MY_TRG_BIOGAS_Q2/24

Document prepared by Carbon Vault Sdn Bhd

Name of the project	MY_TRG_BIOGAS_Q2/24
Project holder	Carbon Vault Sdn Bhd
Project holder's contact information	Email: faris@co2bank.asia Tel: +6011-5738 0887 Address: Lorong Kurau, Bangsar, 59100 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur.
Project participants	Project Participant: Ladang Rakyat Terengganu Sdn Bhd Project Holder: Carbon Vault Sdn Bhd
Version	1.0
Date	12th March 2024
Project type	Other Project Activities
Grouped project	This project articulates the classification of MY_TRG_BIOGAS_Q2/24, which is not a grouped project. Instead, it is an independent GHG project with a well-defined and transparent scope, a solid and conservative baseline, and a strict and dependable sampling technique. Within its established limitations or scope, the project clearly excludes the integration or authorization of subgroups or independent initiatives.
Applied Methodology	AMS-III.H. : Methane Recovery in Wastewater Treatment, Version 19

Project location (City, Region, Country)	- Bandar Cheneh Baru, Kemaman, Terengganu - 4° 08’ 48.8” , 103° 13’ 22.4” - 284 km from central office in Bangsar, Kuala Lumpur
Starting date	1st October 2023
Quantification period of GHG emissions reduction	**Project Activity Instance**: 7 years with the option to renew two times. 1/10/2023 - 5/10/2030
Estimated total and average annual GHG emission reduction amount	Total estimated GHG emissions reductions: - Project Activity : **280,834.40 tCO2e** Average annual GHG reductions: - Project Activity : **40,119.20 tCO2e/year**
Sustainable Development Goals	Project complies with several Sustainable Development Goals (SDGs), including: SDG 7 - Affordable and Clean Energy: Projects contribute to clean and affordable energy. SDG 11 - Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable: Projects contribute to safe, resilient and sustainable human settlements. SDG 12 - Responsible Consumption and Production: Project contributes to more responsible consumption and production. SDG 13 - Climate Action: The project contributes to carbon offset initiatives, demonstrating its commitment to addressing the global challenge of climate change.
Special category, related to co-benefits	Non-applicable

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1 Project Details

1.1 Summary Description of the Project

Description of the Project Activity - Individual Project

The Individual Project encompasses various initiatives focused on implementing systems to recover, flare, or utilize biogas from industrial wastewater in Malaysia. Its primary goal is to reduce greenhouse gas emissions originating from industrial wastewater sources by capturing biogas that would otherwise be released into the atmosphere during baseline wastewater treatment processes.

This initiative will introduce three integrated systems specifically designed for capturing and harnessing methane. These systems comprise a biogas digester system, a biogas treatment system, and a power generation system, as illustrated in accompanying documentation. It is noteworthy that the discharge of wastewater and the handling of sludge will remain unchanged compared to the pre-project scenario.

The Ladang Bukit Bandi Palm Oil Mill operates as an established facility, processing approximately 27.4 metric tons per hour or 240,000 metric tons per year of Fresh Fruit Bunches (FFB). This processing generates a significant volume of wastewater with high organic content, as indicated by its Chemical Oxygen Demand (COD). The current wastewater treatment system comprises 15 ponds, three of which operate under anaerobic conditions (i.e., exceeding 2 meters in depth). In anaerobic environments, COD breakdown releases methane emissions into the atmosphere. This scenario predates the implementation of the initial Project Activity Instance (PAI).

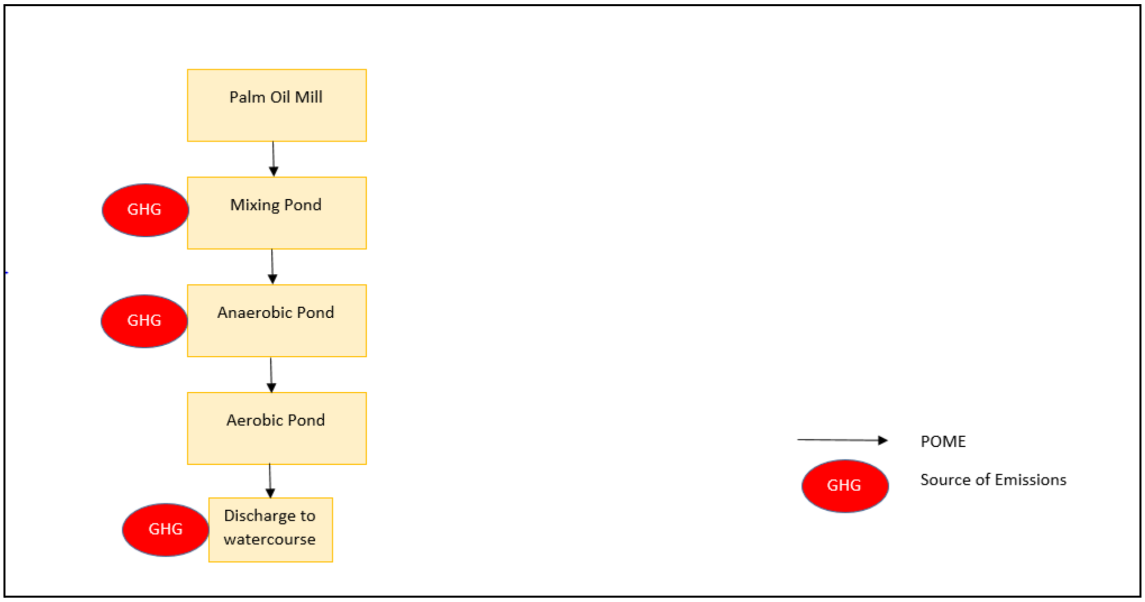

Figure 1: PAI Schematic Diagram (Existing)

PAI will implement three integrated systems to capture and utilize methane: a biogas digester system, a biogas treatment system, and a power generation system, as depicted in the accompanying documentation. The discharge of wastewater and the management of sludge will remain unchanged compared to the pre-PAI situation.

