.4 *Gap Implementation of RDF in Demand Side*

3.2.1 Infrastructure and Technological Readiness Aspects

There is a gap between the technological readiness of industries and the planned expansion of RDF utilization. **The readiness of RDF-consuming industries in Indonesia, particularly the cement industry as the primary end-user, remains suboptimal.** Although RDF utilization in this sector has yet to reach its full potential, the cement industry holds significant capacity to increase RDF uptake under certain conditions. In 2022, the national cement industry's Thermal Substitution Rate (TSR) was recorded at 9.1%, with contributions from biomass sources including RDF accounting for only around 5%[31].

The cement industry decarbonization draft sets a biomass Thermal Substitution Rate (TSR) target of 4% by 2025, 10% by 2030, 13% by 2035, and 15% for the period between 2040 and 2050[32]. However, to utilize RDF in greater quantities, the cement industry needs to invest in pre-processing facilities to improve RDF quality, as well as modify combustion systems to maintain process stability.

In addition to the cement industry, other industrial sectors are considered to have potential for utilizing RDF, but currently lack the supporting infrastructure to adapt RDF to their combustion equipment. Industries seeking to adopt RDF require infrastructure development for the handling, storage, and transportation of RDF within their facilities, including conveyor systems and automated processes to enable seamless integration into production lines. Industries that remain fully dependent on coal typically do not have such infrastructure in place. Dedicated RDF storage facilities are necessary to accommodate the range of RDF particle sizes and to prevent degradation or contamination.

Industries consider substituting coal with alternative fuels such as RDF as a means to reduce energy costs. However, investment decisions are typically made only after thorough technical and economic feasibility assessments. The greater the RDF consumption, the larger the investment required for additional or modified combustion equipment and emission control systems.

Several industries beyond cement such as fertilizer, paper, steel, and chemicals have the potential to utilize RDF; however, they are currently still in the assessment or pilot testing stages. The transition from conventional fuels to RDF requires innovative technologies, which at the initial phase are often complex and costly. This leads many industries to be reluctant to invest due to the high perceived risk..

From the utilization perspective, a reliable RDF supply must be ensured before RDF mandates are incorporated into industrial policies. Furthermore, guaranteeing future RDF availability would provide the necessary certainty for industries to make investment decisions. Non-cement industries will assess the economic benefits before deciding to substitute fuels, while also considering the risks to processes and potential production losses. However, with strong government support for industrial decarbonization, the adoption of RDF could be accelerated.

3.2.2 Financial Aspect

The financing of energy transition from fossil fuels to RDF continues to face complex structural and financial challenges. Currently, there are several private sector initiatives, including direct investments by major companies aiming to meet the Sustainable Development Goals (SDGs), as well as the implementation of Sustainability-Linked Loans (SLLs) for projects aligned with environmental, social, and governance (ESG) principles. In addition, some financial institutions have introduced funding schemes for environmentally

[31] Presentasi Ketua Asosiasi Semen Indonesia, 2024.
[32] Hasil olahan konsultan, 2024.

friendly projects, including waste management and resource efficiency. However, information related to investment feasibility and the risk profile of energy conservation projects remains limited, resulting in a low level of confidence among businesses when making capital-intensive investment decisions. **Moreover, existing financial incentives are not yet sufficiently attractive**, as interest rates for renewable energy loans do not differ significantly from those in the property sector, thereby failing to provide a competitive advantage for industries seeking to transition to RDF.

Ideally, the energy transition financing system should be more structured and supportive of RDF development through low-interest financing schemes, matching grants, and a dedicated credit classification for renewable energy similar to mortgage loans (KPR) in the property sector. In addition, expanding access to affordable credit and integrating RDF into industrial supply chains could encourage more companies to adopt RDF technology. The government, through the Just Energy Transition Partnership (JETP) and administrative support from PT SMI, is expected to identify investment opportunities and establish a more conducive regulatory framework to support the energy transition.

One of the major challenges in utilizing RDF lies in the substantial upfront investment required, particularly for the development of supporting infrastructure. This includes the need for modifications to combustion technology, flue gas treatment systems, as well as the construction of waste handling and processing facilities. These three components are critical and demand significant capital, which can only be realized through cross-sector coordination and access to long-term financing. The gap in RDF infrastructure availability may hinder the implementation of related projects.

The gaps observed in the implementation of RDF indicate that supporting infrastructure remains limited. The development and modification of combustion technologies, flue gas treatment systems, and waste handling facilities require substantial investment and multi-stakeholder coordination. Moreover, the cost of transition extends beyond technological investment it also includes the dismantling of coal-based facilities and social impacts, such as potential job losses due to the shutdown of coal-fired kilns.

The lack of a cost-efficient structure is further exacerbated by the limited scale of production, logistical inefficiencies, and suboptimal technologies, particularly in small to medium-scale processing facilities. Without efforts to reduce operational and maintenance costs through technological efficiency improvements, economies of scale, and fiscal support from the government, RDF will struggle to compete economically with conventional fuels.

3.2.3 Environmental and Social Safeguards

Regulations on emission quality standards (BME) for the cement industry are stipulated in the Regulation of the Minister of Environment and Forestry No. 19 of 2017. However, this regulation is only applicable when the cement industry uses RDF exclusively. If RDF is used in combination with conventional fuels, the applicable BME refers to the standards stated in the environmental permit of each facility. Furthermore, in the same regulation, specifically in Annex 3 it is noted that the **emission standards for the utilization of RDF are stricter than those for hazardous waste (B3 waste), even though RDF itself is classified as non-B3 waste.** This indicates that the use of RDF in the industry must comply with more stringent environmental standards compared to other alternative fuels.

On the other hand, although emission control systems in coal-fired power plants (CFPPs) and cement industries are generally adequate for RDF utilization, there remains a significant gap in their implementation across other industries. Several

industries with potential for RDF usage such as fertilizer, steel, and paper industries still lack sufficient emission control and monitoring systems to ensure that exhaust gases remain within safe limits. Before adopting RDF, each industry must ensure technological readiness to manage the resulting emissions in compliance with prevailing environmental standards. Without effective control systems, the risk of air pollution from RDF combustion emissions may increase, ultimately impacting public health and the environment.

In addition, there is currently **no clear methodology available for offtakers to calculate greenhouse gas (GHG) emissions resulting from the combustion of RDF as an alternative fuel**. The absence of such a methodology can poses a barrier to emission reporting and hinder the accurate assessment of RDF's contribution toward national decarbonization targets.

3.3 Gaps in the Provision of an Enabling Environment

The implementation of RDF in Indonesia has proven to be effective in contributing to urban waste management and reducing the volume of waste ending up in landfills. However, RDF facilities cannot operate in isolation they must be integrated within a broader ecosystem or service chain involving RDF users or offtakers. Currently, RDF utilization in Indonesia is primarily driven by regulatory mechanisms. Therefore, the provision of an enabling environment is a critical component for the implementation and expansion of RDF in the country. This section specifically highlights the barriers and gaps in establishing an enabling environment for RDF adoption and scale-up. A summary of the key gaps in the enabling environment is presented in **Figure 3.5**.

Regulation, Standard & Guidelines (NSPK)

- The specific implementation of RDF technology as part of the renewable energy mix has not yet been fully supported by a comprehensive regulatory framework.
- The availability of technical norms, standards, procedures, and criteria (NSPK) to support RDF management remains limited..

Market Development

- The capacity for RDF production and utilization remains unbalanced.
- RDF pricing has yet to be standardized. The lack of standardized pricing may reduce the attractiveness of RDF and limit its utilization.
- There is currently no national standard regarding RDF specifications.

Incentive Scheme & Mechanism

- The current capacity for RDF production and its utilization remains misaligned, resulting in supply-demand imbalances.
- RDF pricing has not yet been standardized, which may hinder market confidence and reduce its attractiveness as an alternative fuel.

Capacity Building

There is currently no designated institution responsible for RDF capacity development, including the formulation of competency standards and training curricula.

Research and Development

Collaboration in RDF-related research among government, academic institutions, and industry remains limited.

Figure 3.5 *Gap implementation of RDF in Enabling Environment Side*

3.3.1 Regulation, Standard & Guidelines (NSPK) Aspect

Regulatory and Policy Support

The use of RDF technology for waste management represents an innovative strategy to address the dual challenge of greenhouse gas (GHG) emission reduction and the transition toward a more sustainable energy system. Indonesia has established a relatively strong regulatory foundation through Regulation Number. 18 of 2008 about Waste Management, which promotes a waste management hierarchy based on reduction, reuse, recycling, and energy recovery. In addition, the country's global climate commitment reflected in Government Regulation Number 16 of 2016 about the Ratification of the Paris Agreement places Indonesia on a strategic path toward achieving Net Zero Emissions (NZE) by 2060, including through decarbonization of the energy and industrial sectors. **Nevertheless, the specific implementation of RDF technologies as part of the renewable energy mix has yet to be fully supported by a comprehensive regulatory framework.**

Key elements such as regulatory clarity, cross-sector alignment, and dedicated technical guidelines are still limited, potentially constraining the development and scaling up of RDF as a reliable and sustainable alternative fuel.

Incentive mechanisms play a pivotal role in accelerating the industrial transition away from fossil fuels toward waste-derived alternative fuels. Instruments such as a carbon tax targeting fossil fuel users, which are intended to internalize the environmental costs of carbon emissions, have yet to be fully implemented. As a result, RDF still faces competitiveness challenges compared to conventional energy sources.

From a sustainability perspective, RDF technology contributes not only to GHG emissions reduction, but also aligns with several Sustainable Development Goals (SDGs). For instance: SDG 7 (Affordable and Clean Energy): RDF offers a more accessible and cost-effective renewable energy option than fossil fuels. SDG 9 (Industry, Innovation, and Infrastructure): RDF deployment requires new infrastructure development and stimulates technological innovation in the energy and waste sectors. SDG 11 (Sustainable Cities and Communities): RDF reduces the volume of waste sent to landfills, supporting more sustainable urban waste management systems. SDG 13 (Climate Action): By decreasing carbon emissions from both energy generation and waste treatment, RDF supports national and global climate goals. To realize the potential of RDF as part of a sustainable waste and energy solution, an enabling policy environment is essential. This includes not only regulatory and fiscal support, but also the integration of RDF within broader national strategic plans, such as the National Energy Policy (KEN) and the Renewable Energy Utilization Roadmap (2025–2045).

These measures will provide a clearer policy framework and encourage the active involvement of both the private sector and the wider community in utilizing RDF as a sustainable energy solution. This approach has the potential to generate long-term impacts across environmental, economic, and social dimensions.

Norm, Standards, Procedurs, and Criteria

Currently, **the availability of Norms, Standards, Procedures, and Criteria (NSPC) to support RDF management remains limited**. Existing NSPC primarily cover guidelines for the cement industry through national standards (SNI and RSNI) on alternative fuels and emission quality standards. However, other crucial aspects—such as technical standards for RDF facility design and construction, standard operating procedures (SOPs) for operations and maintenance, as well as guidelines for calculating operational costs and RDF economic

feasibility have yet to be comprehensively developed. This lack of comprehensive NSPC creates a significant gap, particularly in ensuring efficiency, sustainability, and compliance with environmental regulations across the entire RDF supply chain. The absence of standardized references may also undermine the attractiveness of RDF investment and its broader adoption as an alternative fuel within the industrial sector.

Monitoring, Evaluation, and Information Systems

In addition to the lack of NSPC, another major challenge lies in the integration and quality of information systems used to monitor and evaluate RDF management. Currently, there are two main platforms: the Waste Management Information System (SIPSN), managed by the Ministry of Environment and Forestry, and the Sanitation Infrastructure Information System (SIINSAN), managed by the Ministry of Public Works and Housing. While SIPSN includes information on waste processing facilities, the data presented often suffers from duplication and inconsistencies, particularly regarding the recorded capacities of RDF facilities. Meanwhile, SIINSAN is only accessible to select users, making its data less available to the public or stakeholders without registered accounts. Poorly verified data can hinder strategic decision-making, especially in ensuring the accurate supply of RDF to industrial sectors.

3.3.2 Market Development Aspect

The development of the RDF market in Indonesia, aside from being influenced by regulatory frameworks, is heavily dependent on several key economic factors. Government-subsidized **coal prices negatively affect RDF uptake, as RDF directly competes with coal.** Currently, RDF demand remains limited, primarily concentrated in the cement industry located in Central and West Java. **Although there is potential for increased RDF production capacity in the future, driven by rising municipal solid waste generation and growing interest from both industry and coal-fired power plants, the current RDF market remains very small**. Existing and ongoing RDF projects with small to medium capacities (below 300 tons/day) reflect limited absorption capacity. This is due to various factors, such as inconsistent RDF quality, inadequate supporting infrastructure, RDF prices that are still relatively high compared to fossil fuels, and regulatory frameworks that do not yet fully support RDF utilization. The readiness of industry players to adopt and use RDF also needs significant improvement.

On the other hand, the rising prices of fossil fuels and the implementation of renewable energy policies have had a positive impact on RDF demand, encouraging industries to seek more sustainable alternative fuels. The availability of waste as feedstock for RDF production is a crucial factor in industrial decision-making when considering a shift from conventional fuels to RDF. In addition, long-term offtaker agreements and transparent pricing structures are essential to ensure stable and predictable revenue for RDF facility operators, thereby making RDF projects more attractive to potential investors. However, coal subsidies negatively influence RDF demand by making fossil fuels more price-competitive. Furthermore, regulatory frameworks that specifically support RDF development remain limited, resulting in RDF utilization often relying heavily on proactive initiatives from the private sector to move forward..

Quality Assurance

RDF quality assurance is crucial, as the fluctuating nature of waste composition can significantly impact product acceptance by industries. The planned Indonesian National Standard (SNI) for RDF in the cement industry includes testing methods necessary to ensure this quality standard. **To maintain consistent RDF production quality, the development of clear standards and guidelines is essential.** RDF products must be

tailored to meet the specifications required by offtakers, and RDF facilities are obliged to conduct laboratory testing on processed product samples to ensure that outputs comply with established standards. This quality assurance is vital both for RDF facility operators and offtakers, as RDF standards are designed to ensure that the final product meets industrial requirements. Furthermore, quality assurance is also necessary to comply with environmental regulations, particularly by ensuring that emissions from RDF combustion remain below the thresholds set by applicable laws and regulations. However, the RDF market in Indonesia remains underdeveloped, and as a result, there is currently no adequate pricing benchmark. This poses a significant challenge in promoting RDF market growth and wider acceptance.

Price of RDF

The aspect of competition with other energy sources indicates that RDF pricing is directly correlated with its quality, which includes factors such as calorific value, moisture content, ash content, sulfur, and chlorine levels. Nevertheless, a key challenge remains the economic viability of renewable energy, including RDF, which is generally still more expensive than fossil fuels. One contributing factor to this situation is the continued subsidy support for fossil fuels, as highlighted in a study by Bappenas (2022) regarding RDF offtakers. Despite this, RDF prices can become more competitive compared to coal, especially if RDF quality meets or exceeds the Indonesian National Standard (SNI). However, the broader energy market including fossil fuels, biomass, and other renewable sources, poses significant competition to RDF, influencing both its market price and demand. Lower energy costs and market prices can negatively affect RDF uptake, as RDF is intended as a substitute for fossil fuels and thus competes directly in terms of price. At present, the RDF market in Indonesia remains in a developmental phase, with unstable demand and selling prices, adding to the investment risks within this sector.

Infrastructure and Distribution Strengthening Aspect

This aspect is essential to ensure accessibility and efficiency in delivering RDF to end-users. It involves considerations such as road conditions, transportation distance, and associated logistics costs, all of which can significantly influence the smooth distribution of RDF. The proximity between RDF processing facilities and industrial offtakers, particularly cement plants, presents a strategic advantage by facilitating easier access to RDF supply for both operators and offtakers.

To support the development and strengthening of infrastructure, expanding public access to RDF is also a key focus. This includes building supporting infrastructure such as transportation networks, temporary storage facilities, and distribution systems to enable an efficient market and sustainably meet domestic demand.

3.3.3 Scheme and Insentive Mechanism Aspect

Fiscal and non-fiscal incentive policies serve as crucial instruments to promote the implementation of innovative technologies such as RDF, which integrate energy efficiency and sustainable waste management. However, current conditions indicate that specific incentives for RDF utilization have yet to be established at both national and regional levels. This absence of targeted incentives has resulted in low adoption of RDF among businesses and local governments, despite its strategic potential in the transition towards sustainable energy and environmentally sound waste management.

At the national level, the Government has identified 17 business sectors eligible for fiscal and non-fiscal incentives, including the Environment and Forestry sector as well as the Energy and Mineral Resources sector. Nevertheless, RDF technology is not explicitly included in these schemes, thus limiting the support for businesses that wish to invest in or adopt RDF. One example is the Corporate Performance Rating Program (PROPER),

where energy efficiency which may include RDF use is categorized under "beyond compliance" criteria and is not mandatory. This reduces the urgency for companies to integrate RDF into their business strategies.

Fiscal incentives such as tax holidays for pioneer industries developing RDF, import duty exemptions for RDF technology equipment, subsidies for carbon emission reductions, and VAT exemptions on RDF sales can serve as strategic measures to attract private sector interest. In addition, enhanced incentive schemes such as up to 300% tax deductions for research and development (R&D) activities and workforce training can strengthen the RDF ecosystem in Indonesia. The consideration for offering up to 300% tax deductions is intended to encourage companies to be more proactive in conducting R&D that results in innovation, new technologies, and technology transfer, thereby enhancing the competitiveness of national industries, as stipulated in Government Regulation No. 45 of 2019, and reinforced by Minister of Finance Regulation No. 153 of 2020. This scheme has already been implemented in Indonesia's pharmaceutical sector, where companies are granted a 100% gross income deduction for R&D expenses, with an additional 200% deduction if the R&D activities result in a patent, reach the commercialization stage, or are conducted in collaboration with research institutions or universities in Indonesia. Other countries such as Malaysia, Singapore, and the European Union, have also adopted super tax deductions or green investment tax allowances for renewable energy and energy efficiency projects, reaching up to 200%–300%. These policies should be integrated with an effective carbon trading scheme, whereby businesses can benefit from carbon credits generated through RDF utilization to improve their financial performance.

On the non-fiscal side, incentives such as streamlined risk-based licensing procedures through the Online Single Submission (OSS) system and the provision of supporting infrastructure, such as waste sorting facilities near major landfills, would significantly support the operationalization of RDF. The government can also promote energy procurement contracts based on RDF between RDF providers and end users such as PLN or other state-owned energy enterprises (SOEs) to establish a stable and predictable market. Local regulations must also be harmonized with global mechanisms, such as the Clean Development Mechanism (CDM) and Article 6 of the Paris Agreement, to ensure compatibility with international carbon trading frameworks.

At the local government level, a clear gap is evident in the limited adoption of RDF initiatives. Currently, only a few regions, such as Kabupaten Banyumas and Kabupaten Sleman, have implemented RDF projects, primarily funded through their regional budgets (APBD). However, the scale remains limited, and the incentives provided to local governments have so far focused only on capital expenditure (CAPEX) support in priority locations designated by the central government. Local governments that have successfully implemented RDF deserve additional operational support (OPEX) as well as access to carbon markets. Furthermore, non-fiscal incentives such as international recognition or awards for effective RDF management could also serve as a motivational tool to encourage other regions to follow suit.

This gap highlights the urgent need for a more comprehensive and integrated incentive policy framework. The provision of targeted fiscal incentives, such as direct subsidies for RDF development, along with non-fiscal incentives, including regulatory simplification and infrastructure support, will help foster a more conducive ecosystem. Achieving this requires close collaboration among the central government, local governments, the private sector, and civil society to ensure the sustainability and success of RDF implementation across Indonesia.

3.3.4 Capacity Building Aspect

Since the adoption of RDF technology for waste management in Indonesia began in 2020, various districts and municipalities have implemented RDF as part of their waste treatment strategies. However, by 2024, only approximately 28% of RDF facilities were operating effectively, while the rest had become non-operational or were functioning sub-optimally. This situation indicates that, despite RDF being perceived as a relatively simple and easy-to-operate technology, the operational capacity of local implementers remains limited, hindering the sustainability of these facilities in the long term.