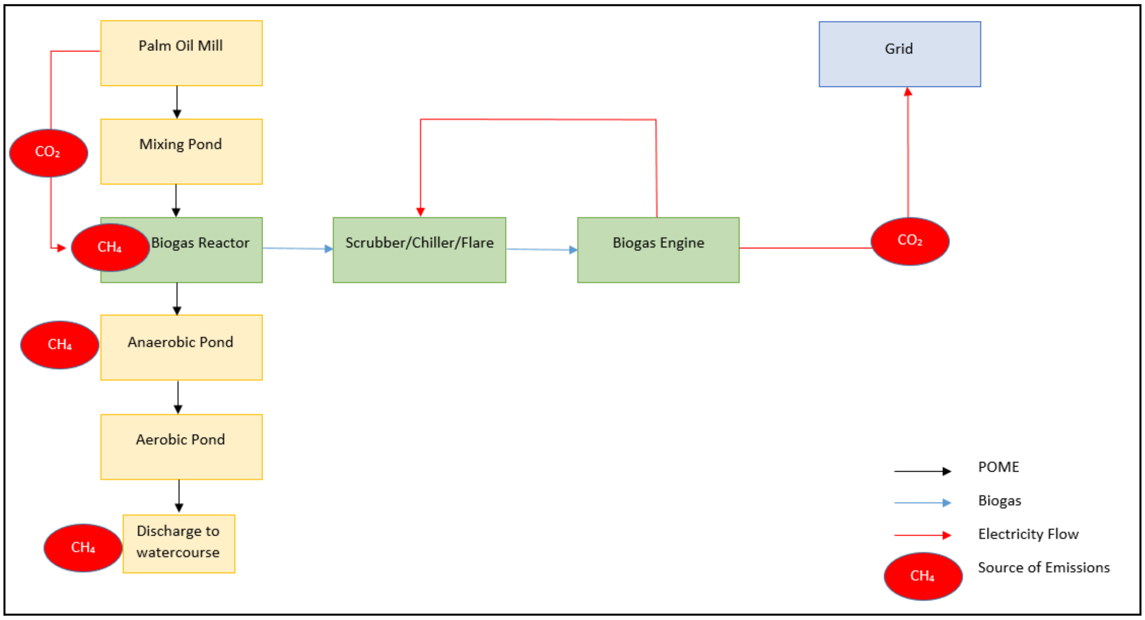

Figure 2: PAI Schematic Diagram (Project)

PAI will include these following technologies:

1. An anaerobic digester - The Biogas Reactor dimensions measure approximately 130m X 64m X 7m in depth, providing an effective volume of 42,032 m³ and spanning an area of 2 hectares. It incorporates an in-ground pond and a covered High Density Polyethylene Geomembrane (HDPE) with a top thickness of 2 mm and bottom thickness of 1 mm. This membrane serves both as a biogas storage facility and as a cover for the reactor. The biogas storage capacity reaches up to 21,000 m³. The hydraulic retention time stands at 35 days. Additionally, the reactor is equipped with hydraulic sludge mixers and an integrated sludge removal system within the digester.
2. Biogas treatment system - This comprises a pair of scrubbers model OREC GREEN02 along with a dehumidifier and chiller brand Hyperchill model ICE150. Two biological scrubbers, each with a capacity of 1,000m³/hr, are employed to oxidize hydrogen sulfide (H2S) into sulfate. The outcome of this scrubbing process is purified biogas with H2S content reduced to below 200 ppm. Subsequently, the biogas undergoes treatment in a dehumidifier/chiller system to decrease its water content from 100% to 50% and to cool it to a suitable temperature for use in the biogas engine. An open flare is also installed as a safety measure if the production of biogas exceeds certain limits.

3. Biogas engine - Two sets of INNIO JENBACHER biogas engine model Type 4: J 416 B, which has a gross electrical output of 1,202 kW each are installed at Loji Biogas Ladang Bukit Bandi. (Note that emissions reductions resulting from the operation of the biogas engine to replace grid-supplied electricity are not accounted for in this Project Activity Instance (PAI).)
4. Control and monitoring system – All essential parameters required for the operation and management of the biogas plant are consolidated within a Supervisory Control and Data Acquisition (SCADA) system.

1.2 GHG Project Name

Throughout the entire documentation and registration process, this GHG project will be referred to as "MY_TRG_BIOGAS_Q2/24".

1.3 Scope in the BCR Standard

The scope of the BCR Standard is limited to:	
The following greenhouse gases, included in the Kyoto Protocol: Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O).	X
GHG projects using a methodology developed or approved by BioCarbon Registry, applicable to GHG removal activities and REDD+ activities (AFOLU Sector).	
Quantifiable GHG emission reductions and/or removals generated by the implementation of GHG removal activities and/or REDD+ activities (AFOLU Sector).	
GHG projects using a methodology developed or approved by BioCarbon Registry, applicable to activities in the energy, transportation and waste sectors.	X
Quantifiable GHG emission reductions generated by the implementation of activities in the energy, transportation and waste sectors.	X

The MY_TRG_BIOGAS_Q2/24 project conforms to the AMS-III.H standard, rigorously adhering to approved methodologies to reduce greenhouse gas emissions and uphold ecological integrity. This alignment enhances the project's environmental reputation and bolsters its credibility in the carbon credit market.

Compliance with AMS-III.H demonstrates a steadfast commitment to environmental responsibility and the preservation of ecosystems and biodiversity. The project's dedication to sustainable practices garners recognition and esteem within both financial and environmental sectors, augmenting the environmental value of its generated carbon credits.

Moreover, AMS-III.H compliance transcends mere financial incentives, prioritizing authentic environmental conservation. This approach resonates with a diverse array of stakeholders who prioritize sustainability and environmental well-being. By adhering to this standard, the project attracts socially conscious investors, fostering a collective dedication to environmental conservation and stewardship.

In summary, the MY_TRG_BIOGAS_Q2/24 project's adherence to AMS-III.H underscores its substantial contribution to a sustainable and ecologically balanced future.

1.4 Project Type

Activities in the AFOLU sector, other than REDD+	
REDD+ Activities	
Activities in the energy sector	
Activities in the transportation sector	
Activities related to handling and disposing of waste	X

1.5 Project Scale

The Project Activity Instance (PAI) will generate electricity with a capacity under 15 MW, leading to annual emissions reductions of less than 60 ktCO2e. Following the guidelines outlined in Appendix B, "Simplified Modalities and Procedures for Small-Scale CDM Project Activities," the project belongs to the following type/category:

Sectoral Scope	13	Waste Handling and Disposal
Type	III	Other Project Activities
Category	AMS-III.H	Methane Recovery in Wastewater Treatment
Version	19	

1.6 Project Holder

Individual or organization	Carbon Vault Sdn Bhd
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1.7 Other Project Participants

Individual or organization	Ladang Rakyat Terengganu Sdn Bhd
Contact person	Ts. Mohd Shazwan Afiq bin Mohd Roffi
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1.8 Project Objectives

This GHG project within a carbon credit framework aims to actively combat climate change by engaging in activities that result in measured and verifiable reductions in greenhouse gas emissions.

Objectives:

1. **Mitigate Climate Change**: Biogas production from organic waste aids in climate change mitigation by curbing emissions of methane (CH_4), a potent greenhouse gas. Methane arises from the decomposition of organic matter in landfills or wastewater treatment plants. By capturing and converting methane into biogas, the process offsets emissions that would otherwise exacerbate global warming.

2. **Assessment of Carbon Sequestration Impact**: Although biogas production doesn't directly sequester carbon, it indirectly aids carbon removal endeavors by displacing fossil fuels. Substituting traditional fossil fuels such as coal or natural gas with biogas for electricity generation diminishes the emission of carbon dioxide (CO_2) into the atmosphere. Assessing the carbon offsetting effect of biogas production entails comparing the emissions avoided through biogas utilization with the emissions that would have resulted from fossil fuel usage.

3. **Promote Sustainable Land Use Practices**: Biogas production promotes sustainable waste management practices by diverting organic waste from Palm Oil Mill Effluent (POME), which can emit methane and other detrimental pollutants into the atmosphere. Moreover, the organic byproducts of biogas production, such as digestate, can serve as nutrient-rich fertilizer for agricultural applications, enhancing soil health and diminishing reliance on synthetic fertilizers.

4. **Community Engagement and Socio-economic Impact Assessment**: Biogas projects frequently entail community involvement, particularly in decentralized or community-scale systems. Collaborating with local communities guarantees equitable distribution of the benefits of biogas production, including enhanced waste management, job opportunities, and access to clean energy. Socio-economic assessments

aid in evaluating the project's comprehensive impact on local livelihoods and economic resilience.

5. **Biodiversity Conservation and Habitat Protection**: Although not directly tied to biogas production, sustainable waste management practices linked with biogas projects can indirectly support biodiversity conservation and habitat protection. By decreasing dependence on landfills and mitigating pollution from organic waste, biogas production aids in preserving natural ecosystems and curtailing habitat degradation.

6. **Align with Sustainable Goal Development (SDGs)**: Biogas production aligns with multiple Sustainable Development Goals (SDGs), notably SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). By incorporating environmental, social, and economic factors into biogas project planning and execution, stakeholders can optimize the beneficial effects on sustainable development objectives.

Overall, biogas production plays a significant role in carbon removal efforts by reducing methane emissions, promoting sustainable waste management practices, and contributing to the transition to a low-carbon economy.

1.9 Description of Project Activity

The focus of the MY_TRG_BIOGAS_Q2/24 projects is on mitigating greenhouse gas (GHG) emissions by enhancing carbon sequestration in biogas plants. The project interventions have led to reductions in GHG emissions, underscoring the effectiveness of the employed technologies and strategies. Field supervisors conducted an initial survey to assess and strategize for this purpose:

1. **Site Selection and Planning**

Just as in reforestation projects, selecting appropriate sites for biogas production facilities is crucial. Factors such as proximity to organic waste sources, availability of suitable technology infrastructure, and regulatory considerations need to be assessed. Choosing optimal locations ensures efficient biogas production and maximizes the utilization of organic waste resources, thus contributing to carbon removal by diverting methane emissions from landfills.

2. **Identification of Tree Species & High-Impact Areas**

While biogas production doesn't involve planting trees, it does involve selecting feedstock sources that have high methane generation potential. Similar to selecting tree species for carbon sequestration, identifying organic waste streams rich in biodegradable materials helps maximize methane capture and conversion to biogas. This ensures that biogas projects focus on areas where they can have the most significant impact on reducing methane emissions, contributing to carbon removal efforts.

3. **Biodiversity and Ecological Considerations**

Although not directly applicable to biogas production itself, considering biodiversity and ecological factors is essential in ensuring sustainable waste management practices. Biogas projects should prioritize organic waste streams that minimize negative environmental impacts, such as contamination of soil and water bodies. By choosing environmentally friendly feedstock sources, biogas projects can support biodiversity conservation indirectly while focusing on methane emission reduction.

4. **Identification of Risk Assessment**

Assessing potential risks and problems in biogas production, such as feedstock contamination, process inefficiencies, or equipment failures, is crucial for project success. Mitigation strategies, such as implementing quality control measures, improving waste handling practices, and investing in backup systems, help minimize disruptions and ensure continuous biogas production. By addressing potential risks proactively, biogas projects can enhance their effectiveness in mitigating methane emissions and contributing to carbon removal.

5. **Community Engagement and Stakeholder Involvement**

Engaging with local communities and stakeholders is vital for the success of biogas projects. Building relationships and understanding community perspectives ensure that biogas projects address local needs and concerns effectively. Involving stakeholders in project planning and decision-making fosters support and participation, leading to smoother project implementation and long-term sustainability. Additionally, community involvement can help identify suitable organic waste sources and ensure their consistent supply for biogas production, enhancing the project's contribution to methane emission reduction and carbon removal.

6. **Legal and Regulatory Compliance**

Like reforestation projects, biogas projects must comply with legal and regulatory requirements related to waste management, environmental protection, and energy production. Obtaining necessary permits and adhering to relevant regulations is essential for ensuring the legality and legitimacy of biogas operations. Compliance with legal requirements also helps mitigate potential risks and conflicts, ensuring the long-term viability and success of biogas projects in contributing to methane emission reduction and carbon removal goals.

Overall, incorporating these activities into biogas project planning and implementation enhances the effectiveness of methane emission reduction efforts and contributes to carbon removal by utilizing organic waste resources efficiently and sustainably.

1.10 Project Location

Geographic area for the Individual Project

Project Activity Instance conducted within Malaysia's borders may be incorporated into and considered part of this Individual Project. Geodetic coordinates are supplied in a KML file for reference.

Geographic area for PAI

The PAI is located at Ladang Rakyat Terengganu, specifically Ladang Bukit Bandi, within the state of Terengganu, Malaysia. It is approximately 284 kilometers northwest of Kuala Lumpur. The geographical coordinates for the site are 4° 08’ 48.8” latitude and 103° 13’ 22.4” longitude. Please refer to the figure below for the exact location of the site.

Figure 3: Location of PAI at Ladang Bukit Bandi, Terengganu.

1.11 Conditions Prior to Project Initiation

The conditions that existed prior to the PAI initiation are the same as described in the baseline scenario (3.4).

1.12 Compliance with Laws, Statutes and Other Regulatory Frameworks

Individual Project

Each additional PAI included in this Individual Project must adhere to all pertinent local, regional, and national laws, statutes, and regulatory frameworks.

PAI

The PAI adheres to the stipulations outlined in the local laws and regulations of Malaysia, with a focus on the following key aspects of relevance:

- Environmental Quality Regulations (Designated Premises) (Crude Palm Oil) 1977 – P.U.(A) 342/77 Regulation 6 - Making Changes that change the quality of the effluent
- Written Declaration on the Design and Construction of Air Pollution Control Systems [Regulation 7(5)] DOE ASPUB
- Construction Site Registration - DOSH JKJ 103
- Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977 - DOE
- Labor Act 1995

PAI has the necessary legal documents including:

- Licensing from the Energy Commission (Suruhanjaya Tenaga or ST).
- Registration of the construction site with the Malaysian Construction Industry Development Board (LPIPM) or CIDB and the Department of Occupational Safety and Health.

Additionally, as of January 2022, there are no specific regulations in Malaysia mandating the management of biogas from PAIs. However, a new condition was introduced in the criteria and guidelines for licensing applications by the Malaysian Palm Oil Board (MPOB). This condition requires new palm oil mills to install wastewater treatment systems capable of capturing biogas. The same requirement applies to existing mills seeking capacity extensions, with the exception of those mills that applied for extensions below 270,000 metric tons of fresh fruit bunches (FFB) per year, as of May 22, 2021. Ladang Bukit Bandi Palm Oil Mill (POM) falls under the category of existing mills and has not undergone any capacity expansions. Consequently, the new criteria do not apply to Ladang Bukit Bandi POM, and there is no obligation to recover and/or utilize the biogas produced.