Currently, there is no dedicated mechanism or institutional body that provides systematic capacity-building services for stakeholders involved in the provision, management, and utilization of RDF. Existing initiatives such as technical assistance, mentoring, and training are generally implemented through short-term project-based schemes. For example, the ISWMP program and the RDFact project led by the Resilience Development Initiative (RDI) have conducted a number of training sessions for local governments to strengthen their institutional capacities.

However, these mechanisms and institutions remain insufficient to meet the growing demand for skilled human resources (HR) in RDF operations, resulting in limited technical expertise and low-quality management practices. There is an urgent need for a more structured and comprehensive capacity-building program, supported by government intervention, to enhance human resource capabilities in this field.

In addition, facilitating knowledge development and exchange through a robust knowledge management system is essential to support the future implementation of RDF. Information and knowledge sharing across stakeholders, including the private sector, non-profit organizations, research institutes, academia, government agencies, financial institutions, and civil society, will help accelerate the development of RDF as a decarbonization strategy. Through such engagement, stakeholders will gain a deeper understanding of waste-to-energy technologies, encompassing technical, social, environmental, economic, business model, and financing aspects.

3.3.5 Research and Development Aspect

Currently, Indonesia's expenditure on Research and Development (R&D) remains relatively low, and significant improvements are still needed to strengthen the research ecosystem. The proportion of government research funding to GDP was only 0.28% in 2021. This proportion is targeted to reach 0.42% in 2024 and 0.63% in 2030. The Indonesian Agency for Research and Innovation (BRIN) has conducted several relevant studies, including research on optimizing the homogeneity and calorific value of alternative waste-derived fuels such as RDF and SRF; techno-economic studies on thermal processing; environmental evaluations of waste treatment through thermal processes; and research and innovation in RDF technology for municipal waste management, including collaborations with private companies from September 1, 2022, to December 31, 2023. However, to date, no official publications on the results of these studies have been made available.

The R&D budget for RDF technology in Indonesia remains relatively low compared to other countries. This condition hinders technological innovation and the development of the RDF market. Increased investment in R&D, collaboration among research institutions, and stronger government support are essential to enhance research capacity and technological development related to RDF. **Effective collaboration between research institutions, the private sector, and the government is crucial to achieving the targeted proportion of R&D expenditure to GDP.**

On the other hand, the presence of Regional Research and Innovation Agencies (BRIDA) as part of the decentralized research governance system has yet to show optimal effectiveness. Currently, BRIDA has not been able to fully function in providing the necessary studies to support local government decision-making. Capacity constraints, limited resources, and weak coordination across levels of government remain key challenges in strengthening the role of BRIDA. As a result, BRIDA's contribution in producing the required studies as a foundation for decision-making in RDF technology development at the regional level remains limited.

04.

Recommendations for RDF Implementation in Indonesia

Based on the gap analysis described previously, there are various challenges in the implementation of RDF in Indonesia. These include the absence of stable demand, misalignment between the locations of RDF facilities and the needs of end-user industries, as well as limitations in regulations and incentive schemes to support broader RDF utilization. These recommendations are formulated as strategic actions to ensure RDF can be effectively adopted across different regions.

One of the key recommendations for RDF expansion is the appropriate selection of facility locations. The provision of RDF infrastructure must consider several critical aspects to ensure the facilities can operate optimally and contribute to reducing the volume of waste disposed of in landfills. RDF facilities should:

Built in areas facing urgent waste management issues that require immediate response, so that the facility can serve as a significant solution in reducing waste generation.

- **Implemented in regions that meet specific criteria,** namely areas with limited landfill space and high volumes of waste generation, making RDF a suitable alternative.
- **Located near offtaker industries that are ready to utilize RDF as an alternative fuel**, ensuring continuous production and preventing surplus RDF from remaining unabsorbed by the market.

At present, the demand side (utilization) for RDF remains limited due to the absence of explicit policies that encourage industries to adopt its use. To increase RDF demand, several interventions are required, such as:

- **Mandating the use of RDF through regulations,** such as roadmaps, energy policies, or sector-specific rules targeting industries that can utilize RDF.
- **Providing attractive incentive schemes for industries, such as tax reductions**, RDF price subsidies, or mechanisms like carbon credits and green bonds, to enhance RDF's competitiveness compared to subsidized fossil fuels.

In addition to addressing the demand side, the production aspect of RDF must also be strengthened to ensure the sustainability of the system. The RDF produced must meet clear quality standards, maintain a consistent supply, and remain competitively priced. This can be achieved through the following measures:

- **Standardizing the quality of RDF** to ensure uniformity in the fuel used by industries.
- **Maintaining a continuous supply of RDF** by ensuring the availability of raw materials and their stable conversion into RDF.
- **Establishing a competitive pricing structure for RDF**, enabling it to compete effectively with other fuel sources.
- **Developing long-term cooperation agreements between RDF producers and industrial users**, providing certainty for both parties and preventing supply instability.

These recommendations are designed to address the identified gaps, focusing on the provision of well-targeted facilities, increasing demand, and strengthening the RDF production and distribution system. To ensure

effective implementation, a phased roadmap for RDF expansion is proposed, with clear milestones to allow for gradual development based on the readiness of infrastructure, regulatory frameworks, and market potential in each region. Each recommendation will be further elaborated in the following subsections, which will outline detailed implementation

	Key Recommendations	Actor
1	**The implementation and expansion of RDF must be policy-driven,** supported by the following necessary policy instruments: a. The Renewable Energy Law, which is currently still under discussion as a draft bill (Rancangan Undang-Undang). b. Revision of Presidential Regulation No. 35 of 2018, by incorporating additional Waste-to-Energy (WtE) technology options, including RDF. c. Updating Presidential Regulation No. 97 of 2017 on the National Policy and Strategy for Household Waste Management (Jakstranas), into a Draft Presidential Regulation on the Transformation of Household and Household-like Waste Management.	Ministry of Energy and Mineral Resources Bappenas Ministry of Environment
2	**The provision of RDF facilities should be based on the following considerations:** a. The urgency of the waste management issue in the targeted area. b. The availability or potential of offtakers, by conducting a thorough mapping of potential offtakers. c. Economic scale, with reference to the Cilacap RDF facility which requires a minimum of 120 tons/day	Bappenas Ministry of Public Work Ministry of Environment Local Governments
3	**The supply and utilization of RDF must take into account the following considerations:** a. Standardization of product quality, to ensure consistency and reliability. b. Competitive value compared to other renewable energy sources, through appropriate price formulation. c. Availability of suitable industrial technology to support the effective use of RDF as an alternative fuel.	Ministry of Energy and Mineral Resources Ministry of Industry Ministry of Public Work Ministry of Home Affairs
4	**The utilization of RDF must be secured through long-term cooperation agreements that take into account investment return periods.**	Ministry of Industry Ministry of Energy and Mineral Resources Ministry of Home Affairs
5	**RDF should be integrated into the circular economy framework through a Presidential Regulation on Circular Economy, in order to unlock broader support from the industrial sector.**	Bappenas Ministry of Environment
6	**Enhancing the utilization (demand) of RDF by industrial offtakers can be achieved** through: a. Mandating the use of RDF through sectoral regulations issued by the relevant Technical Ministries (starting with State-Owned Enterprises by 2030). b. Providing incentive schemes and mechanisms to encourage adoption.	Bappenas Ministry of Energy and Mineral Resources Ministry of Industry Ministry of Finance Ministry of Environment Ministry of State-Owned Enterprises

Figure 4.1 *Key Recommendation of RDF Implementation in Indonesia*

4.1 Recommendation of RDF Utilization (Supply Side)

The provision of RDF (Refuse-Derived Fuel) facilities in Indonesia still faces numerous challenges, ranging from institutional issues, infrastructure limitations, planning gaps, financing constraints, to environmental and social safeguards. The sustainability of the RDF system depends on the establishment of clear policies, adequate infrastructure capacity, and financing schemes that engage multiple stakeholders, including the private sector.

To ensure the smooth operation and continuous supply of RDF, strategic measures are needed covering regulatory frameworks, technical standards, planning mechanisms, and more flexible and innovative financing approaches. The following figure summarizes the key recommendations that can be implemented to strengthen RDF provision, with actors marked by "★" indicating the lead responsible party for each recommendation.

Governance

Gap	Recommendations	Actor
• There is currently no policy or guideline to determine the appropriate entity and institutional form for RDF facility management. • There is currently no performance monitoring tool for RDF facility operators.	Develop guidelines for determining the institutional and legal form of RDF management entities whether managed by local governments (at minimum through UPTD or BLUD schemes) or private sector actors by considering managerial capacity, technology, and offtaker requirements.	★ Ministry of Home Affairs Ministry of Environment Ministry of Public Works Ministry of Energy and Mineral Resources Minsitry of Industry
	Develop a performance assessment framework for RDF facility operations	
Most RDF-based TPSTs have not demonstrated operational reliability and equipment functionality (i.e., they have not yet operated optimally according to their design capacity to process mixed waste and produce RDF that meets offtaker specifications).	Develop a performance assessment guideline for RDF facility management, based on the following key parameters: • Type of technology used; • Functionality (system and equipment operational criteria); • RDF production volume; • Percentage of production relative to design capacity (idle capacity); • Fulfillment of CAPEX and OPEX requirements; • Type of managing entity; • Offtakers involved; RDF absorption rate (percentage uptake by offtakers); Fulfillment of target operating days. RECOMMENDATIONS SUPPLY ASPECT: INFRASTRUCTURE & TECHNOLOGY	★ Ministry of Public Works Ministry of Environment Minsitry of Home Affairs
	Develop a performance reporting mechanism and incorporate relevant indicators into the SIINSAN monitoring system. Example of monitored parameters: facility location, processing capacity, and operational status (operational / non-operational / damaged). RECOMMENDATIONS SUPPLY ASPECT: INFRASTRUCTURE & TECHNOLOGY	★ Ministry of Public Works ★ Ministry of Environemnt Ministry of Home Affairs
	Formulate guidelines for the development of Standard Operating Procedures (SOPs) related to the operation and maintenance of RDF systems and equipment. RECOMMENDATIONS SUPPLY ASPECT: INFRASTRUCTURE & TECHNOLOGY	★ Ministry of Public Works Local Government RDF Operators
Belum ada pedoman terkait pengaturan dan pengelolaan kerja sama dalam pengelolaan RDF, untuk mendukung pemanfaatan RDF yang telah diproduksi. Pada umumnya yang dimiliki Pemerintah Daerah di fase perencanaan adalah MoU.	Establish a regulatory and management guideline for cooperation agreements (PKS) concerning RDF facility management and utilization, addressing the following aspects • Identification of parties required to enter into a cooperation agreement. • Key components and provisions to be included in the agreement; • Appropriate timing or project phase for signing the agreement (e.g., after the infrastructure and technology provision phase is completed);	★ Mnistry of Home Affairs Ministry of Environment Ministry of Public Works Ministry of Industry

Figure 4.2 *RDF Supply Recommendation of Government Aspect*

Planning

Gap	Recommendation	Actor
Not all regions have waste management planning documents that include RDF (Refuse-Derived Fuel) projects."	• Ensure that RDF projects are incorporated into the Waste Management Master Plan (RIPS) at the district/city level and are aligned with the Regional Long-Term Development Plan (RPJPD), the Regional Medium-Term Development Plan (RPJMD), and the Regional Waste Management Strategy (Jakstrada). • Provide guidelines and technical assistance to local governments in preparing RDF-related planning documents.	Ministry of Home Affairs Bappenas Ministry of Public Works Ministry of Environment Local Government

Figure 4.3 *RDF Supply Recommendation of Planning Aspect*

Financial

Gap	Recommendation	Actor
• The operational and maintenance costs for RDF production per ton have yet to meet the Full Cost Recovery (FCR) or Break-Even Point (BEP) principle, hindering the sustainability of RDF plant operations. • RDF funding remains heavily reliant on government sources, while private sector involvement in financing schemes is still limited. • Budget allocation for waste management remains low. Only 5 cities allocate more than 2% of their budget, while 50 identified regions allocate merely around 0.7%. • The absence of tipping fee support adds uncertainty to the operational sustainability of RDF plants, as revenue is still primarily dependent on the volatile sales of RDF.	• Develop Public-Private Partnership (PPP)–based financing schemes. • Expand access to green financing instruments, such as sustainability-linked loans and carbon credits. • Promote the use of green bonds as a sustainable financing instrument to attract potential investors.	Ministry of Finance Ministry of Environement Ministry of Public Works Otoritas Jasa Keuangan Bank Indonesia
	Develop implementation guidelines for calculating RDF OPEX costs, referring to the Ministry of Home Affairs Regulation Number 7 of 2021 on Procedures for Calculating Retribution Tariffs in Waste Management Services, as a reference for local governments with varying fiscal capacities.	Ministry of Home Affairs Ministry of Environment Ministry fo Public Works Development Partner/Donor Local Government
	Formulate technical guidelines for determining: • *tipping fee* for RDF • BLPS for RDF	Ministry of Home Affairs Bappenas Ministry of Finance Ministry of Environement Ministry of Public Works
	Integrate waste management as a mandatory basic service under local government responsibilities, and include it in the Minimum Service Standards (SPM).	Ministry of Home Affairs Ministry of Public Works Ministry of Environement
	Encourage a minimum percentage of regional budget (APBD) allocation for the waste management sector to fulfill the principles mandated by Law Number 18 of 2008 on Waste Management.	Ministry of Home Affairs Ministry of Public Works Ministry of Environement

Figure 4.4 *RDF Supply Recommendation of Financial Aspect*

Infrastructure and Technology

Gap	Recommendation	Actor
• The wide variation in configurations and types of equipment can encourage innovation; however, it may also increase uncertainty in design outcomes. • The lack of certainty regarding the competence of designers in developing RDF configurations poses a risk of failure to achieve operational targets.	Develop a guideline for RDF technology design as a reference for phased planning, consisting of process flow, configuration determination, and RDF equipment selection.	Ministry of Public Works Ministry of Industry National Research and Innovation Agency
	Mengembangkan mekanisme evaluasi teknologi dan menyusun kriteria evaluasi rancangan teknologi RDF berdasarkan kebutuhan kabupaten/kota.	Ministry of Pubic Works National Research and Innovation Agency
	• Develop competency standards and certification procedures for RDF technology designers in configuring systems and selecting equipment. • Ensure that all parties involved in each stage of RDF planning and construction are assessed based on relevant expertise.	Ministry of Pubic Works Ministry of Manpower National Public Procurement Agency of the Republic of Indonesia National Professional Certification Professional Certification Institute
• The sustainability of RDF supply is not yet guaranteed, and TPST facilities are still insufficient to meet the needs of offtakers • Potential industries exist in several regions, but RDF facilities are either unavailable, underperforming, or have insufficient capacity.	Conduct detailed mapping of the number, capacity, and condition of RDF facilities along with their geographic distribution, linked to potential offtakers. This serves as a basis for calculating the need for additional RDF infrastructure capacity, the construction of new facilities, and/or the modernization of existing ones.	Ministry of Public Works Ministry of Environment Local Governemnts
	Modernize and revitalize RDF facilities that are damaged, non-operational, or operating sub-optimally. Revitalization should also cover TPS/TPS 3R sites that serve as RDF feedstock sources, tailored to regional needs.	Ministry of Public Works Local Governments
From the 22 existing RDF facilities, more than 70 percent have not yet demonstrated operational reliability defined as the ability to operate continuously at their design capacity and produce RDF that meets the production targets and quality standards required by offtakers.	Develop performance evaluation guidelines for RDF facilities, incorporating various parameters and benchmarking specific performance against other RDF facilities. REKOMENDASI PENYEDIAAN ASPEK TATA KELOLA	Ministry of Public Works National Research and Innovation Agency
	Conduct regular technical evaluations of operational RDF facilities to monitor system reliability and compliance with environmental quality standards.	Ministry of Public Works Ministry of Environemnt
	Develop guidelines for drafting Standard Operating Procedures (SOPs) for the operation and maintenance of systems and equipment. REKOMENDASI PENYEDIAAN ASPEK TATA KELOLA	Ministry of Public Works Local Governments RDF Operators
	Establish a support mechanism during the RDF facility ownership transition period, including the involvement of technology providers to assist with operations and maintenance (O&M), spare parts supply, and repairs for a defined period.	Ministry of Public Works Ministry of Environemnt
	Develop a standardized RDF facility performance reporting mechanism. REKOMENDASI PENYEDIAAN ASPEK TATA KELOLA	Ministry of Public Works Ministry of Environment Ministry of Home Affairs
RDF distribution network connectivity remains suboptimal.	The development of an integrated and efficient transportation and distribution system is key to enhancing the utilization of RDF as an alternative fuel.	Ministry of Public Works Local Governments
Facilities that were originally designed to produce RDF for a specific industry often lack the flexibility to produce RDF with different specifications required by other industries.	Develop an information system that maps the potential RDF offtakers across different regions along with their required RDF specifications.	Bappenas Ministry of Industry Ministry of Environment Ministry of Energy and Mineral Resources Ministry of Public Works

Figure 4.5 *RDF Supply Recommendation in Infrastructure and Technology Aspect*

Environmental and Social Safeguards

Gap	Recommendation	Actor
There are currently no specific guidelines available for Local Governments to calculate greenhouse gas (GHG) emission reductions, including methane emissions, resulting from waste processing activities into	Local Governments need to be trained and provided with guidelines on calculating emission reductions, including methane emissions.	Ministry of Environment
A standardized and periodic reporting and audit system for environmental and social aspects has yet to be established.	Develop guidelines and training programs for Local Governments on estimating GHG emission reductions from waste-to-RDF processing activities.	Ministry of Environment Ministry of Home Affairs Bappenas
Lack of formal community engagement and limited public education regarding the benefits of RDF.	• Develop guidelines and schemes for green jobs and gender equality in RDF production activities, and ensure community involvement, for instance in waste collection or sorting processes. • Develop public education strategies and social conflict mitigation measures.	Bappenas Development Partner

Figure 4.6 *RDF Supply Recommendation in Environmental and Social Safeguards*

4.1.1 Governance Aspect

In 2022, it was estimated that only 1% of waste was processed, while the majority around 54% ended up in final disposal sites (TPA). This condition has led to overcapacity in many TPAs. Nationally, the capacity and carrying capacity of TPAs are projected to reach their limits by 2028 or even earlier[33]. Therefore, increasing the proportion of waste that is properly treated has become a crucial step to reduce the burden on TPAs. Various waste treatment technologies have been introduced in Indonesia, including biological methods (such as composting and black soldier fly/BSF processing) and thermal methods (such as incineration, PSEL, SRF, and RDF). However, the success and sustainability of these waste treatment facilities largely depend on how well they are managed.

[33] Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2025-2029

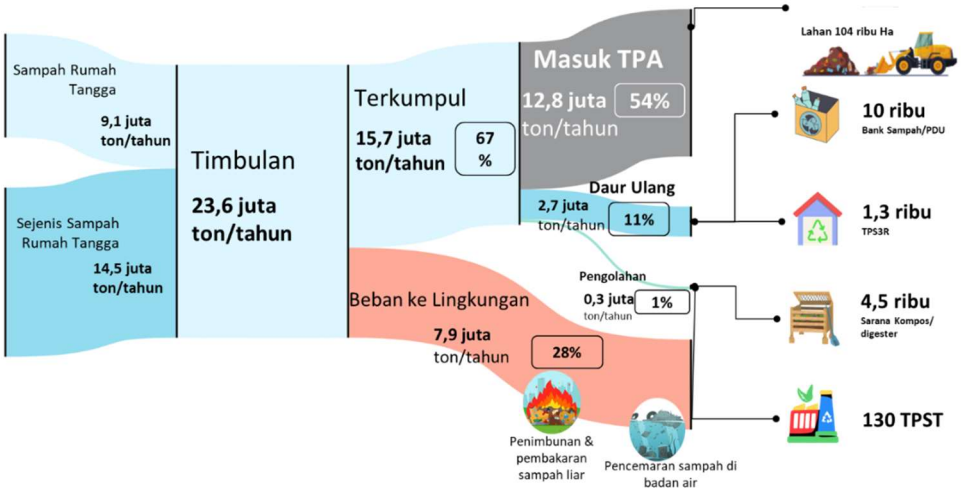

Figure 4.7 *State of National Waste Management in 2022*
Source: Ministry of National Developing/Bappenas, 2023

Governance Recommendations: Institutional Arrangements, RDF Facility Management, and Cooperation Agreements.