1.13 Sustainable Development Goals (SDGs)

The Project Activity Instance complies with several Sustainable Development Goals (SDGs) , notably emphasizing SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

SDG 7: Affordable and Clean Energy

This project activity significantly contributes to achieving SDG 7 by harnessing renewable energy from anaerobic digestion, effectively capturing methane emissions to reduce reliance on fossil fuels and mitigate greenhouse gas emissions. This process optimizes organic waste management, diverting it from wastewater treatment plants to mitigate environmental pollution and associated health risks. Additionally, its decentralized nature facilitates rural electrification, enhancing energy access for remote communities and fostering socio-economic development. Overall, biogas recovery aligns with broader sustainable development objectives, addressing energy access, climate change mitigation, and environmental protection through innovative scientific and technical solutions.

SDG 11: Sustainable Cities and Communities

This project activity substantially contributes to SDG 11 by furnishing sustainable solutions for urban organic waste management, thereby mitigating environmental contamination and health hazards linked to conventional waste disposal practices. Through the capture of methane emissions via anaerobic digestion, biogas systems locally produce renewable energy, bolstering urban energy resilience and curtailing greenhouse gas emissions. The decentralized character of biogas production permits scalable deployment, empowering communities to govern their energy production and fortify urban sustainability. Additionally, biogas recovery underpins the transition to a circular economy by optimizing the value of organic waste streams, advancing resource efficiency and innovation in urban waste management strategies. In essence, biogas recovery acts as a catalyst for sustainable urban development, amalgamating waste management, renewable energy generation, and community engagement to cultivate resilient and environmentally aware cities.

SDG 12: Responsible Consumption and Production

The project is instrumental in advancing SDG 12 by promoting responsible consumption and production practices through the valorization of organic waste streams. By diverting organic waste from conventional disposal methods like landfills or incineration and subjecting it to anaerobic digestion, biogas systems efficiently convert biodegradable materials into renewable energy resources like methane-rich biogas and nutrient-rich biofertilizers. This process not only mitigates the environmental impact associated with waste disposal but also fosters resource efficiency by closing the loop on organic material utilization within a circular economy framework. Moreover, biogas recovery optimizes energy and resource utilization, promoting sustainable production processes and consumption patterns conducive to long-term environmental stewardship and socio-economic development.

SDG 13: Climate Action

The project is a key strategy for achieving SDG 13 by mitigating climate change impacts through the reduction of greenhouse gas emissions. Through anaerobic digestion, biogas systems capture methane emissions from organic waste, preventing their release into the atmosphere where they would exacerbate global warming. By converting methane into biogas, a renewable energy source, biogas recovery not only reduces reliance on fossil fuels but also displaces emissions from traditional energy sources, further lowering the carbon footprint. Additionally, integrating biogas systems into waste management practices promotes sustainable solutions for organic waste disposal, addressing both methane emissions and the overall carbon intensity of waste management processes. Overall, biogas recovery represents a crucial climate action strategy, aligning with the goal of limiting global temperature rise and enhancing resilience to climate change impacts.

1.14 Climate Change Adaptation

In compliance with the BioCarbon Registry (BCR) Standard, this document describes MY_TRG_BIOGAS_Q2/24 project as climate change adaptation activities resulting from GHG project operations. The chosen adaptation measures are consistent with the relevant criteria and indicators provided by the BCR Standard.

Table : Adaptation Criteria and Indicators for Industrial Wastewater:

	Criteria	Indicator
Climate Resilience of Infrastructure	The infrastructure for biogas recovery and utilization is designed to withstand climate-related hazards.	• Incorporate the flood-resistant design features and elevate the critical components to minimize flood risk. • Implement the backup systems for uninterrupted operation during extreme weather events.
Diversification of Energy Sources	The project contributes to diversifying energy sources and reducing reliance on fossil fuels.	• Determine the proportion of energy that comes from biogas in comparison to other renewable and non-renewable energy sources. • Biogas utilization leads to a reduction in fossil fuel consumption.
Policy and Regulatory Support	Supportive policies and regulations incentivize climate-resilient biogas projects.	• Alignment of project activities with national climate mitigation and adaptation goals. • Compliance with relevant environmental regulations and standards for biogas projects.

By incorporating these criteria and indicators, PAI owners can demonstrate their commitment to climate change adaptation activities within the framework of utilizing biogas from industrial wastewater.

1.15 Additional Information about the GHG Project

Leakage Management

No leakage is accounted for under the methodology AMS-III.H version 19 and thus leakage is not relevant to this Individual Project or to Project Activity Instance 1.

Commercially Sensitive Information

- Individual Project

There will be no other PAIs added to this Individual Project, hence there is no need to identify the items for which commercially sensitive information has been withheld from the public version of the Project Description.

- PAI

This is not applicable to PAI as there is no commercially sensitive information that is or needs to be excluded from the public of the project description.

2 Safeguards

2.1 Environmental Aspects

The project carried out an environmental assessment, examining the potential impacts on biodiversity and ecosystems within the project's boundaries. The environmental assessment is supported by credible and current references, such as the initial survey data collection form, which was fully completed by our field supervisor, as well as inquiries concerning the power plant from project participants.

The environmental assessment has found that the PAI have mostly **positive impacts** on biodiversity and ecosystems, such as:

- Ladang Bukit Bandi Biogas Plant has been designed as a treatment plant at an existing degraded palm oil field.

- Industrial wastewater from palm oil mills, which contains high levels of organic pollutants, is treated by diverting it to a biogas plant for treatment and energy generation. This reduces pollution load on water bodies, resulting in improved water quality and a healthier aquatic environment.

- The project contributes to the conservation of freshwater resources that would otherwise be used for traditional wastewater treatment or released into aquatic bodies.

- Biogas generated by anaerobic digestion of palm oil mill wastewater can be used as a sustainable energy source for electricity generation or as a substitute for fossil fuels.

- Anaerobic digestion in the biogas plant breaks down organic matter and releases nutrients that can be utilized as fertilizer for crops or plants. By recycling nutrients, the biogas plant improves soil fertility and ecosystem production.

The environmental assessment has also identified some potential **negative impacts** of the PAI, such as:

- The construction and operation of biogas plants may lead to habitat destruction or alteration, particularly if natural areas are cleared or modified to accommodate the facilities.
- Improper handling or disposal of waste materials from biogas plants or palm oil mills, such as sludge or ash, can result in soil contamination which can affect soil quality and fertility.

The project has proposed the following **actions and corrective measures** to manage and minimize the impacts resulting from the development of the GHG project activities, such as:

- To minimize habitat degradation, the project chooses to locate biogas facilities in places that have already been disturbed or degraded, such as brownfield sites or palm oil plantations with little ecological value.

- The project implemented proper waste management practices to minimize the generation of waste materials from biogas plants and palm oil mills.

- The biogas plant developed and implemented protocols for the safe handling, storage, and disposal of waste materials, such as sludge and ash, to prevent soil contamination.

In order to demonstrate that the project activities cause no net harm to the environment, the project holder has used a No Net Harm tool developed by the BioCarbon Registry. The tool provides a framework for assessing the environmental impacts and risks of the project activities, and for developing and implementing the environmental safeguards and mitigation measures.

2.2 Socio-economic aspects

The project conducted an analysis of the potential socioeconomic impacts of the activities within the project's scope, outlining the assumptions utilized and justifying the results of the analysis. The analysis is supported by credible and current sources, such as our field supervisor's full completion of the initial survey data collection form as well as inquiries concerning the power plant from project participants.

The analysis has found that the PAI have mostly **positive impacts** on the socio-economic aspects, such as:

- The development and operation of biogas facilities necessitate a staff for a variety of jobs such as engineering, construction, maintenance, and operations. This generates job opportunities in local communities, which contributes to regional employment and economic development.

- Biogas plant operations can provide additional revenue streams for palm oil mill owners or operators by selling biogas, energy, or byproducts such as organic fertilizers created during the anaerobic digestion process.

- Biogas generation from industrial wastewater offers an alternative and renewable energy source, lowering reliance on fossil fuels and increasing energy security.

The analysis has also identified some potential **negative impacts** of the project activity, such as:

- Employee health and safety concerns about exposure to air pollutants or contaminated water could lead to respiratory ailments or other health difficulties, resulting in increased healthcare expenditures and productivity losses.

- Increased investment and resources connected with biogas plant construction may cause changes in local economic dynamics. Inflationary pressures, changes in land prices, or increasing competition for resources may all disadvantage local businesses or communities.

The project has proposed the following **actions and corrective measures** to prevent and reduce the socio-economic impacts resulting from the development of the GHG project activity, such as:

- The project has adopted thorough occupational health and safety standards to reduce employee exposure to air pollutants and contaminated water. This includes providing personal protective equipment (PPE), frequently evaluating air quality, and ensuring adequate ventilation systems are in place.

- The project provides adequate training and instruction to personnel on the potential health hazards connected with exposure to pollutants and polluted water, as well as proper safety practices to limit these risks.

- The project used community involvement and stakeholder consultation techniques to involve local businesses and communities in decision-making and resource allocation for the biogas plant.

- Monitor and analyze the biogas plant's socio-economic impacts over time, and alter mitigating measures to address any new difficulties or possibilities.

To demonstrate that the project activities do no net harm to the environment, the project holder used the BioCarbon Registry's No Net Harm tool. The tool provides a framework for assessing the environmental impacts and hazards associated with project activities, as well as planning and executing environmental safeguards and mitigation measures.

2.3 Risk management

The projects have conducted risk assessments and risk management to identify the environmental, financial, and social risks associated with the project's activities, as well as to justify the risk-management measures designed to ensure that GHG emission reductions and/or removals are maintained throughout the project quantification period. The project adhered to the ISO 31000 risk management requirements and best practices.

The PAI identified the following risks in the environmental, financial, and social dimensions, and offered the following management measures:

a) Environmental Risks:

These are the potential natural and anthropogenic risks to which the GHG mitigation activities may be exposed, including water pollution, air pollution, habitat damage, and soil contamination. These threats have the potential to degrade water and air quality, destroy or change habitats, and damage soil quality and fertility.

The project has assessed the likelihood and impact of these risks, and has developed the following measures to mitigate them:

- Implement robust wastewater treatment systems to ensure that contaminants are effectively removed from wastewater before it is used to produce biogas.
- Regularly monitor and maintain treatment systems to prevent environmental pollution.
- Conduct environmental impact assessments to identify potential implications on biodiversity and ecosystems, and then develop mitigation strategies accordingly.

a) Financial Risks:

These are the potential financial risks related to the project's estimated costs and revenue. Operational costs associated with wastewater treatment, maintenance, energy consumption, and labor can all have an impact on the project's financial sustainability. Furthermore, volatility in palm oil and energy commodity prices might have an impact on biogas production revenue, thereby affecting the project's profitability.

The project has assessed the probability and magnitude of these risks, and has developed the following measures to mitigate them:

- Conduct detailed cost-benefit assessments and feasibility studies to appropriately analyze project costs and possible returns on investment (ROI).
- Implement effective project management and monitoring methods to keep costs under control and detect any cost overruns early.
- Examine market conditions and potential risks involved with the sale of biogas and byproducts, such as fluctuates in energy prices or demand.
- Diversify revenue streams and look into long-term contracts or partnerships to reduce market volatility.

b) Social Risk:

These are the potential social risks associated with local community and stakeholder participation in project owner-proposed activities, such as exposure to air pollution or contaminated water, which might endanger workers and adjacent people. Negative effects on local communities, such as pollution, noise, or disruption of livelihoods, might strain relationships and lead to conflict or opposition to the project. Furthermore, the project may provide jobs, but if not properly managed, it can also result in labor disputes, poor working conditions, or labor exploitation.

The project has assessed the frequency and severity of these risks, and has developed the following measures to mitigate them:

- Prioritize staff health and safety by implementing extensive training, safety measures, and regular monitoring. Address concerns about air and water quality in order to protect the health of workers and adjacent populations.
- Engage with local communities and stakeholders throughout the project's lifecycle to address issues, establish trust, and foster beneficial connections. Create grievance procedures to respond to community complaints and input promptly.

- Maintain transparency and accountability in project activities in order to gain and keep a social license to operate. Respect local customs, traditions, and land rights, and emphasize local hiring and procurement to help the community grow.

2.3.1 Reversal Risk

The MY_TRG_BIOGAS_Q2/24 project has remained a carbon removal project that necessitates a comprehensive approach that includes legal agreements, contractual clauses, and a strong management plan to reduce the risk of reversion. Referring to the BCR webpage and utilizing the "Risk and Permanence" tool, essential actions performed to assure the lifespan of PAI by:

- **Legally Agreements and contracts:**

  Establish clear and legally binding land use agreements that specify that the selected area will only be reserved for carbon removal projects. This helps to prevent the property from being converted for other purposes, which could weaken the project's carbon sequestration goals. Contracts with stakeholders, including project developers, investors, and carbon offset buyers, should outline the terms and conditions of the carbon offset project. This can include the duration of the project and the responsibilities of each party.

- **Monitoring and Verification:**

  Create a system for regular monitoring and verification of carbon sequestration levels. This includes conducting impartial third-party audits to monitor changes in carbon stocks, biogas generation, and overall project performance. Remote sensing technology, on-site surveys, and other monitoring techniques should be performed. It also contains aspects of the management plan that allow for modifications based on monitoring data.

- **Management Plan:**

Create a detailed management strategy that explains the project's objectives, major achievements, and the measures required to maintain and improve carbon sequestration over time. Identify potential risks, including the risk of reversion, and design strategies to mitigate them. This could include regular maintenance, pest and disease control, and adaptive management strategies.