Institutional Arrangements

The gap analysis indicates that the type of entity or institutional form managing RDF facilities is not a determining factor for the functionality and sustainability of such facilities. However, selecting the appropriate entity and institutional form remains an important consideration to ensure operational effectiveness and long-term sustainability, as each form presents its own advantages and disadvantages. Discussions held by the review team with the Director of Waste Management at the Ministry of Environment and Forestry recommend that large-capacity RDF facilities should preferably be managed by private sector entities (offtakers /third parties), given the complexity of operations and the required management capacity. Similarly, discussions with the Indonesian Cement Association suggest that RDF facilities should be managed by the offtaker or RDF user, considering their technical capabilities, skills, and established operational standards.

In addition, **government managed institutions are recommended to be established at a minimum as Regional Technical Implementation Units (Unit Pelaksana Teknis Daerah, or UPTD) with a governance model adopting the Regional Public Service Agency (Badan Layanan Umum Daerah, or BLUD) framework. This model provides greater authority, particularly in financial management.** While Regional-Owned Enterprises (Badan Usaha Milik Daerah, or BUMD) offer the broadest scope of authority allowing autonomy across most operational aspects such entities are typically burdened with regional revenue (PAD) targets. These targets often take precedence over essential needs such as investment, service expansion, and quality improvement.

Table 4.1 *Comparison of Institutional Models for Service Management and Provision under Local Government*

Aspect	UPTD Province	UPTD Reg/City	BLUD	BUMD/PD
Initiative for Establishment	Local Government	Local Government	Local & Central Government	Local & Central Government
Legal/Institutional Status Determination	Governor	Regent/Mayor	Minister/Local Head	Minister/Local Head

Aspect	UPTD Province	UPTD Reg/City	BLUD	BUMD/PD
Business Risk	Province + Regency/City	Regency/City	Local Government	Local Government
Decision-Making	Dependent	Dependent	Independent	Very Independent
Service Sustainability	Medium	Medium	High	Very High
Profit Sharing	Considered with Province + Regency/City	Regulating by Regency/City	Designated for Internal Use	Designated for Equity Investment
Operation and Maintenance (O&M)	Province + Regency/City	Regency/City	Internal Funds	Internal Funds
Investment Cost	Local Budget (APBD) + State Budget (APBN)	Local Budget (APBD) + State Budget (APBN)	Partially Funded by Government Capital Injection	Government Equity Participation
Third-Party Cooperation / Partnership	Medium	Medium	High	Very High
Human Resources (HR)	Civil Servants (ASN)	Civil Servants (ASN)	Civil Servants (ASN) + Profesional	Professional
Contribution to Regional Revenue (PAD)	-	-	Low-Medium	High

Source: Guideline for the Preparation of Administrative Documents for the Implementation of Regional Public Service Agencies (BLUD), Ministry of Home Affairs, 2021

To assist local governments and relevant stakeholders providing technical assistance and support for RDF implementation, it is necessary to develop a guideline for determining the appropriate institutional model and legal entity for RDF management. This guideline should take into account factors such as the capacity of the RDF facility, the technology employed, and the quality standards required by beneficiaries or offtakers. Recommendations and selection of the RDF management institution and its legal form should be identified during the preparation of the feasibility study. In addition, to monitor the performance of RDF management institutions, **a performance evaluation framework for RDF operations should be developed.**

Several parameters may be considered, including: functionality of RDF infrastructure or facilities, RDF output volume, percentage of RDF produced relative to the facility's design capacity, percentage of RDF absorbed by the beneficiary/offtaker, fulfillment of capital expenditures (CAPEX) and operation and maintenance costs (OPEX), and other critical indicators. Performance assessments and monitoring should be conducted regularly—e.g., on an annual basis. The results of RDF performance monitoring are recommended to be integrated into existing national waste management monitoring platforms, such as SIINSAN, managed by the Ministry of Public Works, and SIPSN, managed by the Ministry of Environment.

Cooperation Agreement

A cooperation agreement provides certainty in RDF management and production, and is therefore a critical element in RDF governance. Currently, the utilization of RDF by the industry is generally covered by cooperation agreements between local governments and industries. However, cooperation agreements between RDF operators and local governments are typically only applied in cases involving PPP mechanisms or joint operational cooperation. RDF operations that are not supported by such agreements

particularly those with local governments as waste suppliers and contributors to RDF operational costs (through tipping fees) place the risks solely on the RDF operators, rather than distributing them among all involved parties.

Continuity in waste supply has a direct impact on the continuity of RDF production. The Indonesian Cement Association has stated that cement plants require a specific quantity of alternative fuels (AF) to meet the targeted Thermal Substitution Rate (TSR) necessary for their production processes. If RDF supply is insufficient, cement industries are compelled to blend RDF with biomass or other waste materials to meet their AF and TSR targets. Therefore, inconsistent RDF supply will lead to fluctuations in the industrial production operational costs.

Accordingly, cooperation agreements are recommended to be adopted in all institutional schemes of RDF management, including RDF managed directly by local governments. In this study, a minimum institutional form such as a UPT-BLUD (Regional Technical Implementation Unit with Public Service Agency status) is recommended, as it has the authority to enter into cooperation agreements with third parties. Cooperation agreements are also recommended with machine and equipment providers to ensure support for repair and troubleshooting beyond the RDF operator's capacity. Some RDF facilities have ceased operations due to machinery and equipment issues that the operator could not resolve. In its formulation, the cooperation agreement can refer to Presidential Regulation Number 38 of 2015 on Government Cooperation with Business Entities in Infrastructure Provision.

This study recommends that cooperation agreements between relevant parties be designed to ensure the following aspects:

a) Cooperation agreements between RDF operators and local governments to ensure a consistent waste supply and secure the provision of RDF processing fees (tipping fees). If the RDF operator is a local government entity through a UPT-BLUD, it is recommended that internal regulations or decrees be issued by the regional head or the relevant agency head to formalize the arrangement.
b) Cooperation agreements between the local government or RDF operator and RDF-utilizing industries to guarantee agreed-upon offtake volumes, product quality, and RDF selling price.
c) Cooperation agreements with RDF machinery and equipment providers to support maintenance and troubleshooting assistance for RDF operators.

In addition, such cooperation agreements (or contracts) are recommended to have a long-term duration exceeding five years to match the facility's design lifespan and the value of investments already made. **Therefore, a standardized guideline is needed for drafting cooperation agreements or contracts, which should provide references regarding:**

a) The parties that must enter into a cooperation agreement;
b) The key provisions to be included in the cooperation agreement; and
c) References and benchmarks to guide the formulation of such provisions.

4.1.2 Planning Aspect

The development of RDF facilities in each region requires thorough and integrated planning. **RDF project planning documents must be included in the regional waste management masterplan or the Regional Waste Management Plan (RIPS) at the regency/municipal level and be aligned with the Regional Long-Term Development Plan (RPJPD), the Regional Medium-Term Development Plan (RPJMD), and the Regional Government Work Plan (RKPD).** The synchronization and coordination process for infrastructure development programs has been carried out through discussions and reviews at the local government level. **The Central Government may provide guidelines**

and technical assistance to Regional Governments in preparing the masterplan, feasibility studies (FS), and detailed engineering design (DED) for the development of RDF facilities according to local needs. Furthermore, all RDF project planning documents, whether for existing or future facilities, must undergo a review process to ensure their quality and alignment. To address the existing gaps, integration of RDF project planning documents with the regional waste management masterplan must be ensured.

The preparation of a comprehensive and integrated masterplan for RDF facility development is a crucial step that must include detailed construction plans, including site location, capacity, technology, and implementation schedule. The process of masterplan development should involve various stakeholders, including central and regional governments, industry, academia, and the community, to ensure the relevance and success of the plan. In this context, the prioritization of RDF facility development should be based on local needs and aligned with the goals and targets of the regional waste management masterplan so that RDF facility development contributes effectively to the achievement of overall waste management objectives.

Additionally, a comprehensive and integrated analysis of the needs and feasibility of RDF facility development must be conducted in line with the regional waste management plan to ensure that the facilities built are appropriate and capable of operating efficiently and effectively. Land acquisition and permitting processes must also be integrated with the waste management masterplan to streamline and expedite the required procedures. Well-planned and integrated budgeting is also critical to ensure funding availability and prevent project delays or failures. Finally, strong coordination and collaboration among the relevant institutions must be strengthened to ensure alignment and consistency in the planning and implementation of RDF projects, including effective communication, clear division of roles and responsibilities, and efficient problem-solving mechanisms.

4.1.3 Infrastructure and Technology Aspect

The development of RDF technology design guidelines serves as a reference for various stages of the design process, including process flow, configuration determination, and RDF equipment selection. One of the key elements in this development is the establishment of design evaluation criteria prior to facility construction.

For example, one requirement is that the proposed design must have been successfully implemented in another location with an equivalent capacity and must have achieved operational targets exceeding 85% over a specified period. Furthermore, the selected equipment and configuration must be proven reliable and supported by guarantees from the technology provider. In this way, newly constructed RDF facilities are expected to represent improvements over previous designs.

Once an RDF facility is constructed, it is essential to ensure that the technology provider remains responsible throughout the commissioning phase until operational targets are met within a defined period. In addition, the technological design to be implemented in a particular city or regency must undergo evaluation against established criteria and be assessed for alignment with local needs. **To support the success of this process, the development of a certification procedure for RDF designers is a critical step, aimed at ensuring the competence of designers in carrying out technology engineering.** Designers must also possess prior experience in projects at other locations that have successfully operated according to their design capacity. These measures are expected to ensure that RDF facilities operate effectively and efficiently while meeting established standards.

Operational Reliability

To ensure the long-term operational sustainability of RDF facilities, long-term cooperation with technology providers in operation and maintenance (O&M) activities is essential. This cooperation includes the involvement of equipment vendors who provide spare parts and repair services. Vendor involvement is chosen to ensure flexibility in maintenance, guarantee spare parts availability, and offer competitive pricing for system and equipment services and repairs. This strategy aims to minimize operational downtime, optimize maintenance costs, and ensure the smooth long-term operation of RDF facilities.

To achieve optimal conditions, RDF technology development should focus on diversifying RDF products with specifications tailored to the varying needs of industries, including advanced technologies such as gasification to produce other high-value products. Research and development (R&D) efforts must also be enhanced to deliver more efficient, reliable, and environmentally friendly RDF technologies. In addition, information systems can be developed to map potential RDF offtakers in different regions along with their specific requirements.

Domestic Component Level (TKDN)

To enhance the implementation of the Domestic Component Level (TKDN), greater government support is needed through incentives and policies that encourage domestic technology and industry development, along with the improvement of human resources in relevant technology sectors. Strengthening government support, developing local technologies, and improving the quality of the workforce in related technical fields are key to increasing TKDN implementation.

Distribution Network

The development of an integrated and efficient transportation and distribution system is crucial to increasing the use of RDF as an alternative fuel. This requires investment in supporting infrastructure and technology, as well as collaboration among stakeholders.

Establishing RDF facility performance evaluation guidelines is also essential to ensure efficient operations based on system and equipment operation criteria. Therefore, technical evaluations of existing RDF facilities must be conducted to assess the reliability of current systems and equipment, and to benchmark specific performance parameters against other RDF facilities. This evaluation includes assessing both the overall system and individual components, identifying potential disruptions, and formulating mitigation strategies to minimize or eliminate operational failure risks due to equipment damage. Additionally, it is important to develop standard operating procedures (SOPs) that govern the operation and maintenance of systems and equipment to ensure consistent and effective implementation. To support the transition of RDF facility ownership, an expert assistance system should be developed to facilitate the transfer of experience and knowledge over a designated period. To enhance transparency and management, a performance reporting mechanism for RDF facilities should be developed. This should include information such as location, capacity, and operational status (operational/non-operational/damaged), and can be facilitated through the SIPSN platform or other platforms. Furthermore, cooperation or contracts with technology providers are essential for O&M activities during a specific period, including the involvement of equipment vendors to support spare parts and repairs, ensuring maintenance flexibility and competitive service and repair costs.

RDF Facility Mapping

Detailed mapping of the number and capacity of RDF facilities and their geographical distribution, along with the identification of potential offtakers, is a critical first step for estimating modernization needs and enhancing the capacity of existing

infrastructure, as well as for planning the construction of new RDF facilities in priority areas. In this context**, the modernization and revitalization of damaged, non-operational, or sub-optimally operating RDF facilities are highly necessary.** This includes enhancing the capacity of TPS 3R (reduce, reuse, recycle) centers as sources of RDF feedstock based on regional needs. It is also important to improve the efficiency of waste collection and transport systems especially for sorted waste—to ensure a reliable supply of quality feedstock for RDF facilities. These efforts must be supported by strengthening coordination and collaboration between government and other stakeholders to develop transportation and distribution networks in areas targeted for RDF facility development, thereby enabling a more effective and sustainable waste management system

4.1.4 Financial Aspect (CAPEX and OPEX)

The development and implementation of financing schemes tailored to the specific needs of each RDF project is key to increasing funding efficiency. This approach enables more targeted allocation of funds from both public sources such as the national and regional budgets (APBN and APBD), and from international grants and non-public financing. **Optimizing resource management requires clearly defined roles: the national budget (APBN) may focus on supporting national policies and basic infrastructure development, while regional budgets (APBD) can prioritize operations and management of RDF facilities at the local level, which are the primary entities responsible for waste management.** For example, India's Swachh Bharat Mission program provides subsidies for RDF infrastructure and facilitates local government operation management using local revenue.

In allocating funding roles for RDF facility development, budget responsibilities should be clearly delineated for instance, village funds may be used for supporting infrastructure, while APBN funds may finance core facilities. In regions adopting non-public financing, incentives such as establishing 3R TPS (Reduce, Reuse, Recycle) facilities in other locations can be provided to support the sustainable expansion of waste management infrastructure. Expanding access to non-public financing, such as Sustainability-Linked Loans (SLLs) and Public-Private Partnerships (PPP or KPBU), can help address public funding limitations and offer private sector solutions for large-scale infrastructure development.

Optimizing third-party cooperation is a viable alternative, including through long-term contracts with relevant industries, as regulated in Presidential Regulation No. 38/2015 and the Ministry of National Development Planning (Bappenas) Regulation No. 7/2023. These regulations can serve as guidelines for calculating RDF OPEX costs, particularly to assist local governments with varying fiscal capacities.

Incentives for investors, such as import tax exemptions for heavy equipment and machinery used in RDF projects and guaranteed RDF purchase prices through long-term contracts, are essential to attract private sector participation. **Meanwhile, the development of sustainable financing models such as through SLLs and green bonds (per OJK Regulation No. 60/2017) offers environmentally friendly financing alternatives that support the long-term sustainability of RDF projects.** The RDF financing mechanism should consider both short and long-term aspects. Ideally, RDF plants should achieve a Full Cost Recovery (FCR) model, meaning that revenues from RDF sales fully cover operational costs without relying on subsidies or cost-sharing mechanisms. In the short term, however, financial support from local governments remains important particularly through tipping fees to offset operational gaps not covered by RDF sales revenue.

Tipping fees should cover operational and maintenance costs of RDF facilities, while an annual adjustment mechanism that accounts for inflation or increased waste volume should be established to ensure long-term facility sustainability. Over time, stable financing sources could include revenue from carbon credit sales regulated by the government, RDF sales to cement or power industries, and low-interest green financing from financial institutions. **Strengthening the legal framework for green infrastructure financing, such as revising Law No. 23/2014 on Regional Government and Ministerial Regulation No. 3/2013 on Waste Infrastructure Management, is also necessary to support the implementation and sustainable management of RDF facilities. Synergy between the central government, local government, and financial institutions (banking and non-banking) is crucial for the success of RDF projects.** Based on the above, synergy between the Central Government, Local Governments, and financial institutions (both banking and non-banking) is essential to support the successful implementation of RDF

The development of clear guidelines for calculating RDF OPEX (operational expenditure) is vital to establishing a transparent and efficient financing system. **These guidelines should clarify funding contributions from all relevant parties, including tipping fee mechanisms from local governments and potential private sector contributions**. For example, collaboration with major companies such as Unilever in the RDF project in Cilacap demonstrates how the private sector can play a significant role in financing RDF facilities, accelerating sustainability goals and reducing environmental impact.

Furthermore, a **national guideline should be established for determining the Waste Management Service Fee (BLPS), based on the performance of RDF facilities**. This standard would offer an objective framework to evaluate RDF operational effectiveness and ensure performance aligns with set standards, supporting the sustainability of RDF-based waste management programs. Active involvement from the Ministry of Finance, Ministry of Public Works and Housing, and local governments is essential for effective implementation of these guidelines and the appropriate allocation of funding according to each party's roles and responsibilities.

The development of carbon-based financing mechanisms, such as carbon offsets or carbon credit markets, is a promising approach for strengthening long-term RDF project financing. Through these mechanisms, RDF projects can generate carbon credits to be traded on domestic or international markets, providing financial incentives for stakeholders investing in carbon reduction. Such schemes also offer governments a pathway to encourage private sector participation in sustainable waste management. Therefore, synergy among government institutions, including the Ministry of Finance, Ministry of Public Works, Ministry of Home Affairs, and regional governments, is essential to formulate policies and legal frameworks that support carbon market development and more efficient and sustainable RDF management.

4.1.5 Environmental and Social Safeguard

Environmental Pollution Reduction through RDF

The utilization of RDF in Indonesia holds significant potential to reduce waste volume and greenhouse gas (GHG) emissions; however, it requires strong policy support at both the national and regional levels. Specific regulations are needed to explicitly recognize RDF as an alternative waste-to-energy processing method. More ambitious targets for the "waste-to-RDF utilization" program can be set by prioritizing districts/municipalities with high potential offtakers and critical landfill land availability. These targets can be aligned with national commitments such as the NDC and zero waste strategies, and outlined in a comprehensive RDF implementation roadmap. Regular monitoring and evaluation of TPST facilities should be conducted to ensure optimal technology performance and alignment

between waste volumes and processing capacities. **To support GHG emission reduction, local governments should be trained and provided with guidelines for calculating emission reductions, including methane emissions.** Strengthening the operational systems of RDF plants is also essential through operational standardization, technical guidelines, and operational cost support to maintain facility sustainability. In addition, mapping potential industries as offtakers and planning RDF distribution from TPST within an optimal radius should be designed to ensure logistics efficiency. In the environmental aspect, enhancing the technical capacity of operators and implementing SOPs for emission control and leachate treatment at TPST are crucial. Strict monitoring is necessary to ensure that dust, pollutants, and other emission control technologies meet established standards.

Impact of RDF Implementation on Communities

Furthermore, RDF utilization has significant potential to deliver socio-economic benefits, particularly through the creation of decent green jobs and the empowerment of women and vulnerable groups. To realize this potential, **comprehensive and specific guidelines are needed to optimize local community involvement throughout the RDF value chain from waste collection and sorting to RDF processing and distribution as an alternative fuel.** In the context of green jobs, the government and stakeholders should develop green job schemes in the RDF-based energy sector, covering feedstock collection, RDF processing, distribution, and utilization in end-user industries. In addition, skills mapping and technical training are needed to enhance local capacities in operating RDF machinery and dryers, equipment maintenance, and operational management of RDF facilities. Such training should include competencies in renewable energy and the circular economy, ensuring that local workers are prepared for a transition toward greener and more sustainable employment. Collaboration with vocational schools and local polytechnics should be strengthened to develop training curricula relevant to the needs of the RDF industry, while partnerships with the private sector can foster wider internship and employment opportunities for local communities.