- **Financial Mechanisms:**

  Secure long-term financing commitments or endowments that can be used to cover continuing maintenance costs by establishing escrow accounts to keep funds specifically allocated for project maintenance, with disbursement restrictions tied to achieving established milestones. Implementing insurance policies also can provide financial protection against unforeseen events, such as natural disasters or fires, which could jeopardize the project's success.

- **Long-Term Contracts:**

  Establish contracts with entities that purchase carbon removal to assure a long-term commitment to the project. These contracts should detail the agreed-upon terms, such as the period of the offsetting commitment, pricing techniques, and consequences for noncompliance. Furthermore, these contracts include conditions requiring offset purchasers to give financial guarantees or insurance to cover the risk of reversion, guaranteeing that money is available for project maintenance.

2.4 Consultation with interested parties (stakeholders)

PAI

Ladang Rakyat Terengganu Sdn Bhd comprises six distinct palm oil plantations, each certified under the Malaysia Sustainable Palm Oil (MSPO) standards. Specifically, these certifications adhere to MS2530-3:2013 General Principles for Palm Oil Plantations and Organised Smallholders (effective January 8, 2020), covering a combined area of 14,561.636 hectares. Additionally, Kilang Sawit Bukit Bandi holds certifications under MSPO MS2530-4:2013 General Principles for Palm Oil Mills (effective January 8, 2020) and Malaysia Sustainable Palm Oil (MSPO) Supply Chain Certification (effective January 5, 2020).

The project conducted stakeholder consultations using appropriate and widespread consultation techniques. Stakeholder consultation is the process of engaging and communicating with relevant and affected stakeholders, such as plantation landowners, biogas plant management, environmental authorities, and civil society organizations, in order to apprise them about the project's objectives, activities, and benefits, as well as solicit feedback and suggestions for improvement.

The stakeholder consultation process meets the relevant requirements, as follows:

The scope of stakeholder consultations:

- Stakeholder engagements take place throughout the project cycle, from project design and implementation to monitoring and verification, benefit sharing, and grievance redress. The stakeholder engagements also cover essential themes and topics relevant to the project, such as additionality, baseline, leakage, permanency, environmental and social implications, and project safeguards.

The number of stakeholders consulted:

- The project consulted around 20 stakeholders for project activity, representing a varied and representative sample of relevant and affected groups. The project has made certain that stakeholder consultations are inclusive and participative, and that the perspectives and interests of underrepresented or disadvantaged groups, such as women, youth, and ethnic minorities, are fully acknowledged and respected.

The means used to invite interested parties to participate in the consultations:

- The project invited interested people to engage in the discussions through a variety of channels, including emails, phone calls, social media platforms, and in-person meetings. Furthermore, the programs have utilized local languages, media, and platforms to ensure that the invites are accessible and intelligible to stakeholders.

The information that was made available to stakeholders during the consultation process:

- During the consultation process, the projects provided stakeholders with relevant information and documentation, including the project design document, monitoring report, validation and verification reports, environmental and social impact assessment, and benefit-sharing and grievance redress mechanisms. The project has also supplied information and documentation in local languages, formats, and media to ensure that stakeholders can understand and be transparent about the situation.

The meetings, workshops and other processes developed in the framework of the stakeholder consultation:

- As part of the stakeholder consultation process, the project organized and facilitated informational meetings such as focus groups, surveys, interviews, field trips, and feedback sessions. The project has also guaranteed that meetings are held on time, with respect and cultural sensitivity, and that the outcomes and recommendations are documented and reported.

The project has provided documentary (or other) evidence to ensure that invitations were sent to relevant stakeholders. The evidence includes:

Figure 4: Meet and site visit with project participants and stakeholders from the Biogas Plant in Ladang Bukit Bandi.

2.5 Double counting avoidance

MY_TRG_BIOGAS_Q2/24 implements methods to prevent double counting, focusing on the ideas and requirements outlined in the BioCarbon Registry's "Avoiding Double Counting (ADC)" tool. The goal is to ensure that the accounting, issuance, and retirement of GHG reduction results meet the most stringent criteria while avoiding duplicative counting, which can jeopardize the environmental integrity and effectiveness of climate action and GHG accounting systems, as well as erode stakeholder and public trust.

Double Counting Avoidance Requirements:

- **Prohibition on Accounting**

MY_TRG_BIOGAS_Q2/24 closely adheres to the restriction on double-counting GHG reduction results. This necessitates thorough and precise reporting of emissions, ensuring that each metric tonne of emission reduction or removal is properly accounted for.

- **Prohibition on Issuance**

Carbon credit allocation is thoroughly reviewed to ensure that no duplicate occurs. Every credit granted means a clear and demonstrated reduction or elimination of emissions, and the technique adheres to the ADC tool's requirements.

- **Prohibition on Retirement**

The retirement of carbon credits is handled properly. MY_TRG_BIOGAS_Q2/24 project assures that retired credits are precisely related with verifiable emission reductions or removals, and they cannot be utilized for any form of reimbursement or assertion.

Application of BCR Tool "Avoiding Double Counting (ADC):

- **Transparent Documentation**

Throughout the project cycle, the MY_TRG_BIOGAS_Q2/24 project provides clear and detailed documentation. This involves detailed documentation of proven emission reductions or eliminations, as well as credit issuing and retirement. All documentation is provided for independent third-party verification.

- **Verification Process**

The ideas from the ADC tool are included into the verification process. The tool is used by independent third-party verifiers to assess whether a project follows the rules for avoiding duplicate counting. Any inaccuracies are properly investigated and corrected before carbon credits are granted.

Continuous Monitoring and Improvement:

- **Regular Audits**

Internal and external audits are conducted on a regular basis to examine the efficiency of procedures used to prevent duplicate counting. Any uncovered vulnerabilities are promptly addressed to ensure the project's integrity.

- **Stakeholder Awareness**

Stakeholders, including project participants, local communities, and investors, are educated about the need of minimizing duplicate counting. This understanding fosters a culture of accountability and ensures that everyone involved understands their role in preventing repeated tallying.

MY_TRG_BIOGAS_Q2/24 project is committed to maintaining the highest levels of integrity in its GHG mitigation initiatives. The initiative assures that each ton of emission removal is precisely accounted for, issued, and withdrawn only once by strictly applying the BCR Tool "Avoiding Double Counting (ADC)," which contributes to the BioCarbon Registry Program's credibility and transparency.

3 Application of Methodology

3.1 Quantification methodology

Project Activity Instance adhere to the methodology below:

Title of the Methodology: AMS-III.H Small-scale Methodology Methane Recovery in Wastewater Treatment, Version 19.0, Sectoral scope: 13.