Moreover, RDF implementation should also consider Gender Equality and Social Inclusion (GESI) to ensure inclusivity and empowerment of vulnerable groups. Based on current field conditions, the majority of workers in the waste sorting sector are women—particularly waste pickers, who are perceived as more meticulous in separating high-value materials. Additionally, most operators and administrative staff in TPST RDF facilities are also women. Therefore, targets for women's participation in each stage of the RDF value chain can be established. Women's empowerment programs can also be designed to enhance technical and managerial competencies so that women are not only active in the informal sector but can also hold strategic positions in RDF management.

Public education on the benefits of RDF and the importance of gender participation should be conducted to increase community support for RDF programs. **Conflict mitigation strategies should also be developed and regularly monitored to prevent potential social conflicts arising from RDF operational impacts, such as noise or odor disturbances affecting nearby communities.** Formal community participation schemes can also be established to ensure local community involvement in all stages of RDF processing both as workers and as business partners thus securing the sustainability of RDF programs through strong community support. With an inclusive approach, RDF can serve not only as a waste management and renewable energy solution but also as a catalyst for creating green jobs and socially and economically empowering women and vulnerable groups.

4.2 Recommendation of RDF Utilization (Demand Side)

Although RDF holds potential as a more environmentally friendly alternative fuel, its utilization remains limited due to challenges across various aspects. Several RDF-utilizing industries still face difficulties in adjusting their equipment and ensuring compliance with environmental regulations. The recommendations in the figure below are formulated to strengthen the utilization aspect of RDF in Indonesia, with "★" indicating the primary responsible party for each recommendation.

Infrastructure and Technology Readiness

Gap	Recommendation	Actor
• The cement industry has yet to reach an optimal level in utilizing RDF but holds significant potential to increase RDF absorption under certain conditions. Meanwhile, other industries such as fertilizer, chemicals, and paper have the potential to use RDF but are currently still in the study or pilot testing phase. • Transitioning to alternative fuels requires innovative technologies, which entail high initial implementation challenges and substantial investments. As a result, industries are often reluctant to invest due to the associated high risks.	To encourage industries to utilize RDF, the following supportive policy measures are recommended: • Recognize RDF as an option under the Green Industry Standard, provided there are minimum thresholds for the use of alternative fuels, including biomass such as RDF. • Include RDF as a low-carbon alternative fuel option in decarbonization policy frameworks • Classify RDF as a form of biomass within the renewable energy mix in the context of energy	★ Ministry of Industry ★ Ministry of Energy and Mineral Resources Bappenas
	Additionally, introduce incentive mechanisms or recognition systems for companies that successfully reduce fossil fuel consumption through the utilization of RDF.	★ Ministry of Industry ★ Ministry of Energy and Mineral Resources Bappenas

Figure 4.8 *Recommendations on RDF Utilization in Aspect of Infrastructure and Technological Readiness*

Financial

Gap	Recommendation	Actor
There is currently no available fiscal incentive scheme that can attract potential RDF offtakers.	Develop fiscal incentive schemes such as tax reductions and RDF price subsidies for industrial users.	★ Ministry of Finance Ministry of Environment Ministry of Energy and Mineral Resources Ministry of Industry Private Sector
RDF users (industries) face significant investment requirements to modify combustion equipment or processing units to match RDF characteristics	Provide financial support for initial investments by industries, including fiscal incentives for technology retrofitting, soft loan schemes, and access to green financing mechanisms.	★ Ministry of Finance Ministry of Invest/BKPM Minisrty of Industry Financal Institution Private Sector

Figure 4.10 *Recommendations on RDF Utilization in the Financing Aspect*

Environmental and Social Safeguard

Gap	Recommendation	Actor
Based on Annex 3 of the Minister of Environment and Forestry Regulation Number 19 of 2017, the RDF Emission Quality Standards (BME) are stricter than those for hazardous and toxic waste (B3), despite RDF being classified as non-B3 waste. Furthermore, the regulation currently applies only to the cement industry when RDF is utilized as a primary fuel.	A revision of the Minister of Environment and Forestry Regulation Number 19 of 2017 is required to adjust the BME requirements for RDF users.	Ministry of Environment Ministry of Industry
Emission control and monitoring systems in industries other than coal-fired power plants (CFPPs) and the cement industry are, in some cases, inadequate for RDF utilization.	The preparation of guidelines outlining the environmental requirements and documentation that must be fulfilled by industries prior to RDF utilization is necessary.	Ministry of Environment Ministry of Industry
Currently, no reference methodology exists for offtakers regarding greenhouse gas (GHG) emission calculations from RDF combustion as an alternative fuel.	Guidelines and training should be developed for offtakers on calculating GHG emission reductions from RDF combustion in industrial applications, in order to assess their contribution toward the Enhanced Nationally Determined Contribution (ENDC) targets.	Ministry of Environment Ministry of Industry

Figure 4.11 *Recommendation of RDF Supply in the Aspect of Environmental and Social Safeguard*

4.2.1 Infrastructure and Technological Readiness

Through supportive policies, key measures can be undertaken to promote RDF utilization. This includes incorporating assessment criteria into the Green Industry Standards System, with parameters that define minimum thresholds for the use of low-carbon fuels, including RDF. Additionally, decarbonization policies and mandates for minimum renewable energy mix (EBT) thresholds in the energy transition as well as the inclusion of RDF in the decarbonization roadmap for eight industrial sub-sectors are crucial steps to achieving this objective. To facilitate knowledge and technology transfer for RDF utilization within industries, international cooperation in training and related initiatives must be strengthened. The development and commercialization of such technologies require targeted policies that encompass mandates for the dissemination of sustainable alternative fuels, appropriate financial mechanisms, and instruments that support technology development and subsequent market deployment such as loan guarantees. Greater support for research, development, and demonstration (R&D) will help expand the range of viable technologies. Furthermore, mechanisms for financing both domestic and international are essential to assist industries in acquiring combustion technology adaptations. Introducing such financing schemes can catalyze industrial transitions and unlock access to cleaner fuel alternatives. **Additional policy incentives, such as recognition and rewards for companies that successfully reduce fossil fuel consumption through RDF adoption, could further encourage industrial participation.** Finally, expanding collaborative research efforts aimed at developing more efficient RDF utilization technologies, alongside introducing accessible financing facilities for industrial RDF infrastructure readiness, will be key to achieving long-term sustainability and energy efficiency.

Enhancing Research Collaboration and Development of New Technologies for RDF Management

Providing fiscal incentives, such as tax reductions to industries that adopt RDF, is a strategic measure undertaken by the Ministry of Industry and the Ministry of Finance. Supportive policies, regulatory enforcement, and these incentives will attract investor interest in participating in RDF project development provided that regulatory changes are carefully designed to send positive signals to investors and business leaders.

This is essential to creating an enabling environment for the sustainable development of RDF projects. Furthermore, enhancing the commercial viability of RDF projects is crucial, where policy interventions can serve as solutions to overcome technical barriers. Continuing reforms on fossil fuel subsidies and improving the regulatory framework will help remove obstacles to RDF as a renewable energy source, while simultaneously strengthening positive signals to the private sector and consumers to invest. The removal of coal subsidies and the internalization of costs arising from pollution due to fossil fuel usage will contribute to creating a level playing field for RDF. In addition, facilitating international cooperation that provides support in the form of grants or low-interest loans for projects focused on the implementation of renewable fuels, including RDF particularly for burner technology and efficient storage infrastructure is highly important. Hosting annual awards for companies that successfully increase their RDF usage to a certain threshold will further encourage active participation in this effort. Considering that the mobilization of financial resources is key to the successful scaling up of RDF, projects should leverage the major shift in financial capital allocation toward a low-carbon economy. This includes climate bonds, investments based on ESG principles, institutional investments, and various forms of green financing.

4.2.2 Financing Aspects

The provision of fiscal incentives, such as tax reductions, to industries that adopt RDF technology constitutes a significant step in accelerating the transition towards renewable energy use

These incentives can encourage private sector participation in the development and operationalization of RDF facilities, particularly considering the limitations of public funding, which often pose major challenges to the expansion of renewable energy infrastructure. In addition, supportive policies, consistent regulatory enforcement, and clear and structured incentives are essential for creating an enabling investment climate. With appropriate regulations in place, the government can send strong signals to investors and business actors that the RDF sector holds promising long-term prospects. Therefore, policies that enhance the commercial viability of RDF projects and resolve technical barriers should be prioritized to improve the sector's investment attractiveness. The active role of the Ministry of Finance and the Ministry of Industry in formulating appropriate fiscal policies will be instrumental in ensuring the success of this program.

On the other hand, government-led fossil fuel subsidy reforms, accompanied by improvements in the regulatory framework, will reinforce RDF's position as a commercially viable renewable energy source. The removal of coal subsidies and the internalization of external costs resulting from fossil fuel pollution can create a more level playing field for RDF. These policies will not only provide fiscal incentives for the private sector to invest in environmentally friendly technologies, but also send a clear signal to consumers to shift towards more sustainable energy sources. In this context, the Ministry of Finance plays a critical role in designing fiscal policies that reduce dependence on fossil fuels and support the transition towards a low-carbon economy.

Furthermore, **international cooperation facilitated by the government in the form of grants or concessional loans can accelerate RDF infrastructure development**. Support from international institutions in advancing efficient combustion technologies and improving RDF storage infrastructure will enhance the global competitiveness of RDF projects. Therefore, the Ministry of Industry, Ministry of Public Works, and Ministry of Finance must work in synergy to bridge this cooperation and ensure that financing flows are well-targeted and effective.

Finally, the establishment of an annual award for companies that significantly increase the utilization of RDF can serve as an effective mechanism to encourage the adoption of this technology within industry. Such recognition not only provides an incentive for companies to innovate but also helps mobilize greater financial resources toward a low-carbon economy. **With the availability of financial instruments such as green bonds or sukuk, ESG investments, and other forms of green finance, RDF projects can access more affordable and sustainable financing options.** Ministry of Energy and Mineral Resources and the Ministry of Industry has a key role in designing such award programs and are expected to accelerate RDF technology adoption while generating a positive environmental impact.

4.2.3 Environmental and Social Safeguards

A revision of the Minister of Environment and Forestry Regulation Number 19 of 2017 is necessary to ensure that BME (Substitute Fuel Material) regulations for industries utilizing RDF are more appropriate and broadly applicable.

The regulatory revision could include more flexible, science-based provisions that take into account the specific characteristics of RDF, as well as differentiate requirements between industries that fully utilize RDF and those that co-fire it with conventional fuels. The

government needs to develop standards applicable to all RDF-utilizing industries not limited to the cement industry, to ensure a broader energy transition and to promote RDF as a more optimal solution for waste management.

In addition to regulatory aspects, enhancing the readiness of industries in RDF emission control should be a priority to prevent adverse environmental impacts. **Therefore, the government and relevant stakeholders need to develop technical guidelines that set out environmental requirements and documentation to be fulfilled by industries prior to RDF utilization.** These guidelines may include recommended emission control technologies such as scrubbers, SNCR (Selective Non-Catalytic Reduction), and baghouse filters, along with measures to mitigate air pollution. Furthermore, incentive programs are needed for industries investing in emission control systems to encourage the wider adoption of RDF without increasing the risk of environmental pollution.

To ensure that RDF contributes to national decarbonization targets, the development of a standardized methodology for calculating GHG emissions from RDF combustion is required. **The government may formulate guidelines for calculating carbon stored and released during the combustion process. In addition, training programs for industries and offtakers must be carried out to enable accurate emission reporting and ensure recognition of their contribution to national emission reduction efforts.** With a clear and structured calculation system in place, RDF can gain greater recognition as an alternative fuel that supports Indonesia's green energy transition.

4.3 Enabling Environment Recommendation

A supportive policy and regulatory ecosystem plays a crucial role in accelerating the implementation of RDF in Indonesia. However, various barriers still exist, including the lack of specific regulations, the absence of national standards for RDF, and limited incentives for industry actors and local governments. In addition, the capacity of human resources and research in the RDF sector remains limited, requiring further efforts in institutional strengthening and capacity building. The following figure presents recommendations for establishing a supportive environment for the provision and utilization of RDF, with "★" indicating the main responsible party for each recommendation.

Regulation and NSPK

Gap	Recommendation	Actor
The specific implementation of RDF technology as part of the renewable energy mix has not yet been fully supported by a comprehensive regulatory framework.	Policies are required to integrate RDF into the national strategic plan.	★ Bappenas Ministry of Environmenrt Ministry of Energy and Mineral Resources
	Amendment of Presidential Regulation No. 35 of 2018 to incorporate other technology options within Waste-to-Energy (WtE) initiatives.	★ Ministry of Energy and Mineral Resources Bappenas Ministry of Public Works Ministry of Environmenrt Local Government
	Updating Presidential Regulation No. 97 of 2017 on the National Policy and Strategy for the Management of Household Waste and Similar Types of Household Waste (Jakstranas) into a Draft Presidential Regulation on the Transformation of Household Waste and Similar Waste Management.	★ Bappenas Kementerian Pekerjaan Umum Ministry of Public Works Ministry of Energy and Mineral Resources
The availability of Norms, Standards, Procedures, and Criteria (NSPK) supporting RDF management remains limited.	Develop technical standards for the design and construction of RDF facilities, standard operating procedures (SOP) for operation and maintenance, as well as guidelines for calculating RDF operational costs and economic feasibility.	★ Kementerian Ministry of Public Local Government

Figure 4.12 *Recommendation for Enabling Environment in Aspect of Regulation and Technical Guidelines (NSPK)*

Market Development

Gap	Recommendation	Actor
RDF production capacity and utilization remain unbalanced.	• Develop an RDF market mechanism that ensures balance between RDF production and consumption. • Enhance market certainty for RDF through long-term contracts between producers and industrial users. • Strengthen distribution infrastructure, connectivity, and digitalization to support RDF market development.	Ministry of Environment Ministry of Industry Ministry of Public Works Ministry of Finance Private Sector Local Government
Non-standardized pricing may reduce the attractiveness of RDF, potentially limiting its utilization.	Establish pricing formulation guidelines for RDF based on Gross As Received (GAR) calorific value. In accordance with the Minister of Energy and Mineral Resources Regulation No. 12 of 2017 on Renewable Energy Policy, RDF can be treated as one of the renewable energy sources that should be accorded fair pricing consideration.	Ministry of Energy and Mineral Resources Ministry of Home Affairs
Such standardization is essential to ensure consistency in RDF quality. Without a national standard, industries may be reluctant to invest in RDF utilization.	Formulate an Indonesian National Standard (SNI) for RDF specifications for priority industries.	Ministry of Energy and Mineral Resources Ministry of Industry Indonesian National Standardization Agency (BSN)

Figure 4.13 *Recommendation for Enabling Environment in Aspect of Regulation and Market Development*

Incentive Schemes and Mechanisms

Gap	Recommendation	Aktor
Currently, there is no dedicated incentive mechanism (both fiscal and non-fiscal) specifically designed to promote the utilization of RDF.	Develop fiscal incentive schemes such as tax holidays, carbon tax reductions, green bonds, and import duty exemptions for RDF-related equipment.	Ministry of Finance Ministry of Environment Ministry of Industry Financial Service Authority (OJK) Local Government Public Sector
Limited incentives/assistance are available for Local Governments implementing RDF.	Develop non-fiscal mechanisms, including streamlined licensing procedures for Local Governments adopting RDF.	Central Government Ministry of Finance Financial Service Authority (OJK) Bank of Indonesia Financial Institutions

Figure 4.14 Recommendation for Enabling Environment in Aspect of Incentive Schemes and Mechanisms

Capacity Building

Gap	Recommendation	Actor
There is currently no dedicated institution for RDF capacity building, including competency standards and curriculum.	• Develop an RDF training and certification center integrated with industry and academia. • Enhance the capacity of RDF workforce through nationally standardized technical training.	★ Ministry of Industry Ministry of Environment Ministry of Public Works

Figure 4.15 *Recommendation for Enabling Environment in Aspect of Capacity Building*

Research and Development

Gap	Recommendation	Actor
Limited research collaboration on RDF between the Government, academia, and industry.	Engagement, cooperation, and collaboration between the Government, businesses, and academia, as well as technology transfer from both domestic and international sources, are required to foster innovation and enhance capacity in RDF technology: • Technological innovations in RDF processing, particularly in RDF sorting and drying processes; • Integration of RDF technology with other technologies such as Refuse-Derived Fuel Power Plants (BBJP), composting, Black Soldier Fly (BSF), etc.; • Advanced technological innovations to produce Class 4, 5, and 6 RDF according to the needs of non-cement industries	★ Bappenas Ministry of Industry Ministry of Public Works Ministry of Energy and Mineral Resources National Research and Innovation Agency (BRIN). Research Agency University Higher Education
	Encourage RDF research funding through research grant schemes, research endowment funds, and international cooperation to accelerate the development of RDF technology.	★ National Research and Innovation Agency (BRIN). University/Higher Education Research Agency

Figure 4.16 *Recommendation for Enabling Environment in Aspect of Research and Development*

A study conducted by RDC Environment on the utilisation of RDF and SRF facilities, from the perspective of legislative status and economic balance (RDF/SRF utilisation plants – legislative status and economic balance), highlights that public policy is a critical factor in shaping the RDF market (public policies influencing the market for RDF), as illustrated in **Figure 4.6**.

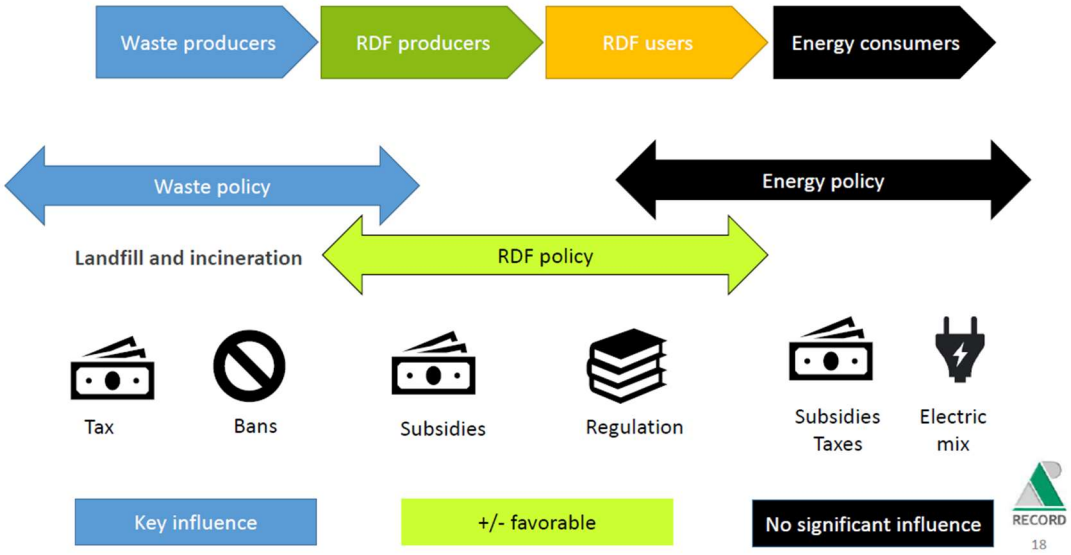

***Figure** 4.17 Public Policy are Impact on Market Dynamics*

Source: RDC Environment

4.3.1 Regulation and Technical Guidelines Aspect

In terms of regulations and NSPK, **strategic policies are required to explicitly integrate RDF technology into the national energy plan.** This step is essential to ensure that RDF is recognized as part of the renewable energy mix. To date, RDF implementation has not been fully protected by robust policies, resulting in slow and inconsistent development across different regions. By incorporating RDF into national-level policies, investment planning, infrastructure development, and cross-sectoral support can be more targeted and coordinated.