3.2 Applicability conditions of the methodology

The scopes and applicability conditions for AMS-III.H. is tabulated as below:

Scopes & Applicability Conditions	Applicability to the PAI
As per paragraph 2 of AMS-III.H. This methodology involves implementing measures aimed at recovering biogas from biogenic organic material in wastewater through one or a combination of the following approaches: (a) Replacing aerobic wastewater or sludge treatment systems with anaerobic systems equipped for biogas recovery and combustion; (b) Integrating anaerobic sludge treatment systems with biogas recovery and combustion into wastewater treatment plants without sludge treatment; (c) Integrating of biogas recovery and combustion to a sludge treatment system; (d) Integrating biogas recovery and combustion into anaerobic wastewater treatment systems like anaerobic reactors, lagoons, septic tanks, or on-site industrial plants; (e) Introducing anaerobic wastewater treatment	Applicable PAI involves implementing a sequential phase of wastewater treatment with biogas recovery and combustion, without sludge treatment, into an anaerobic wastewater treatment system lacking biogas recovery, as outlined in option (f) under section 2.1 of AMS-III.H.

with biogas recovery and combustion, either with or without anaerobic sludge treatment, to untreated wastewater streams; (f) Introducing a sequential wastewater treatment stage with biogas recovery and combustion, with or without sludge treatment, to anaerobic wastewater treatment systems lacking biogas recovery (e.g. implementing treatment in an anaerobic reactor with biogas recovery as a subsequent treatment step for wastewater presently being treated in an anaerobic lagoon without methane recovery)	
As per paragraph 3 of AMS-III.H In cases where the baseline system comprises anaerobic lagoons, the methodology is applicable under the following conditions: (a) The lagoons are ponds with a depth of two (2) meters, without aeration. The depth value can be determined from engineering design documents, direct measurement, or by dividing the surface area by the total volume. If the lagoon's filling level fluctuates seasonally, the average of the highest and lowest levels may be used; (b) The ambient temperature remains above 150°C, at least during part of the year on a monthly average basis; (c) The minimum interval between two consecutive sludge removal events shall be 30 days	<u>Applicable</u> The project activity instance meets all applicability conditions: (a) The lagoons are ponds with a depth greater than two (2) meters, without eration. (b) Ambient temperature above 150C, at least during part of the year on a monthly average basis, (c) The minimum interval between two (2) consecutive sludge removal events shall be 30 days.
As per paragraph 4 of AMS-III.H The biogas recovered from the above measures can also be utilized for the following purposes instead of combustion/flaring:	<u>Applicable</u> The Project Activity Instance utilizes the biogas for the direct generation of electrical energy, although this is not

(a) Direct generation of thermal, mechanical, or electrical energy; (b) Generation of thermal, mechanical, or electrical energy after bottling of upgraded biogas. In this scenario, additional guidance outlined in Annex 1 must be adhered to; (c) Generation of thermal or mechanical, electrical energy after upgrading and distribution. In this case, additional guidance provided in Annex 1 should be followed: I. Upgrading and injecting biogas into a natural gas distribution grid without significant transmission constraints; II. Upgrading and transporting biogas through a dedicated piped network to a cluster of end users; or III. Upgrading and transporting biogas (e.g., via trucks) to distribution points for end users. (d) Hydrogen production; (e) Use as fuel in transportation applications after upgrading	considered for the purposes of claiming emission reductions, as stated below.
As per paragraph 5 of AMS-III.H If the recovered biogas is employed for project activities under paragraph 4(a), that component of the project activity can adopt a corresponding methodology under Type I	<u>Not Applicable</u> Although the captured methane will be utilized for generating renewable electricity, for which the approved Type I methodology, AMS-I.D., could be utilized to quantify emission reductions, this is not claimed by PAI.
As per paragraph 6 of AMS-III.H For project activities falling under paragraph 4(b), if bottles containing upgraded biogas are sold beyond the project boundary, it is necessary	<u>Not applicable</u> The project activity instance does not include the generation of thermal or mechanical electrical energy after the

to ensure the end use of the biogas through a contract between the bottled biogas vendor. No emission reductions (ERs) may be claimed from displacing fuels resulting from the end use of bottled biogas in such scenarios. However, if the end use of the bottled biogas is within the project boundary and is monitored throughout the crediting period, CO_2 emissions avoided by displacing fossil fuels can be claimed using the corresponding Type I methodology, such as AMS-I.C. for thermal energy production with or without electricity	bottling of upgraded biogas.
As per paragraph 7 of AMS-III.H For project activities falling under paragraph 4(c)(i), ERs from the displacement of the use of natural gas are eligible under this methodology, given that the geographical extent of the natural gas distribution grid lies within the boundaries of the host country	Not applicable The project activity instance to be implemented under the Individual Projects does not involve upgrading and injection of biogas into a natural gas distribution grid.
As per paragraph 8 of AMS-III.H For project activities covered under paragraph 4 (c) (ii), ERs for the displacement of the use of fuels can be claimed following the provision in the corresponding Type I methodology, e.g. AMS-I.C	Not applicable The project activity instance to be implemented under the Individual Projects does not involve upgrading and transportation of biogas via a dedicated piped network to a group of end users.
As per paragraph 9 of AMS-III.H For case of 4(b) and (c)(iii), take into account physical leakage during the storage and transportation of upgraded biogas, as well as the emissions resulting from fossil fuel consumption by vehicles used for transporting biogas. Procedures outlined in paragraph 11 of Annex 1 of AMS-III.H. "Methane recovery in wastewater treatment" should be followed	Not applicable The project does not include generating thermal or mechanical electrical energy after bottling upgraded biogas or upgrading and transporting biogas to distribution points using trucks.
As per paragraph 10 of AMS-III.H	Not applicable

For project activities described in paragraph 4 (b) and (c), this methodology is suitable if the biogas's upgraded methane content aligns with relevant national regulations (where these exist) or in the absence of such regulations, a minimum of 96% methane content by volume is required for applicability	The project activity instance does not involve thermal or mechanical electrical energy generation after bottling of upgraded biogas or after upgrading and distribution.
As per paragraph 11 of AMS-III.H If the recovered biogas is used for hydrogen production (project activities falling under paragraph 4(d)), that aspect of the project activity should adhere to the corresponding methodology, AMS-III.O. Hydrogen production using methane extracted from biogas	<u>Not applicable</u> The project activity instance does not involve hydrogen production.
As per paragraph 12 of AMS-III.H If the recovered biogas is utilized for project activities specified in paragraph 4(e), the methodology AMS-III.AQ, Introduction of Bio-CNG in road transportation, should be applied for that particular aspect of the project activity	<u>Not applicable</u> The project activity instance does not include the utilization of biogas as fuel in transportation applications after upgrading.
As per paragraph 13 of AMS-III.H New facilities (Greenfield projects) and project activities that involve a change of equipment leading to an increase in capacity of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system are eligible to apply this methodology only if they meet the relevant requirements outlined in the General guidelines to SSC CDM methodologies. Additionally, they must adhere to the requirements for demonstrating the remaining lifetime of the replaced equipment, as described in the general guidelines	<u>Not Applicable</u> The project activity instance does not entail new facilities and/or a change of equipment that would increase the capacity of the wastewater or sludge treatment system beyond the designed capacity of the baseline treatment system.