Although the Financial Services Authority (Otoritas Jasa Keuangan – OJK) has issued regulations related to green financing, such as OJK Regulation No. 51/POJK.03/2017 and the Indonesia Green Taxonomy (Taksonomi Hijau Indonesia – TKBI), access to such financing remains limited. Many RDF projects face difficulties in meeting the requirements set by green financing institutions, including technical criteria, financial feasibility, and ESG reporting standards. This highlights the need for stronger supporting regulations so that more RDF projects can access green financing. In addition, the government could introduce supplementary incentives for investors supporting environmentally based projects to enhance the attractiveness of investment in the RDF sector.

Amendments to Presidential Regulation No. 35 of 2018 are also an important step that must be undertaken promptly. The purpose of these amendments is to provide greater flexibility in the use of various technologies within the Waste-to-Energy (WtE) framework, including RDF. The current regulation remains somewhat exclusive to certain technologies, limiting the ability of local governments to choose energy-based waste management solutions best suited to their specific conditions and capacities. By incorporating RDF as

one of the WtE options, the government can encourage innovation and the adoption of technologies better aligned with local contexts and capabilities.

Furthermore, **the revision of Presidential Regulation No. 97 of 2017 on the National Policy and Strategy (Jakstranas) for Waste Management is also necessary to strengthen the transformation of the waste management system.** The revised regulation is expected not only to emphasize waste reduction and handling but also to promote the utilization of waste as a resource, including through RDF. This update will serve as an important foundation for aligning waste management policies with energy policies, which to date have largely been implemented separately.

To support practical implementation, the development of NSPK is crucial. **Clear technical standards are needed to ensure that the design and construction of RDF facilities meet safety and efficiency requirements. In addition, operational and maintenance SOPs, as well as guidelines for calculating RDF operational costs and economic feasibility, are necessary so that both industry players and local governments have consistent and reliable references.** The current limitations in NSPK remain a major obstacle to expanding RDF adoption nationwide, and therefore its development should be prioritized in the near term. Based on the identified gaps and the recommendations described in other aspects, the NSPK required to support the expansion of RDF utilization are presented in **Table 4.2**.

Table 4.2 *List of Recommended Standards and Guidelines*

No.	Required Standards and Guidelines (NSPK)
1.	Guidelines for RDF Technology Design, including process flow, configuration determination, RDF equipment selection and usage guidelines, as well as references for preparing SOPs for Local Governments.
2.	Guidelines for Evaluating RDF Technology Designs, covering evaluation scope and assessment criteria.
3.	Competency Standards and Certification Procedures for RDF Designers to ensure designer qualifications.
4.	Competency Assessment System for planning consultants and contractors in RDF design and construction.
5.	Guidelines for Determining RDF Management Entities, whether managed by Local Government (at minimum in the form of UPTD-BLUD) or private sector, considering capacity, technology, and offtaker needs.
6.	Guidelines for Assessing RDF Management Performance, based on parameters such as: • Technology type; • Functionality (system and equipment operational criteria); • RDF production volume; • Production percentage compared to design capacity (idle capacity); • Fulfilment of CAPEX costs; • Management entity type; • Offtaker; • RDF absorption rate; • Achievement of operational day targets. These guidelines should also serve as a reference for the audit process by Local Governments/Audit Institutions, with monitoring conducted annually.
7.	Mechanism for Reporting RDF Performance, integrating it into monitoring parameters in SIINSAN (Ministry of Public Works) and SIPSN (Ministry of Environment), including data such as location, capacity, and status (operational/non-operational/damaged).
8.	Guidelines for Preparing SOPs for the operation and maintenance of RDF systems and equipment.
9.	Guidelines for Arranging and Managing Cooperation Agreements in RDF management and utilization, including: • Parties required to have cooperation agreements (PKS);

No.	Required Standards and Guidelines (NSPK)
	• Provisions to be included in the PKS; • Appropriate project phases for PKS execution (e.g., post-completion of infrastructure and technology provision); • Duration of the PKS.
10.	Implementation Guidelines for Calculating RDF OPEX based on Minister of Home Affairs Regulation No. 7/2021 on Procedures for Calculating Tariffs for Waste Management Services, providing references for Local Governments with varying fiscal capacities.
11.	Guidelines on Determining: • RDF tipping fees; and • RDF BLPS (Environmental Service Levies).
12.	Integration of Waste Management as a mandatory public service responsibility of Local Governments, regulated under Minimum Service Standards (SPM).
13.	Guidelines for Local Governments and Offtakers on estimating GHG emission reductions from waste processing into RDF and its combustion in industry, to measure its contribution towards GHG reduction targets or the ENDC.
14.	Guidelines for RDF Price Formulation based on calorific value (GAR).
15.	Indonesian National Standards (SNI) for RDF specifications for priority industries.
16.	Guidelines for Preparing Feasibility Studies (FS) and for evaluating or assessing FS viability.

4.3.2 Market Development Aspect

The development of the RDF market in Indonesia requires a comprehensive strategy to enhance both supply and demand capacity. Collaboration between RDF operators and offtakers is essential to secure RDF supply through long-term cooperation contracts involving local governments, RDF operators, and offtakers. To encourage the development of industrial energy conversion projects, supportive policies should be implemented, such as limiting GHG emissions and gradually reducing coal subsidies to industries, as well as policies that encourage coal-fired power plants (CFPPs) to increase their share of renewable energy in the energy transition.

Removing restrictive regulations, such as coal subsidies, can create a more competitive market for RDF, as RDF prices will become more competitive compared to coal. Industrial GHG emission limits would also positively impact the RDF market by accelerating the transition from fossil fuels to RDF, which has a lower emission factor. In this regard, it is important to develop affordable RDF technologies that are easy to implement at various scales, with a focus on the development and commercialization of technologies that can adopt RDF and significantly reduce GHG emissions. Creating a low-risk investment climate will ensure market access and predictable revenue streams, as well as facilitate financing for the construction and operation of RDF facilities.

Support for the development of RDF business schemes—enabling access to alternative financing and involving offtakers is also necessary to establish a clear supply pathway. Strengthening inter-agency and stakeholder cooperation will help improve RDF quality and provide the necessary information to facilitate connections between operators and offtakers. Promoting RDF for use in industries utilizing boilers and disseminating best practices in waste-to-RDF management, as well as facilitating matchmaking between local governments and investors, will further increase demand and usage of RDF.

Additionally, the development of national standards for RDF specifications will increase consumer confidence and improve plant operating cost efficiency. Given the complexity of the MSW-to-RDF conversion process, which involves significant risk management, government involvement and contributions from public sources are crucial to ensuring project economic viability, while also improving public health, environmental cleanliness, and pollution reduction through multi-stakeholder engagement and pentahelix

collaboration at the local level. Strengthening inter-regional cooperation and synergy, as well as coordination with the central government, is also a priority to align national and local objectives.

This market development strategy includes increasing RDF production capacity, improving RDF quality, diversifying RDF products, developing adequate supporting infrastructure, optimizing stakeholder cooperation, and formulating policies and regulations that support RDF utilization. Large-scale promotion and outreach efforts are also essential to increase industry understanding and acceptance of RDF as an alternative fuel.

Supply Assurance

Supported by policies and long-term contracts between producers and offtakers, the supply of RDF is expected to become stable and sufficient to meet industrial needs. Quantity assurance is a critical aspect for offtakers, as it ensures that the RDF supply is available at the right time in accordance with confirmed orders. To enhance the bankability of RDF projects, targeted assistance focusing on project feasibility is essential, enabling investors and stakeholders to gain greater confidence in investing. However, on the other hand, specific regulations to support RDF development remain limited, which can be an obstacle in accelerating the growth and utilization of RDF in the market.

The establishment of an RDF development plan must take into account the potential of existing offtakers. These targets will then be translated into the quantity and type of facilities required for each priority region, thereby achieving a balance between RDF supply and demand. The Ministry of Public Works plays a role in this matter by setting policies for the implementation of RDF as part of waste management strategies in cities and regencies.

One important measure is the formulation of Regional Regulations on Waste Management, which mandate processing at intermediate facilities, where only residual waste will be transported to the landfill site. Local governments also need to facilitate inter-regional cooperation within a province, establish partnerships, and build networks in waste management to ensure a steady supply of raw materials for RDF production.

In addition, organizing coordination, guidance, and performance supervision of regencies/municipalities in waste management is an important responsibility of local governments. The waste management policies and strategies adopted must be aligned with national and provincial policies to create a comprehensive framework. Regular monitoring and evaluation, conducted annually over a ten-year period for RDF TPSTs, is also crucial to ensure that the RDF facilities and infrastructure constructed operate effectively as intended.

The Ministry of Public Works holds a strategic role in ensuring RDF supply assurance through several mechanisms. This ministry is responsible for developing waste management infrastructure, including the construction of several RDF TPSTs and sanitary landfills. By building efficient and integrated RDF TPST facilities, the Ministry of Public Works can ensure a consistent supply of waste for processing into RDF.

The Ministry of Public Works can collaborate with local governments to create policies that support effective waste management, including the formulation of regulations governing the management and utilization of waste. Furthermore, the ministry also plays a role in facilitating cooperation between the public and private sectors. By engaging private parties in the management and development of RDF processing facilities, the Ministry of Public Works can increase production capacity and expand RDF supply reach. The ministry is also responsible for monitoring and evaluating the performance of waste management systems funded by the state budget (APBN). Through strict supervision, the Ministry of

Public Works can identify and address potential issues within the RDF supply chain, thereby supporting the development and sustainability of supply.

Quality Assurance

Recommendations for the development of RDF fuel include the formulation of an Indonesian National Standard (SNI) as a reference for product standards and quality, similar to SNI for biomass and Solid Recovered Fuel (SRF), to support co-firing applications in coal-fired power plants (PLTU). To meet the quality requirements expected by end users and ensure profitability, RDF producers must implement strict quality control management techniques, which often require additional investment in specialized technical equipment. In this regard, facilitation and coordination with PLN, relevant ministries/agencies, and stakeholders, including the Ministry of Energy and Mineral Resources, are essential to encourage synergy in the implementation of such standards. Furthermore, quality management of waste sources as RDF feedstock must be carried out through a robust quality control system, involving collaboration between Local Governments and RDF operators. To maintain product quality, regular evaluation and laboratory testing of RDF products should be conducted to ensure that the quality produced meets established standards and provides added value for all parties involved.

RDF Price

In this aspect, guidelines for RDF price formulation are established based on calorific value (GAR). In accordance with the Minister of Energy and Mineral Resources Regulation Number 12 of 2017 on Renewable Energy Policy, RDF can be treated as one of the renewable energy sources that deserves a fair pricing consideration. This recommendation can enhance RDF's competitiveness, including through the implementation of fiscal incentive policies, taxation, and compensation for industries utilizing RDF. In addition, the gradual removal of coal subsidies to industries, as well as policies encouraging coal-fired power plants (PLTU) to increase the share of renewable energy in the energy transition, are also crucial. The main driving factors affecting RDF competitiveness include fossil fuel prices, consistency of RDF quality, supply security, taxes or fees related to RDF usage, transportation costs, and potential CO_2 savings within the context of an emissions trading system.

Infrastructure Strengthening

Gap analysis indicates that the availability of infrastructure supporting the distribution and utilization of RDF in factories or power plants is a key factor in the development of the RDF market. Meanwhile, utilizing facilities such as dedicated ports as temporary storage bases provides a strategic advantage in terms of access from both land and sea, which is highly beneficial for producers and end-users who use port facilities as part of the RDF supply chain. **Recommendations to improve connectivity include the development of roads and other distribution routes, the introduction of new transportation modes, and the strengthening of connectivity infrastructure and logistics support facilities such as telecommunications and digitalization, which are essential to support RDF market development. In addition, regional management and the application of transfer station mechanisms can also be considered as future solutions.**

Ministry of Finance plays a key role in facilitating the development of RDF infrastructure built by the Central Government through the State Budget (APBN) and can facilitate assistance in providing special allocation funds (BLPS) for the operation of waste processing facilities.

The Ministry of Finance also plays a role in developing fiscal policies that support investment in green infrastructure, including fiscal incentives for projects related to waste management and renewable energy, such as tax reductions, subsidies, or access to low-

interest financing, which make TPST projects more attractive to private investors and Local Governments. The Ministry of Finance may collaborate with the Ministry of Home Affairs, the Ministry of Public Works, and Local Governments to ensure that allocated funds are used efficiently and achieve the intended objectives. By conducting regular monitoring and evaluation of fund utilization, the Ministry of Finance can ensure that the operation of TPST RDF runs effectively, meets sustainability standards, and delivers optimal benefits to society.

4.3.3 Incentive Scheme and Mechanism Aspect

Fiscal and non-fiscal incentive policies to support RDF aim to create a conducive ecosystem for the development of technology as a sustainable energy solution. In the fiscal aspect**, the Government may grant a tax holiday to pioneering RDF industries as a form of substantial initial investment support, thereby reducing financial risks and increasing the sector's attractiveness to investors.** In addition, carbon tax reductions or direct subsidies for the production and use of RDF can encourage the transition from fossil fuels to more environmentally friendly alternative fuels.

Other incentives, such as the exemption of Value Added Tax (VAT) on RDF sales and the exemption of import duties for RDF technology equipment, will reduce cost barriers faced by businesses. Tax deductions of up to 300% for research and development (R&D) activities and workforce training also have the potential to enhance technological innovation and human resource capacity in this sector. On the financing side, green financing instruments, such as green bonds and green sukuk, provide attractive funding alternatives for companies, while macroprudential policies from Bank Indonesia that support green credit can expand access to financing for RDF projects.

An aspect to consider is strengthening fiscal incentive policies by including the cement, textile, paper, and biomass-based power generation industries in the category of pioneering industries entitled to tax holiday and tax allowance facilities. Currently, pioneering industries eligible for tax incentives are still limited to sectors such as basic metals, petrochemicals, basic chemicals, motor vehicles, and economic infrastructure. If RDF user industries can be categorized as strategic industries contributing to energy transition and carbon emission reduction, investment attractiveness in RDF will increase significantly. Furthermore, the super deduction tax scheme for research and development activities can be utilized to encourage technological innovation in RDF processing for higher energy efficiency and lower emissions.

In addition to tax incentives, customs facilities also have the potential to become strategic instruments in accelerating RDF adoption. Currently, the Ease of Import for Export Purposes (KITE) policy exempts import duties and VAT on raw materials used in export-oriented industries. If RDF can be included in this scheme as an alternative fuel for cement and textile industries that export their products, production costs can be reduced, increasing the competitiveness of Indonesian products in global markets particularly in facing carbon tax regulations such as the European Union's Carbon Border Adjustment Mechanism (CBAM). Another approach could be to provide additional points in the evaluation of government procurement tenders for contractors using cement produced with RDF, as an incentive factor. Thus, RDF incentive policies would not only focus on domestic usage but also be directed toward strengthening the export competitiveness of RDF-based industries.

Investment certainty and infrastructure guarantees should also be strengthened to make RDF projects more attractive to investors. One strategy is to designate RDF as a national strategic project in accordance with Presidential Regulation Number 78 of 2010 on the Acceleration of Priority Infrastructure Development. With this status, RDF projects can gain

access to infrastructure guarantee schemes from PT Penjaminan Infrastruktur Indonesia (PT PII), which will improve the financial feasibility of RDF projects. Studies conducted by the Asian Development Bank (ADB) show that renewable energy projects receiving infrastructure guarantees have higher attractiveness to investors compared to those relying solely on conventional financing schemes. Therefore, RDF incentive policies should be synergized with various sustainability-based investment schemes so that RDF projects have a solid financial foundation and can attract more funding from the private sector and green financing institutions.

In addition to fiscal and customs incentives, cross-sectoral coordination remains a major challenge in RDF implementation. Currently, RDF-related policies are scattered across various regulations covering waste management, taxation, energy, and industry, potentially creating misunderstandings among ministries and agencies responsible. Therefore, a more structured coordination mechanism between the Ministry of Finance, the Ministry of Energy and Mineral Resources, and the Ministry of Environment is necessary to ensure effective RDF implementation without bureaucratic obstacles hindering the realization of provided incentives.

Furthermore, local governments also need to be more proactive in supporting waste processing infrastructure and RDF distribution to user industries, ensuring that RDF policy implementation can be optimized across all regions of Indonesia. With a more integrated approach between fiscal incentives, customs facilities, investment, and cross-sectoral coordination, RDF can become a more effective solution in supporting the energy transition and enhancing the competitiveness of national industries in facing the challenges of a green economy–based global economy.

In the non-fiscal aspect, **RDF-based energy procurement contracts between the Government and the industrial sector through PLN or other state-owned enterprises in the energy sector can create a stable and guaranteed market for RDF.** In addition, including RDF in the national renewable energy (RE) target will enhance RDF's strategic recognition as an integral part of the energy transition. This effort needs to be supported by the development of supporting facilities, such as waste sorting facilities at major landfills and dedicated transportation means, to improve RDF production efficiency. At the regulatory level, harmonizing local policies with global mechanisms, such as the Clean Development Mechanism (CDM) and Paris Agreement Article 6, will increase RDF competitiveness in the international market framework. Enhancing carbon trading activities through incentives and sanctions related to carbon emissions is also expected to create new opportunities for monetizing avoided emissions through RDF utilization.

For Local Governments, fiscal incentives in the form of assistance for RDF infrastructure development costs (CAPEX) and operation and maintenance costs (OPEX) can be provided through various funding mechanisms, both from the Central Government (State Budget, ministerial/agency spending, Special Allocation Funds) and from non-government sources, such as foreign grants, climate funds, or corporate social responsibility (CSR) programs. Non-fiscal incentives for Local Governments may include awards at regional and international forums for regions that successfully manage RDF, thus providing moral motivation and enhancing regional reputation.

Another form of non-fiscal incentive is the provision of a green certificate, which is an environmental certification recognizing a company's or region's contribution to renewable energy use and carbon emission reduction. This certificate can enhance industry competitiveness and open access to global green markets and financing. In addition, higher rankings in the PROPER (Environmental Performance Rating Program) can also encourage RDF adoption. Industries utilizing RDF as an alternative energy source may gain

added value in environmental evaluations by the Ministry of Environment, ultimately strengthening company reputation and increasing attractiveness to investors.

To ensure RDF projects are eligible for optimal guarantees and incentives, RDF needs to be promoted as one of the national development priorities. Waste processing has already been included among the 20 national development priorities in the National Long-Term Development Plan (RPJPN) 2025–2045. Therefore, RDF is recommended to be included as a priority program in the National Medium-Term Development Plan (RPJMN) from 2030 to 2045. With national priority status, the Government can allocate more comprehensive incentive policies, both fiscal and non-fiscal, to enhance investment attractiveness and accelerate RDF adoption as a sustainable waste management solution

Short-Term Incentives

Short-term incentives are forms of support whose benefits can be immediately felt by RDF operators as well as the industries that utilize RDF. These incentives take the form of tax reliefs, subsidies, and direct financing aimed at enhancing competitiveness and accelerating RDF adoption within industries.

Several fiscal incentives that can be provided in the short term include:

1. **Tax Incentives** such as Tax Holiday and Super Tax Deduction, which reduce the tax burden for RDF investors or industry players, thereby making investment in this sector more attractive.
2. **Subsidies and Funding** in the form of RDF price subsidies, grants, and green financing, enabling industries to obtain RDF at a more affordable cost.
3. **Import Duty and Local Tax Incentives** by reducing the cost of importing RDF equipment or raw materials and providing tax incentives for companies that adopt RDF in their production processes.
4. **Operational Subsidies for RDF Facilities** aimed at assisting RDF operators in covering operational costs, thus enabling more efficient production.
5. **Corporate Income Tax (CIT) Reduction** for companies involved in RDF production and utilization, providing fiscal relief.
6. **Value-Added Tax (VAT) Borne by the Government for RDF Equipment Procurement,** which can ease the tax burden when acquiring RDF machinery and technology.
7. **Low-Interest Loans and Green Bonds**, providing access to low-interest financing for RDF industry players to expand their business.
8. **RDF Logistics Subsidies** to reduce RDF distribution costs and improve accessibility for user industries.
9. **Carbon Credit Registration & Audit** to provide recognition for industries contributing to carbon emission reductions, enabling them to gain financial benefits from carbon trading.

These incentives are expected to deliver rapid and tangible impacts for RDF operators and user industries. With the provision of subsidies and tax reliefs, industries can adapt more quickly to RDF utilization without having to bear the substantial upfront costs

Long-Term Incentives

Unlike short-term incentives, which are direct in nature, long-term incentives focus more on structural and systemic aspects in building a sustainable RDF ecosystem. The implementation of long-term incentives requires collaboration among the Government, the private sector, and the community to create more stable and long-term-oriented policies.

Several incentives in this category include:

1. **Infrastructure Guarantee from PT PII**, which functions to reduce investment risks in RDF infrastructure development, thereby making investors more interested in participating in such projects.
2. **Carbon Credit & Impact Fund**, aimed at providing financial incentives for industries that can reduce carbon emissions through RDF utilization, while also supporting the financing of environmental projects.
3. **Supporting Regulations and Policies**, covering clear rules on RDF standards, sustainable fiscal incentives, and policies that encourage broader RDF adoption.
4. **Partnerships and Collaborations** between the Government, private sector, and research institutions in the form of PPPs, workforce training, and the provision of research facilities for RDF innovation
5. **Simplified Licensing and Regulation, intended to streamline the permitting process for RDF industries so that adoption can proceed more quickly and efficiently.**
6. **RDF Standardization and Certification** to ensure that the RDF produced meets both national and international standards, making it more acceptable to user industries.
7. **Human Resource (HR) Assistance and Capacity Building**, aimed at improving the competencies of RDF sector workers through training and certification programs.
8. **Strengthening of Supporting Infrastructure**, such as the development of RDF processing facilities and integration with more efficient waste management systems.
9. **Corporate Performance Rating Program (PROPER) Program** as a ranking system for industries committed to sustainable business practices, including the use of RDF as an alternative energy source.
10. **Green Industry Standards**, encouraging companies to adopt green economy principles and integrate RDF into their sustainability strategies.

These long-term incentives aim to create a business and regulatory environment that supports the sustainable growth of the RDF industry. Their implementation requires a holistic approach involving the active role of various stakeholders to ensure that the RDF system can develop optimally over an extended period.

4.3.4 Capacity Building Aspect

To support the sustainable implementation of RDF, national policies, regulations, and standards must be accompanied by guidance and supervision. The facilitation role of various stakeholders including the Ministry of Public Works, the Ministry of Environment, informal sector associations, NGOs, similar institutions, as well as the private sector and universities is key to ensuring effective RDF management. These efforts should also include

enhancing human resource capacity and public education through regular forums at the local level, aimed at strengthening partnerships between the informal sector, Government, and waste management businesses.

Several capacity-building options currently under discussion with relevant ministries and agencies include the utilization of the Sanitation Technology Center (BTS) under the Ministry of Public Works. However, this option still requires significant support, particularly in the development of training modules and the readiness of trainers. Another alternative is **the established of an "RDF Center" managed by an institution with capacity and experience in RDF management, such as an industry association.** However, this initiative also requires funding support and technical assistance to operate effectively and sustainably.

In addition, the **development of training programs should be optimized with the latest RDF technologies and supported through collaboration with higher education institutions** to expand the knowledge and skills of the workforce in this sector. Sustainable capacity-building programs for local governments, waste management operators, and industries are essential to deepen their understanding of RDF production and utilization, as well as the environmental and economic benefits that can be achieved. **A more structured and continuous training system needs to be established** to replace project-based approaches with time limitations, such as those previously implemented under the ISWMP program and the RDFact project by RDI (Resilience Development Initiative).

Facilitating the development and exchange of knowledge through knowledge management mechanisms is also a strategic step in promoting RDF implementation in Indonesia. Information exchange among various stakeholders including the private sector, academia, financial institutions, and the public will accelerate the adoption of RDF technology as part of the national decarbonization strategy. Technology transfer and sharing of best practices from both national and international RDF projects can accelerate innovation and solutions in RDF management.

Innovations that can be directly utilized by communities, the development of high-quality human resources, and technology certification programs will create a competitive advantage for RDF products. Technical assistance in RDF facility development, public education and outreach, as well as advocacy through positive campaigns, should be continuously strengthened to encourage greater public involvement in RDF development. Close collaboration between the Government, universities, and other stakeholders will ensure that these efforts are implemented systematically and deliver long-term environmental and economic impacts.

4.3.5 Research and Development Aspect

The ideal conditions for fostering innovation and research in technology must include strong collaboration between private companies and academia, as well as cross-sector coordination involving multiple stakeholders. In addition, adequate funding for research and development (R&D) and the creation of a research ecosystem that supports sustainable innovation are essential.

To achieve these conditions, several efforts must be undertaken, including improving the quality of institutional regulations related to science and technology, with consistent research and innovation policies and support for good research governance. This also includes strengthening financial sector regulations to fund R&D activities. Institutional reform is crucial, such as integrating intermediary institutions into the system of translating inventions into innovations, as well as improving research accountability mechanisms.

Enhancing the quality of human resources in research must be pursued alongside improving incentives and funding, which can be facilitated through endowment funds for research and competitive R&D funding. Gap analyses indicate that to achieve the desired technological progress and increase industrial complexity, consistent research and development are indispensable. Therefore, efforts are needed to reach the target proportion of the Government's research budget to GDP, ensuring that investments in research and innovation make a significant contribution to overall economic growth and development.

Multi-stakeholder engagement and collaboration among the Government, businesses, research institutions, and universities are crucial to drive innovation in RDF processing technology, particularly in RDF sorting and drying processes. Integrating RDF technology with other technologies, such as BBJP, composting, and BSF, is also a key focus in creating more effective solutions. Furthermore, advanced technological innovations are needed to produce Class 4, 5, and 6 RDF to meet the needs of non-cement industries.

Cooperation in knowledge and technology transfer among stakeholders both domestic and international is essential to enhance collective capacity in addressing current technological challenges. Implementing an integrated information system is a strategic step to monitor and manage the latest technology data, RDF supply and demand data, and knowledge and technology transfer needs, thus facilitating better decision-making. Integrating RDF methods with other technologies such as BBJP is expected to generate positive impacts, including more efficient fuel use, the production of a wider variety of products, and increased revenue. With continuous technological refinement, it is expected that RDF of higher quality will be produced, making it more attractive to offtakers and increasing the market appeal of this product.

4.4 Recommendations for RDF Provision and Management Models and Funding Schemes

In efforts to expand RDF facilities in Indonesia, a sustainable business model is required one that can be effectively implemented across various regions. The appropriate business model should not only ensure operational and financial sustainability but also encourage active participation from the Government, the private sector, and RDF users. Accordingly, the business model recommendations in this study take into account investment aspects, partnership arrangements, economic incentives, and regulatory frameworks that can support the development and sustainability of RDF as a waste management solution that is both environmentally friendly and economic valuable.

4.4.1 Provision and Management Model Recommendations

Model 1

This model adopts a government-driven approach for the provision and management of RDF

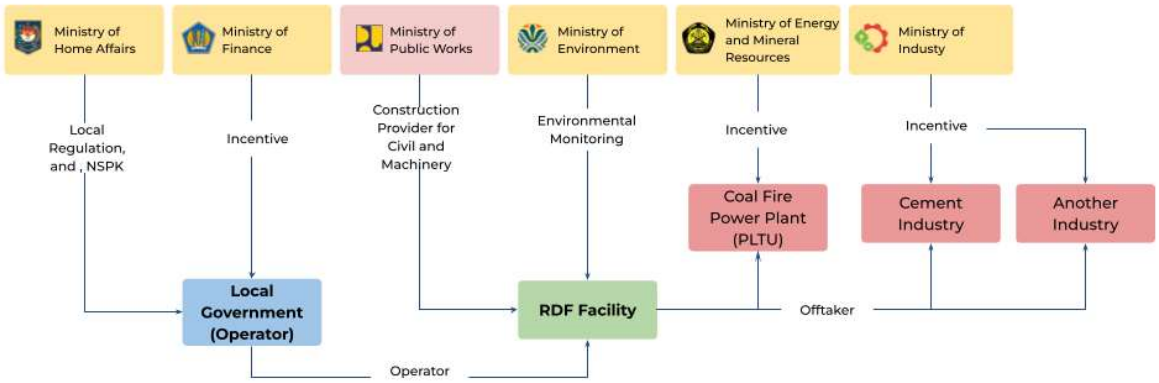

Figure 4.18 *Recommendation of Model I*

The first model relies on the Local Government as the primary operator of RDF facilities. Under this scheme, the Local Government receives regulatory support from the Ministry of Home Affairs and financial incentives from the Ministry of Finance. RDF infrastructure is supported by the Ministry of Public Works in terms of civil works and machinery provision, while environmental oversight is conducted by the Ministry of Environment and Forestry. The RDF output is then absorbed by industries such as coal-fired power plants (CFPPs) and cement factories, with incentive support from the Ministry of Energy and Mineral Resources and the Ministry of Industry. This model grants full control to the Local Government but requires adequate operational and managerial capacity to ensure the sustainable operation of RDF.

In this model, the Local Government serves as the main operator in managing RDF facilities. The Local Government obtains regulatory support, fiscal incentives, and technical assistance from various relevant ministries, such as the Ministry of Home Affairs, the Ministry of Finance, and the Ministry of Public Works. With such support, RDF project implementation is more assured as it is directly managed by the authority at the regional level. Furthermore, inter-agency coordination is more straightforward, given that the Local Government has direct access to ministries providing regulatory and technical assistance. Another advantage is the availability of technical guidance in planning and providing RDF facilities, including civil works and machinery procurement. The Local Government is also entitled to fiscal incentives and policy support from the Central Government, which can help accelerate the realization of this project.

However, this model presents several challenges. One major constraint is the limited funding available to the Government, given that RDF projects require substantial investment. Moreover, since Local Governments are primarily service-oriented, economic considerations, technical capabilities, and financial sustainability are often not the main priorities, creating a risk of operational inefficiency. The operational capacity and capability to manage RDF at the regional level are still relatively low, particularly in terms of efficiency and sustainable facility management. Additionally, RDF operations are highly dependent on annual budget allocations from both the Central and Local Governments, which may fluctuate based on fiscal policies. Another factor affecting RDF sustainability is its reliance on industry as the offtaker. Without long-term agreements with offtakers, RDF utilization may be hindered, potentially jeopardizing the continuity of the project.

Overall, this model provides regulatory certainty and full Government support but faces challenges in funding and management efficiency. The success of RDF implementation with the Local Government as the operator largely depends on strong synergy between the Local Government, relevant ministries, and RDF-consuming industries.

Model II

This model adopts a government-driven approach for the provision and management of RDF by utilizing funding sourced from Regional Government Budgets (APBD).

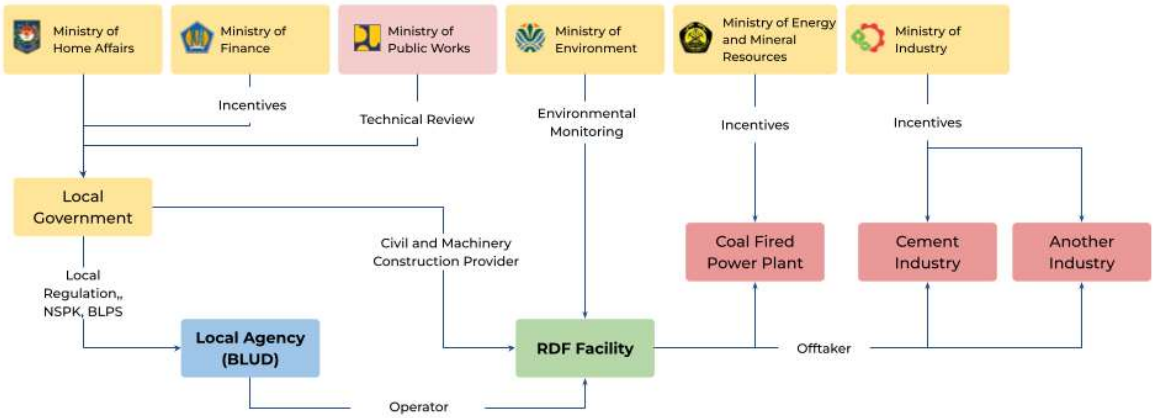

Figure 4.19 *Recommendation of Model II*

The second model outlines an RDF facility management scheme involving multiple stakeholders, including ministries, Local Governments, local agencies or Regional Public Service Agencies (BLUD), as well as industries serving as offtakers. Under this scheme, the Local Government plays a role in formulating regional regulations and policies while ensuring financial support through incentive mechanisms provided by the Ministry of Finance and other relevant ministries. Local agencies or BLUD act as operators managing the RDF facilities, while providers of civil works and machinery are responsible for constructing the required infrastructure. The RDF facilities then distribute their products to various industries such as coal-fired power plants, cement factories, and other industrial sectors which receive incentives from the relevant ministries for utilizing this alternative fuel.

The advantages of this model include a higher degree of implementation certainty, as it is directly managed by the Local Government through BLUD, which facilitates coordination and access to support from various ministries. Additionally, there is technical assistance available for planning and facility provision, along with policies and fiscal incentives provided by the Central Government. Another strength is the flexibility afforded to Local Governments in adapting the model to their fiscal capacity, making it more responsive to local conditions.

However, this model also presents certain drawbacks, particularly concerning the limited funding available from the Government, which may affect the operation and development of RDF facilities. Furthermore, economic and financial considerations are not the primary focus in this model, potentially leading to a lack of emphasis on efficiency and profitability. Management capacity and capability also remain a challenge, as operations are largely conducted under the principles of public service and rely heavily on government budgets. The sustainability of RDF utilization is also highly dependent on cooperation agreements with offtakers; without long-term agreements, the program risks facing instability in its implementation.

Model III

This model adopts a government-driven approach for the provision of RDF, while its management is driven by the private sector or industry (private-driven).

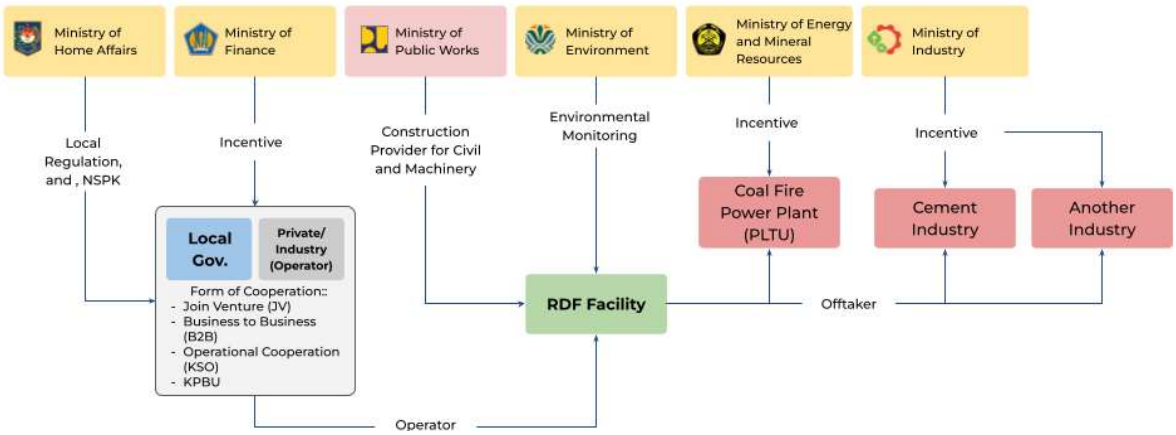

Figure 4.20 *Recommendation of Model III*

The third model involves collaboration between Local Government and the private sector in operating RDF facilities. This partnership can take the form of a joint venture (JV), business-to-business (B2B) arrangement, joint operation (KSO), or a Public-Private Partnership (PPP). The Local Government continues to serve as the regulator and recipient of incentives, while the private sector is responsible for operational management. Under this scheme, the financial and operational burden on the Local Government is reduced, while the private sector gains business opportunities in waste management and RDF production.

The main advantages of this model include implementation certainty supported by regulations and fiscal incentives from relevant ministries, such as the Ministry of Finance and the Ministry of Public Works. In addition, collaboration with the private sector improves management efficiency, reduces dependence on government budgets, and ensures that RDF facilities are operated more professionally. Involving industry also enhances RDF management capacity and capability compared to when facilities are solely managed by the Local Government.

However, this model also faces a number of challenges. One of the main constraints is the limited government funding for RDF facility provision, meaning that initial investment relies heavily on private sector participation. Furthermore, the partnership process tends to take longer due to multiple bureaucratic stages, from obtaining permits to finalizing contractual agreements. The partnership period is also relatively short—particularly outside of PPP schemes, which generally span only around five years. There is also a risk of contract termination with private parties if there are changes in policy or disagreements during project implementation. Moreover, although the Government has a supervisory role, its capacity to ensure operator performance remains limited, which could affect the long-term operational effectiveness of RDF facilities.

Overall, this model offers a more efficient and professional RDF management solution through private sector involvement. However, its success largely depends on an efficient bureaucratic process, strong government oversight, and sustained cooperation with industry to ensure that RDF projects can operate optimally and sustainably.

Model IV

This model adopts a joint government- and private-driven approach for RDF provision, while its management is private- or industry-driven.

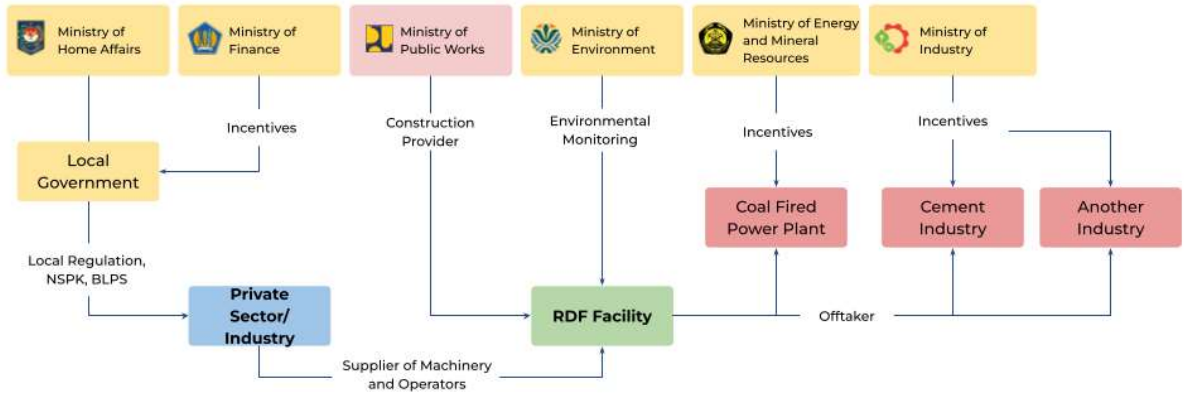

Figure 4.21 *Recommendation of Model IV*

In the fourth model, the private sector/industry plays a more prominent role compared to the previous model. The Local Government continues to provide regulations and incentives, while RDF operations are entrusted to the private sector, which acts as both the equipment provider and the facility operator. This approach enables faster development of RDF facilities, as the private sector possesses expertise and efficiency in RDF technology investment and operation. However, the success of this model relies heavily on the availability of attractive incentives for investors and the assurance of a stable RDF market

The main advantages of this model include greater certainty of implementation supported by robust regulations and incentives from various ministries. Additionally, coordination and support from multiple stakeholders, including technical assistance in planning and provisioning, further streamline RDF facility operations. Policy incentives and cost-sharing with the private sector also help reduce dependence on government budgets. By involving industry as the primary operator, RDF management capacity and capability are enhanced, while the risk of technological unreliability in operations is reduced.

Nevertheless, this model also has several drawbacks. One major challenge lies in the lengthy collaboration process due to complex bureaucracy. The partnership period remains limited averaging only around five years outside the PPP scheme. The risk of contract termination with the private sector is another obstacle that must be anticipated to ensure sustainable RDF operations. Furthermore, the Government's ability to facilitate and mediate dispute resolution between private parties and industry is still limited, which could delay conflict settlement. Oversight of operator performance is also challenging, given the Government's capacity constraints in ensuring RDF operations meet the established standards.

Overall, this model offers a more effective solution for RDF management through a clearer division of roles between the Government and the private sector. Nonetheless, challenges in bureaucracy, partnership sustainability, and oversight effectiveness must be addressed to ensure RDF facilities operate optimally and deliver long-term benefits.

Model V

This model adopts a private-driven approach in which the provision and management of RDF are led entirely by the private sector.

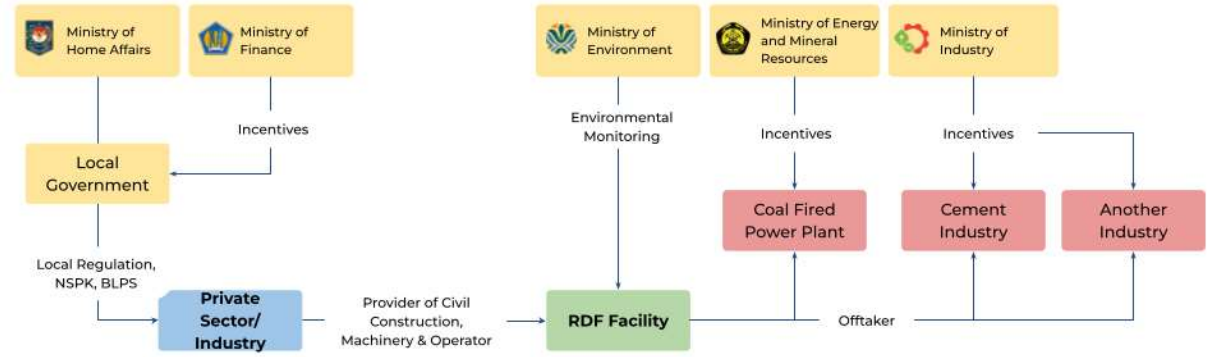

Figure 4.22 *Recommendation of Model V*

The fifth model grants a dominant role to the private sector/industry in all aspects of RDF operations, from civil construction and equipment provision to daily operations. The Local Government continues to provide regulations and incentives but does not directly participate in RDF facility management. Under this approach, the construction and operation processes can be more efficient, particularly when involving companies with experience in waste and energy processing. Nevertheless, a robust oversight mechanism is required to ensure that environmental and social interests are safeguarded

This model encourages the active role of the private sector in providing technology and operational management, thereby reducing the fiscal burden on the Government through private self-financing schemes. Furthermore, the provision of incentives and policies from relevant ministries helps accelerate implementation and provides greater certainty for business actors. RDF facility management also becomes more flexible and adaptive to technological developments, enabling higher operational efficiency and more effective resource utilization.

On the other hand, complex licensing and bureaucratic processes may hinder implementation, while the financial risk for the private sector increases due to limited guarantees or regulatory certainty from the Government. The lack of technical support in planning and operations may also affect the effectiveness of RDF facility management. In addition, negotiations and partnership agreements often require considerable time before implementation. The Government still faces limitations in facilitating cooperation and ensuring optimal oversight of RDF facility operator performance.

4.4.2 Funding Scheme Recommendations

Funding Schemes for RDF Facility Provision

To expand the utilization of Refuse-Derived Fuel (RDF) as a solution for waste management and an alternative energy source in Indonesia, a comprehensive funding scheme involving multiple stakeholders is required. The infrastructure and equipment necessary for RDF facilities demand substantial investment, thereby necessitating financing from diverse mechanisms ranging from government budgets, international grants, green financing, to private investment through clearly defined cooperation schemes.

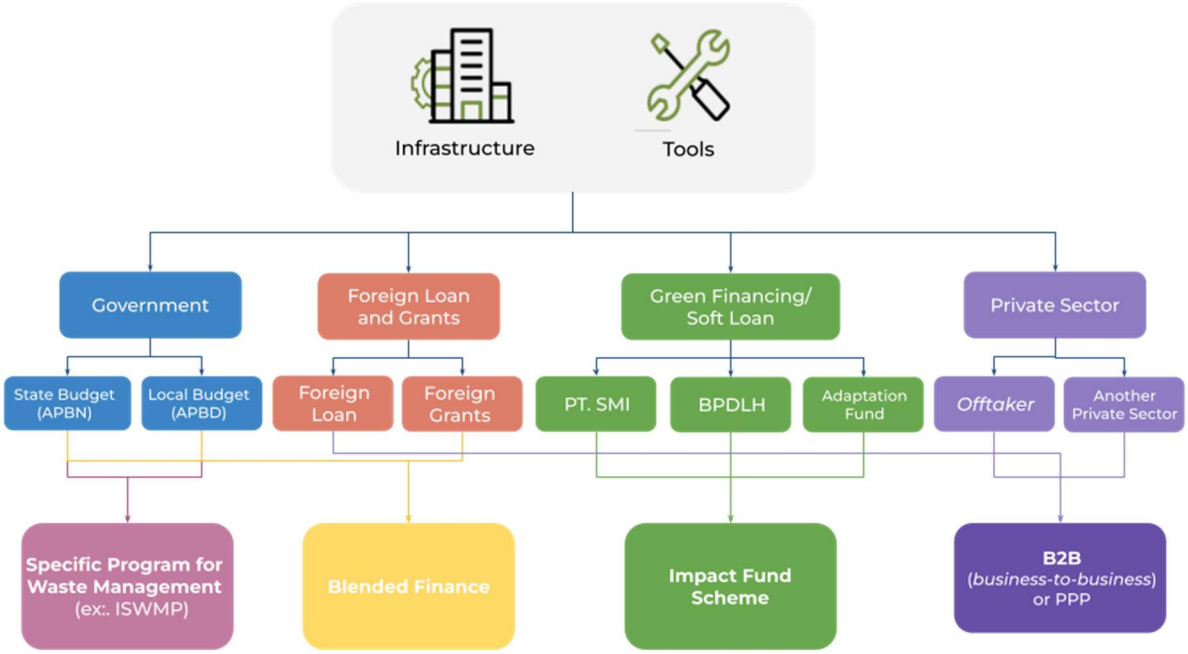

Figure 4.23 *Financing Scheme for RDF Facility Provision*

The Government plays a central role in promoting the development of RDF facilities through funding sourced from the State Budget (APBN) and Regional Budgets (APBD). Local Governments, the Ministry of Public Works and Housing, and the Ministry of Finance are key actors in allocating budgets for waste management infrastructure, including RDF. Regions must prioritize APBD allocations for the waste management sector as an essential public service. In certain regions, waste management infrastructure can be financed through APBD, and once the infrastructure is established, Local Governments must also allocate budgets for operational and other requirements, rather than relying solely on the Regional Solid Waste Management Service (BLPS). Furthermore, grants from international organizations and development partners can serve as significant sources of funding. For instance, foreign grant and loan schemes (Hibah LN and Loan LN) managed by global development partners can support specific programs such as the Indonesia Sustainable Waste Management Project (ISWMP), which aims to enhance integrated waste management, including the incorporation of RDF as part of landfill waste reduction strategies.

While APBN/APBD funding and foreign grants can facilitate the construction of RDF facilities, ensuring project sustainability remains a challenge. The Government must ensure adequate incentives are in place to attract private sector investment in RDF operations and management. Without an attractive incentive framework, RDF projects risk overreliance on government funds, which are often constrained.

As an alternative financing mechanism, green financing and concessional loans can be leveraged to support RDF investments. These schemes focus on funding environmentally friendly and sustainable projects. PT Sarana Multi Infrastruktur (PT SMI) and the Environmental Fund Management Agency (BPDLH) play pivotal roles in providing access to environmentally oriented financing. BPDLH, operating under the Ministry of Finance, manages environmental funds that can be allocated to green infrastructure projects, including RDF.

However, despite the existence of green financing regulations issued by the Financial Services Authority (OJK), access to such funding remains limited in Indonesia. Many RDF projects struggle to meet the eligibility criteria set by green finance institutions. Stronger enabling regulations are therefore necessary to broaden access to green financing for RDF projects. The Government can also introduce additional incentives for investors supporting environmentally based projects to enhance the attractiveness of RDF investment

Private sector participation is critical in RDF facility development and operations. One viable approach is the business-to-business (B2B) model, where industries requiring RDF as an alternative fuel can directly invest in or partner with RDF providers. Offtaker companies such as cement manufacturers and alternative-fuel power plants hold significant potential as primary RDF buyers, thereby strengthening project viability.

In addition to the B2B model, the Government can promote the application of Public-Private Partnerships (PPP) in RDF projects. Under this scheme, the private sector participates in RDF facility construction and management with government support. However, successful implementation requires legal certainty and clear guarantees on investment continuity. Regulatory uncertainty and high investment risks often deter private sector participation in waste management infrastructure projects. Therefore, the Ministry of Finance, the Ministry of Public Works and Housing, and the Financial Services Authority must establish more conducive policies to attract private investment in RDF projects.

The successful expansion of RDF facilities in Indonesia depends on a combination of various funding schemes involving the Government, financial institutions, and the private sector. The Government can provide initial funding through APBN/APBD and foreign grants; however, long-term sustainability requires private sector incentives to stimulate investment. Green financing represents an attractive option, though its accessibility must be expanded through stronger regulatory support. Meanwhile, B2B and PPP models offer long-term solutions but require legal certainty and supportive policies to appeal to investors.

Blended finance represents an approach that integrates public funds, concessional loans, and private investment to develop sustainable waste management infrastructure. This model aims to reduce financial risk, enhance investment attractiveness, and ensure RDF project sustainability particularly in cases where reliance solely on market mechanisms is economically unfeasible. In this scheme, grants from the Government or international organizations are used for initial funding, such as feasibility studies and equipment procurement, while concessional loans from financial institutions support infrastructure development. One example of blended finance implementation in Indonesia is the SDG Indonesia One platform managed by PT SMI, which successfully combines public and private funds to support green infrastructure projects, including waste management and renewable energy. Under this scheme, initial grants cover preparatory activities, while concessional loans finance infrastructure construction. Private investment is introduced at the operational stage through B2B or PPP mechanisms, enabling industries to utilize RDF as an alternative energy source.

The blended finance mechanism for RDF operates in stages beginning with grants to reduce initial project barriers, followed by concessional loans to accelerate infrastructure realization, and culminating in private sector participation to ensure operational sustainability. This scheme allows for a fairer distribution of risk, with the Government acting as a catalyst by providing seed funding and supportive regulations, while the private sector contributes technological expertise and operational efficiency.

From both economic and sustainability perspectives, blended finance for RDF offers significant benefits optimizing public budget use while creating a more inclusive investment ecosystem. Economically, the combination of funding sources reduces the Government's fiscal burden by attracting private participation; socially and environmentally, RDF supports the transition towards a circular economy and carbon emission reduction. Consequently, blended finance serves not only as a funding mechanism but also as a strategy for transforming waste management systems towards greater efficiency and environmental responsibility.

Through synergy among all stakeholders, RDF development in Indonesia can become an effective solution for reducing waste accumulation and creating a more environmentally friendly alternative energy source. With an appropriate funding strategy and supportive regulations, RDF can evolve into a key component of a more sustainable waste management system in Indonesia.

RDF Management Funding Scheme

Refuse-Derived Fuel (RDF) as a solution for converting waste into alternative fuel in Indonesia requires a funding scheme that involves multiple actors, including the central and local governments, industries as offtakers, and the private sector. The three key aspects of RDF management operations, maintenance, and logistics require sustainable financial support to ensure the program's effectiveness and long-term viability.

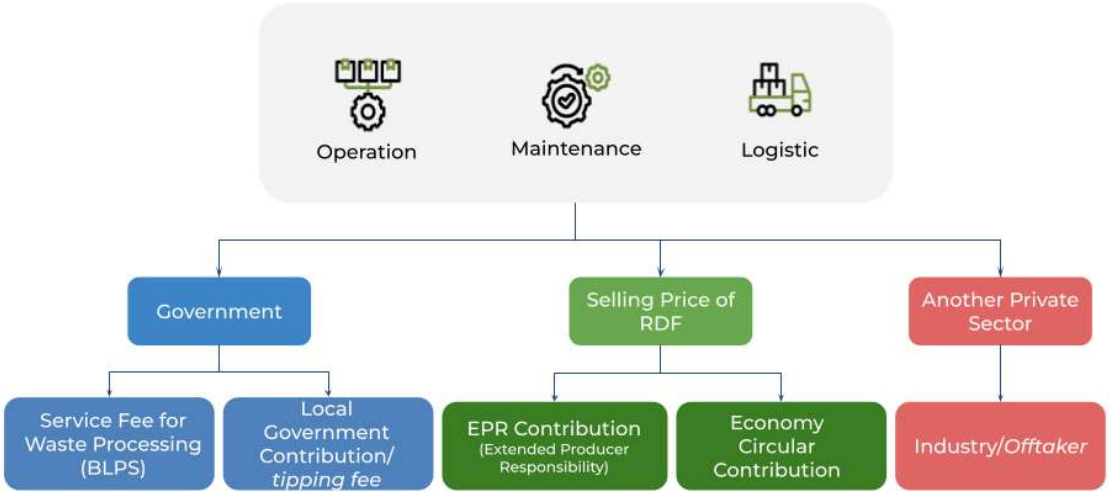

Figure 4.24 *Financing Scheme for RDF Management*

Government support plays a crucial role in the RDF funding scheme, particularly through the tipping fee mechanism paid by local governments, as well as through funding from the Regional Solid Waste Management Service (BLPS) and other financing sources. The key actors in this scheme include the Ministry of National Development Planning (Bappenas), the Ministry of Finance, the Ministry of Environment and Forestry, the Ministry of Industry, and the Ministry of Energy and Mineral Resources. However, to date, regulations governing the tipping fee amount and its financing mechanism remain insufficiently robust. Moreover, the active role of local governments in waste management is critical. Local governments are not only responsible for paying tipping fees but also for allocating budget from the Regional Budget (APBD) for the construction and operation of waste management infrastructure. According to the Ministry of Environment and Forestry, the ideal allocation for waste management is 3% of the APBD. However, data shows that the average allocation for waste management at the regional level is still below 1% of the total APBD, indicating a need for stronger fiscal commitment from local governments. Clearer

policies and stronger fiscal support from local governments are therefore required to enable broader and more effective RDF implementation.

In addition to government support, the RDF funding scheme also relies on RDF sales to industries or offtakers, which can serve as a primary revenue source. Industries using RDF as an alternative fuel acting as offtakers need to be encouraged to actively adopt RDF. For this to succeed, the RDF market must remain stable, and industries must be given incentives to shift from conventional fuels to RDF. The Ministry of Industry and the Ministry of Energy and Mineral Resources play an important role in creating policies that foster increased demand for RDF in the industrial sector.

The private sector also holds significant potential in supporting RDF financing, particularly through Extended Producer Responsibility (EPR) mechanisms and contributions to the circular economy. Stakeholders in this scheme include industrial players, other private companies, and relevant ministries such as the Ministry of Environment and Forestry and Bappenas. Unfortunately, the EPR concept in Indonesia is still in its developmental stage and has yet to be widely adopted by large industries. With stronger regulations and the right incentives, EPR could become a significant source of RDF funding while also encouraging producers to take responsibility for managing their waste.

Similarly, contributions from the circular economy hold considerable potential in supporting RDF, especially through recycling and waste reduction efforts by private companies. However, the current implementation of this concept remains limited and requires more proactive government policies as well as greater private sector participation.

To ensure the sustainability of RDF management in Indonesia, it is necessary to strengthen regulations related to tipping fees and EPR, stabilize the RDF market, and increase private sector participation in the circular economy. Collaboration between the central and local governments, industries as offtakers, and the private sector is key to creating an effective and sustainable RDF funding system. With stronger, more concrete support from all stakeholders, RDF can be expanded as a viable solution for addressing waste issues while supporting the transition towards cleaner and more environmentally friendly energy.

05.

Conclusion

This gap analysis report has identified challenges in expanding RDF in Indonesia across three main domains: RDF provision (supply), RDF utilization (demand), and the enabling environment. While RDF holds significant potential as both a waste management solution and a substitute for fossil fuels, its implementation continues to face various obstacles, including limited infrastructure, underdeveloped regulatory frameworks, suboptimal financing schemes, and constraints in technical capacity and research.

From the supply side, key challenges include the limited capacity of RDF processing facilities, the absence of comprehensive technical standards for RDF production processes, unclear institutional arrangements for facility management, and a high dependency on government funding. The sustainability of RDF supply is also not fully guaranteed due to the lack of binding cooperation agreements that ensure the continuity of feedstock and facility operations. To address these issues, a national policy should be established to define the institutional framework for RDF management, develop guidelines for stakeholder cooperation agreements, and implement a performance monitoring system for RDF facilities. From an infrastructure perspective, expanding the number of strategically located RDF facilities and developing an efficient distribution network will be necessary to ensure nationwide RDF availability.

In terms of the enabling environment, RDF-related regulations and policies in Indonesia still require significant strengthening. The absence of a national standard for RDF specifications, a lack of supportive incentive mechanisms, and limited research and development (R&D) capacity pose serious challenges to developing a sustainable RDF ecosystem. Addressing these gaps will require the introduction of national regulations governing RDF utilization as part of the energy transition, the implementation of attractive fiscal and non-fiscal incentives for industries and local governments, and enhanced collaboration between government bodies, research institutions, and the industrial sector in RDF-related R&D.

To ensure effective and targeted implementation of RDF expansion, the recommendations presented in this report can be classified into three priority levels, as shown in **Table 5.1**. In addition, all recommendations require the active participation of stakeholders. The central government should take the lead in setting national policies and incentives. Local governments can manage RDF infrastructure and supply. Industry can serve as the primary RDF end user and undertake necessary technological adjustments. Meanwhile, research institutions and academia can support innovation and relevant technological development.

Table 5.1 *Priority of Recommendation Implementation*

High Priority	• Strengthening national regulations related to RDF utilization and its specification standards. • Preparation of guidelines for environmental requirements and documentation that must be fulfilled by industries prior to utilizing RDF. • Preparation of cooperation agreement guidelines among stakeholders. • Development of fiscal incentive schemes such as tax holidays and the removal of import duties on RDF technology.
Medium Priority	• Development of RDF financing schemes based on green finance. • Development of interregional RDF distribution networks
Long Term Priority	• Strengthening research and development of local RDF technology.

In addition, based on this study, further recommendations have been identified to develop a waste segregation system at the source as a priority and fundamental step to improve the efficiency of waste management and to achieve RDF quality standards that meet industrial requirements. Furthermore, additional supporting studies should be conducted in the following order of priority:

1. A study on the formulation of business models and best practices for RDF in Indonesia to ensure a more structured and sustainable implementation.
2. From an economic scale perspective, a study is required to determine the feasible capacity of RDF facilities to enable economical and efficient operations.
3. From an industrial perspective, a cost–benefit analysis is necessary to evaluate the advantages and costs of utilizing RDF, thereby enabling broader adoption by industries as an alternative fuel

The implementation of these recommendations is expected to support the adoption of RDF in Indonesia and to enhance its contribution in reducing the volume of waste ending up in landfills, lowering greenhouse gas emissions, and supporting the energy transition. The successful implementation of RDF in Indonesia requires synergy and coordination among various parties.

Therefore, a shared commitment from all stakeholders is essential for more effective waste management. With coordinated efforts underpinned by a robust policy framework, RDF can serve as one of the key solutions in achieving the national waste management targets. Another recommendation that remains necessary is a comprehensive study and roadmap on various waste processing technologies, both Waste-to-Energy (WTE) and non-WTE, not only concerning the modalities that already exist but also those that need to be developed to ensure a sustainable ecosystem for diverse waste processing technologies.

Appendix

Appendix (List of Cosntructed RDF TPST in 2025)

Ministry of Public Works and Public Housing has developed various Integrated Waste Processing Facilities (TPST) utilizing Refuse-Derived Fuel (RDF) technology in several regions of Indonesia during the 2022–2024 period. This infrastructure aims to promote more sustainable waste management by converting waste into alternative fuel. The following list provides information on the location, capacity, operator, type of financing, and operational status of TPSTs that have been constructed, are under construction, or are in the tendering phase. This initiative is expected to contribute to reducing waste accumulation while providing a more environmentally friendly energy solution.

Table 1 *List of Mapped TPST Infrastructure Constructed with RDF Technology*

No.	Name of RDF Facility	Location	Year Constructed	Funding Source	Capacity		Pengelola	Offtaker	Form of Agreement		Operational Status	Description
					Waste Processed (Tons/day)	RDF (Tons/day)			CA/MoU	Between		
1	TPA Jeruk Legi	Kab. Cilacap, Jawa Tengah	2020	State Budget (APBN), Local Budget (APBD), Loan	160	60	PT. Solusi Bangun Indonesia (Private, and as an offtaker)	PT. Solusi Bangun Indonesia	CA	Local Government with PT Solusi Bangun Indonesia	Operational	
2	RDF Bantar Gebang	Kota Bekasi, Jawa Barat	2020	State Budget (APBN through (PEN), Local Budget (APBD)	2000	700	UPT-BLUD (Local Government DK Jakarta)	1. PT Indocement Tunggal Perkasa 2. PT Solusi Bangun Indonesia	CA	Local Government of Jakarta with PT Indocement Tunggal Perkasa and PT Solusi Bangun Indonesia	Suboptimal Operational	Not yet operating at full designated capacity
3	RDF Rorotan	Daerah Khusus Jakarta	2024	Local Budget (APBD)	2500	875	UPT-BLUD (Local Government DK Jakarta)	PT Indocement Tunggal Perkasa	CA	Local Government of Jakarta with PT Indocement Tunggal Perkasa	Trial Operational	Trial operation, but the equipment design has not produced RDF according to targets and environmental requirements.
4	RDF TOSS Klungkung	Kab. Klungkung, Bali	2017	Local Budget (APBD)	50	20	PT Cahaya Terang Bumi Lestari (Local Government)	UMKM dan Rumah Tangga	CA	PT Cahaya Terang Bumi Lestari with Local Government Kab. Klungkung	Suboptimal Operational	Not yet operating at full designated capacity

No.	Name of RDF Facility	Location	Year Constructed	Funding Source	Capacity		Pengelola	Offtaker	Form of Agreement		Operational Status	Description
					Waste Processed (Tons/day)	RDF (Tons/day)			CA/MoU	Between		
5	RDF TPA Jabon	Kab. Sidoarjo, Jawa Timur	2021	Private	60	20	PT Cahaya Terang Bumi Lestari (Pihak Ketiga)	1. PLTU Paiton 1 & 2 2. PLTU Tanjung Awar-Awar	CA	PT Cahaya Terang Bumi Lestari dengan Pemerintah Kab. Sidoarjo	Not Yet Operational	Revenue does not cover operation and maintenance (O&M) costs
6	RDF TPA Ngipik	Kab. Gresik, Jawa Timur	2015	Local Budget (APBD)	20	3,5	Local Government (Kab. Gresik)	PT. Semen Indonesia Group	MoU	Pemerintah Kab. Gresik dengan PT Semen Indonesia Group	Suboptimal Operational	Not yet operating at full designated capacity
7	TPST Belahanrejo	Kab. Gresik, Jawa Timur	2023	Local Budget (APBD)	20	8	Local Government (Kab. Gresik)	PT. Semen Indonesia Group	MoU	Pemerintah Kab. Gresik dengan PT Semen Indonesia Group	Suboptimal Operational	Not yet operating at full designated capacity
8	RDF Indocement Palimanan	Kab. Cirebon, Jawa Barat	2008	Private	10	4	PT Indocement Tunggal Perkasa dan BUMDes	PT. Indocement Tunggal Perkasa	CA	PT. Indocement Tunggal Perkasa dengan BUMDes setempat	Operational	
9	RDF TPST Samtaku	Kab. Badung, Bali	2021	State Budget (APBN)	120	48	PT Reciki Solusi Indonesia	UMKM	CA	Pemerintah Daerah dengan PT Reciki Mantap	Operational	
10	RDF TPST Kertalangu	Kota Denpasar, Bali	2023	State Budget (APBN) (through ISWMP program)	450	240	PT Bali CMPP (third party)	1. PT Solusi Bangun Indonesia 2. Semen Indonesia Group	CA	PT Bali CMPP dengan Pemerintah Kota Denpasar	Not Yet Operational	Unable to meet design capacity, tipping fee does not cover operating costs, and the third-party contract has been terminated.

No.	Name of RDF Facility	Location	Year Constructed	Funding Source	Capacity		Pengelola	Offtaker	Form of Agreement		Operational Status	Description
					Waste Processed (Tons/day)	RDF (Tons/day)			CA/MoU	Between		
11	TPST Padangsambian	Kota Denpasar, Bali	2023	State Budget (APBN) (through ISWMP program	120		PT Bali CMPP (third party)	1. PT Solusi Bangun Indonesia 2. Semen Indonesia Group	CA	PT Bali CMPP dengan Pemerintah Kota Denpasar	Not Yet Operational	Unable to meet design capacity, tipping fee does not cover operating costs, and the third-party contract has been terminated.
12	RDF TPST Cicukang Holis	Kota Bandung, Jawa Barat	2022	State Budget (APBN) (through ISWMP program	10	4	Local Government (Kota Bandung)	Indonesia Power	MoU	Pemerintah Kota Bandung dengan Indonesia Power	Suboptimal Operational	Not yet operating at full designated capacity
13	RDF TPST Cicukang Oxbow	Kota Bandung, Jawa Barat	2022	State Budget (APBN) (through ISWMP program	20	8	Pemerintah Daerah (Kota Bandung)	Indonesia Power	MoU	Pemerintah Kota Bandung dengan Indonesia Power	Suboptimal Operational	Not yet operating at full designated capacity
14	TPST RDF Cimenteng	Kota Sukabumi	2024	Private	330	100	Local Government (Kota Sukabumi)	PT Cahaya Yasa Cipta	CA	Pemerintah Kab. Sukabumi dengan PT Semen Siam Cement Group (SCG)	Trial Operational	Constraints due to incomplete environmental requirement documents (EIA/AMDAL)
15	RDF TPST BLE Banyumas	Kab. Banyumas, Jawa Tengah	2023	Local Budget (APBD)	75	<10	Kelompok Swadaya Masyarakat	1. PT Solusi Bangun Indonesia 2. PLTU Cilacap Greenprosa	MoU	Pemerintah Kab. Banyumas dengan PT Solusi Bangun Indonesia dan PLTU Cilacap Greenprosa	Operational	
16	RDF TPST Tegalsari	Kab. Purwakarta, Jawa Barat	2022	State Budget (APBN) (through ISWMP program	15	6	Local Government of Kab. Purwakarta	PT. Solusi Bangun Indonesia	MoU	Pemerintah Kab. Purwakarta dengan PT Solusi Bangun Indonesia	Suboptimal Operational	Not yet operating at full designated capacity
17	RDF TPST Jayakerta	Kab. Karawang, Jawa Barat	2023	State Budget (APBN) (through ISWMP program	25	10	Local Government of Kab. Karawang	Not Any Information	-	-	Not Yet Operational	Equipment is non-functional, and there is no monitoring & evaluation process

No.	Name of RDF Facility	Location	Year Constructed	Funding Source	Capacity		Pengelola	Offtaker	Form of Agreement		Operational Status	Description
					Waste Processed (Tons/day)	RDF (Tons/day)			CA/MoU	Between		
18	RDF TPST Sentiong	Kota Cimahi, Jawa Barat	2024	State Budget (APBN) (through ISWMP program	50	20	Local Government of (Kota Cimahi)	PT. Indocement Tunggal Perkasa	MoU	Pemerintah Kota Cimahi dengan PT Indocement Tunggal Perkasa	Not Yet Operational	Not yet operating at full designated capacity
19	RDF TSPST Kebun Kongok	Kab. Lombok Barat, NTB	2023	State Budget (APBN through ITDP)	120	20	BUMDes	PLTU Jeranjang	MoU	Pemerintah Kab. Lombok dengan PLN	Not Yet Operational	No delivery to Jeranjang coal-fired power plant (PLTU) in 2024
20	RDF TPST3R Argodadi	Kab. Bantul, Yogyakarta	2024	Local Budget (APBD)	49	15-30	Local Government (Kab. Bantul)	PT. Solusi Bangun Indonesia	MoU	Pemerintah Kab. Bantul dengan PT Solusi Bangun Indonesia	Not Yet Operational	Not yet operating at full designated capacity
21	RDF TPST Sendangsari	Kab. Sleman, Yogyakarta	2024	Local Budget (APBD)	45	15-30	Local Government of (Kab. Sleman)	PT. Solusi Bangun Indonesia	MoU	Pemerintah Kab. Sleman dengan PT Solusi Bangun Indonesia	Not Yet Operational	Suboptimal waste processing has caused odor issues at TPST Sendangsari
22	TPST RDF Rawa Kucing	Kota Tangerang, Banten	2024	Local Budget (APBD)	50	15	Local Government of (Kota Tangerang)	PT. Solusi Bangun Indonesia	-	-	Trial Operational	No delivery to the offtaker due to pending regional tariff regulation (Perda) and cooperation agreement (PKS)

Source: Mnistry of Public Works, 2024

Table 2 List of Potential RDF Offtakers among Coal-Fired Power Plants (CFPPs) In Accordance with Ministry of Energy and Mineral Resources Regulation No. 12 of 2023 on the Utilization of Biomass as a Co-Fuel in Steam Power Plants.

No	Nama PLTU	Jumlah Unit	Kapasitas (MW)	Lokasi	Pemilik PLTU	Pengelola PLTU	Jenis Boiler	Jenis B3m	Penyedia B3m	Keterangan
1	Suralaya 1-7	7	3400	Kec. Pulomerak, Kota Cilegon, Banten	PIP	PIP	PC	Sawdust, BBJP	ADC, BBN, Palasaraya	
2	Suralaya 8	1	625	Kec. Pulomerak, Kota Cilegon, Banten	PIP	PIP	PC	Sawdust	ADC, BBN, BBRB	
3	Labuan Banten	2	600	Sukamaju, Kec. Labuan, Kab. Pandeglang, Banten	PIP	PIP	PC	Sawdust, BBJP	ADC, PD PBM, RAE, Palasaraya	
4	Adipala	1	660	Bunton, Kec. Adipala, Kab. Cilacap, Jawa Tengah	PIP	PIP	PC	Sawdust, LRUK	ADC, BWSM, AIS	
5	Pelabuhan Ratu	3	1050	Pelabuhanratu, Kec. Pelabuhanratu, Kab. Sukabumi, Jawa Barat	PIP	PIP	PC	Sawdust, Sekam	ADC, SDT, AW TECH	
6	Lontar	3	945	Lontar, Kec. Kemiri, Kab. Tangerang, Banten	PIP	PIP	PC	Sawdust	ADC	
7	Asam Asam	4	260	Asri Mulia, Kec. Jorong, Kab. Tanah Laut, Kalimantan Selatan	PIP	PIP	PC	Sawdust	PBJ	
8	Sintang	3	21	Kedabang, Kec. Sintang, Kab. Sintang, Kalimantan Barat	PIP	PIP	STOKER	Ck Sawit	PKS, ADC, MJC	
9	Sanggau	2	14	Sungai Muntik, Kec. Kapuas, Kab. Sanggau, Kalimantan Barat	PIP	PIP	STOKER	Ck Sawit, Tankos	PKS, EKN, MJC	
10	Barru	2	100	Lampoko, Kec. Balusu, Kab. Barru, Sulawesi Selatan	PIP	PIP	CFB	Sawdust, Woodpellet	CV Mandiri Jaya, PT Lakulasse, PT MAP	
11	Pangkalan Susu	4	220	Tj Pasir, Kec. Pangkalan Susu, Kab. Langkat, Sumatera Utara	PIP	PIP	PC	Sawdust	ADC, PBM, BES	
12	Ombilin	2	200	Sijantang Koto, Kec. Talawi, Kota Salahwunto, Sumatera Barat	PIP	PIP	PC	Sawdust	ADC, KDM	
13	Teluk Sirih	2	224	Tlk. Kabung Tengah, Kec. Bungus Tlk Kabung, Kota Padang, Sumatera Barat	PIP	PIP	CFB	Sawdust, Woodchip	ADC, RHJ, KDM	
14	Bengkayang (Kalbar 3)	2	100	Sungai Raya Kepulauan, Kab. Bengkayang, Kalimantan Barat	PIP	PIP	CFB	Sawdust, Tankos	SKM, EKN	
15	Berau	2	14	Tlk. Bayur, Kec. Tlk Bayur, Kab. Berau, Kalimantan Timur	PIP	PIP	STOKER			
16	Labuhan Angin	2	230	Tapian Nauli I, Kec. Tapian Nauli, Kab. Tapanuli Tengah, Sumatera Utara	PIP	PIP	CFB	Woodchip	BWSM, BES	
17	Tanjung Balai Karimun	2	14	Tebing, Kec. Tebing, Kab. Karimun, Kepulauan Riau	PIP	PIP	STOKER			
18	Paiton 1-2	2	800	Kec. Paiton, Kab. Probolinggo, Jawa Timur	PNP	PNP	PC	Sawdust	PT RMG, PT Eksekutif, PT BIM	
19	Paiton 9	1	660	Kec. Paiton, Kab. Probolinggo, Jawa Timur	PNP	PNP	PC	Sawdust	PT Arjuna, PT Barokah Jaya, PT Eksekutif	
20	Indramayu	3	990	Kec. Sukra, Kab. Indramayu, Jawa Barat	PNP	PNP	PC	Sawdust	PT BRI, PT Wahana Ijo, PT DPA	
21	Rembang	2	630	Kec. Sluke, Kab. Rembang, Jawa Tengah	PNP	PNP	PC	Sawdust	PT Best YPK, PT BRI	
22	Pacitan	2	630	Kec. Sudimoro, Kab. Pacitan, Jawa Timur	PNP	PNP	PC	Sawdust	PT Best YPK, PT Brahma Esatama, PT Putra	
23	Tj Awar Awar	2	700	Kec. Jenu, Kab. Tuban, Jawa Timur	PNP	PNP	PC	Sawdust	PT Best YPK, PT BRI, CV Barokah, PT Wijaya S	
24	Pulang Pisau	2	120	Kec. Kahayan Hilir, Kab. Pulang Pisau, Kalimantan Tengah	PNP	PNP	CFB	Woodchip	PT Manata Gawe Sabumi	
25	Tarahan	2	200	Kec. Katibung, Kab. Lampung Selatan, Lampung	PNP	PNP	CFB	Woodchip	PT Bintang Sejati Utama, PT Tiara Anugrah	
26	Sebalang	2	200	Kec. Katibung, Kab. Lampung Selatan, Lampung	PNP	PNP	CFB	Woodchip	PT EMI, PT BSU, PT Rekadaya Samitra	
27	Bukit Asam	4	260	Lawang Kidul, Kab. Muara Enim, Sumatera Selatan	PNP	PNP	PC	Sawdust	CV Tiara Anugrah Lestari, CV KASENDA	
28	Punagaya	2	220	Bangkala, Kab. Jeneponto, Sulawesi Selatan	PNP	PNP	CFB	Bonggol Jagung, Sekam Padi	PT SHM, CV Penggilingan Padi Haspa Jaya	
29	Anggrek	2	55	Anggrek, Kab. Gorontalo Utara, Gorontalo	PNP	PNP	CFB	Ck Sawit	PT SHM	
30	Ampana	2	6	Ampana Tete, Kab. Tojo Una-Una, Sulawesi Tengah	PNP	PNP	STOKER	Woodchip		
31	Nii Tanasa Kendari (1-2)	3	36	Lalonggasumeeto, Kab. Konawe, Sulawesi Tenggara	PNP	PNP	STOKER	Ck Sawit, Woodchip	PT Puyaka Jaya Konawe	
32	Amurang	2	50	Tenga, Kab. Minahasa Selatan, Sulawesi Utara	PNP	PNP	CFB	Woodchip	PT SHM	
33	Tenayan	2	220	Kec. Tenayan Raya, Kota Pekanbaru, Riau	PNP	PNP	CFB	Woodchip, Sekam Padi	PT Marela Sukses Prima, PT Prima Khatulistiwa	
34	Ketapang	2	20	Delta Pawan, Kab. Ketapang, Kalimantan Barat	PNP	PNP	CFB	Ck Sawit	PT Prima Khatulistiwa Energi	
35	Tembilahan	2	14	Tembilahan, Kab. Indragiri Hilir, Riau	PNP	PNP	STOKER	Woodchip	CV Tiara Anugrah Lestari	
36	Balikpapan	2	220	Balikpapan, Kota Balikpapan, Kalimantan Timur	PNP	PNP	CFB	Woodchip	PT AW Technology	
37	Nagan Raya	2	220	Kec. Kuala Pesisir, Kab. Nagan Raya, Aceh	PNP	PNP	CFB	Ck Sawit, Sekam Padi, Sawdust	PT Palma Banna, PT Kurma Karya Global	
38	Jeranjang	3	75	Dusun Jeranjang, Desa Taman Ayu, Kab. Lombok Barat, NTB	UIW NTB	PIP	CFB	Woodchip, SRF, Sawdust, LRUK	PT SRM, PT BBM, PT PBA, PT BMRS, DLHK TPA Kebun Kongok	
39	Sumbawa Barat	2	17	Desa Kertasari, Taliwang, Kab. Sumbawa Barat, NTB	UIW NTB	UPK TAMB	STOKER	Bonggol Jagung, Woodchip, Briket	PT MAP, PT SRM	Go live pada 20 Mei 2022 Tongkol Jagung
40	Holtekamp	2	20	Holtekamp, Muaratami, Jayapura	UIW P2B	PIP	STOKER	Woodchip	PT PLN EPI QQ, PT Surya Muda Laksana	Go live pada Juni 2023, jenis biomassa Woodchip
41	Tidore	2	14	Desa Rum Balibunga, Kec. Tidore Utara, Kota Tidore Kep., Maluku Utara	UIW MMU	PNP	STOKER			
42	Ropa	2	14	Trans Utara Ende KM67, Ropa, Maurole, Kab. Ende, NTT	UIW NTT	PNP	STOKER	Pellet	PT Gama Energi Persada	Cangkang kemiri dan pellet
43	Bolok	2	33	Kuanheum, Kupang Barat, Kupang, NTT	UIW NTT	PNP	CFB	Woodchip	PT Timor Bio Energi	Woodchip
44	Suge Belitung	2	33	Desa Suge Pegantungan, Belitung	UIW BABE	PNP	CFB	Woodchip	CV Tiara Anugerah Lestari, PT Belindo Agro Makmur	Woodchip
45	Air Anyir	2	60	Desa Air Anyir, Kec. Merawang, Kab. Bangka, Bangka Belitung	UIW BABE	PNP	CFB	Woodchip	PT Bakti Energi Sejahtera	Woodchip
46	Malinau	2	6	Malinau Utara, Kab. Malinau, Sulawesi Tenggara	MKIT	PNP	STOKER			
47	Nii Tanasa Kendari 3	1	10	Lalonggasumeeto, Kab. Konawe, Sulawesi Tenggara	MKIT	PNP	STOKER			
48	Lontar Extension	1	315	Lontar, Kec. Kemiri, Kab. Tangerang, Banten	MKIT	JIP	PC			
49	Sulsel Barru 2	1	110	Lampoko, Kec. Balusu, Kab. Barru, Sulawesi Selatan	MKIT	PIP	PC			
50	Sofifi	2	6	Oba Utara, Kota Tidore Kep., Maluku Utara	UIW MMU	JIP	STOKER			
51	Lombok FTP2	2	100	Desa Padak Guar, Kec. Sambelia, Lombok Timur, NTB	UIW NTB	JIP	PC			
52	Kalselteng	2	200	Asri Mulia, Kec. Jorong, Kab. Tanah Laut, Kalimantan Selatan	MKIT	JIP	PC			