As per paragraph 2.2.14 of AMS-III.H The Project Design Document (PDD) must uniquely define and describe both the location of the wastewater treatment plant and the source generating the wastewater.	Applicable In the Project Design Document (PDD) for the project activity instance to be implemented under the Individual Projects, the location of the wastewater treatment plant and the source generating the wastewater will be uniquely defined and described. This includes providing the relevant address, map, and geographical positioning system (GPS) coordinates. Additionally, a diagram illustrating the source of Palm Oil Mill Effluent (POME) and its treatment process for both the baseline and project activity instance will be included.
As per paragraph 2.2.15 of AMS-III.H Measures are limited to those that result in aggregate emission reductions of less than or equal to 60ktCO2 equivalent annually from all Type III components of the project activity	Applicable Measures are restricted to those that lead to aggregate emission reductions of 60,000 metric tons of CO2 equivalent or less annually from all Type III components of the project activity.

3.3 Project boundaries, sources and GHGs

In the MY_TRG_BIOGAS_Q2/24 carbon removal initiative project, project boundaries delineate the precise parameters or limitations that define the scope and extent of the project.

The project delimitation for the **Project Activity** is as follows:

1. This project is operated and owned by Ladang Rakyat Terengganu Sdn Bhd, focuses on biogas recovery.
2. The project is operated under Suruhanjaya Tenaga License (S.T).
3. The project covers a total area of 2 hectares allocated for a biogas plant.
4. The plant is easily accessible via any vehicles through the main road.

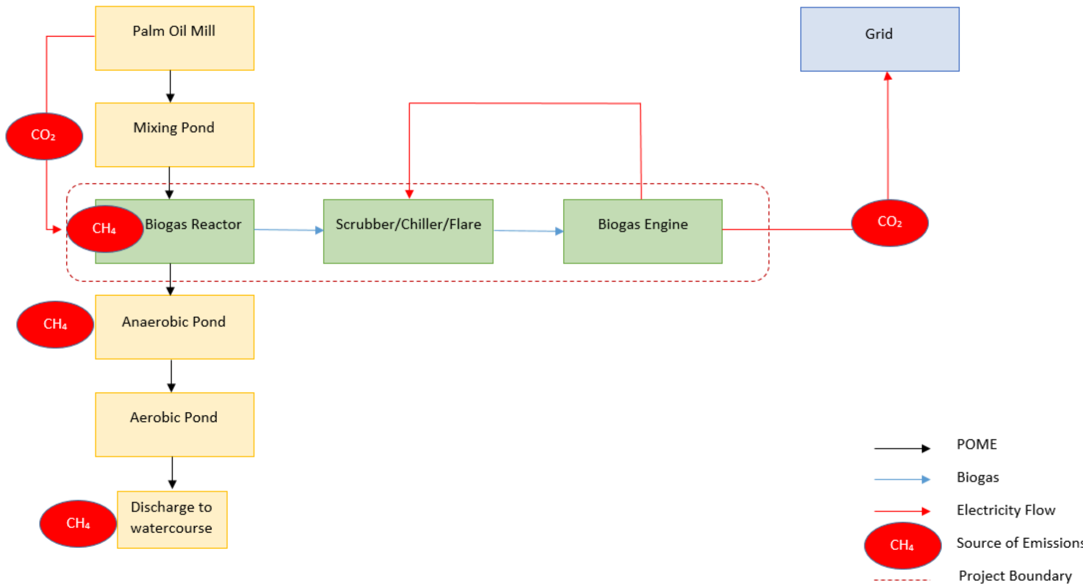


Figure 5: PAI Boundary

3.3.1 Carbon reservoirs and GHG sources

The following GHG sources, sinks and reservoirs for the project and baseline scenarios should be assessed to Project Activity Instance , as per AMS.III-H:

Source or reservoir		GHG	Included (Yes/No/Optional)	Justification
Baseline	Emission from the Existing wastewater treatment system (ie open lagoon system, including discharge to river)	CO_2	Excluded	CO2 emissions from the decomposition of organic matter are not accounted for because they are biogenic in nature.
		CH_4	Included	Emission from decomposition of organic matter in anaerobic open lagoons and from discharge to river.
		N_2O	Excluded	Excluded for simplification.

Project	Emissions from the Project wastewater treatment system, including discharge to river	CO_2	Excluded	CO2 emissions from the decomposition of organic matter are not accounted for because they are biogenic in nature. Any on-site electricity consumed by project activity which is imported from the grid will be accounted for. This is not material in PAI.
		CH_4	Included	Emissions in the project activity are from: ● Decomposition of the organic matter in open anaerobic lagoons and from discharge to river ● Physical leakage from the biodigester ● Incomplete flaring (if applicable)
		N_2O		Excluded for simplification. This is conservative.

3.3.2 Time limits and analysis periods

In accordance with BCR Standard section 10.5, the project time frame corresponds to 7 years, with the possibility of renewal for two additional terms.

3.3.2.1 Project start date

According to the BCR Standard, the project start date is determined as the initiation of activities resulting in the generation of GHG emission reductions or removals. The Project Activity Instance commenced on 1/10/2023, coinciding with the commissioning of the biogas plant. This date serves as the Initial Operating Date (IOD), verified by TNB.

3.3.2.2 Quantification period of GHG emission reductions

The crediting period for the Project Activity Instance will span 7 years, with the possibility of renewal for two additional terms. The initial project crediting period extends from 1/10/2023 to 5/10/2030.

3.3.2.3 Monitoring periods

The monitoring period for the Project Instance will be carried out annually, from 1/10/2023 to 5/10/2030.

3.4 Baseline Scenario

The Baseline Scenario

The effluent derived from the palm oil mill is characterized by a high Chemical Oxygen Demand (COD), primarily attributable to the organic constituents originating from the palm oil extraction process. Under the baseline conditions, this effluent undergoes treatment within a system comprising 15 ponds, with ponds 7 to 9 exhibiting depths exceeding 2 meters and maintaining an average temperature of 30°C, thus fostering an anaerobic milieu. This anaerobic environment facilitates methane generation through the decomposition of organic matter present in the effluent, as quantified by its post-treatment COD levels. Baseline monitoring campaigns reveal an 80% COD reduction attributed to treatment within the anaerobic lagoons (ponds 7 to 9). Upon completion of the baseline treatment regimen, the effluent meets the established legal thresholds mandated in Malaysia before discharge into nearby water bodies.

Preceding the initiation of the Project Activity Instance (PAI), sludge removal from the lagoons occurred sporadically due to limited sludge accumulation resulting from the anaerobic treatment processes. The disposal of extracted sludge onto adjacent lands within the palm oil mill premises entails negligible greenhouse gas emissions.

In the absence of the PAI, the baseline scenario entails the perpetuation of existing wastewater treatment practices, with concurrent methane emissions persisting from the anaerobic lagoon system.

The Project Scenario

In the Project Scenario, the Biogas Reactor is implemented to bypass the treatment process, diverting effluent before it enters the anaerobic pond (pond 7), effectively preventing the release of greenhouse gasses through the biogas recovery system. Anticipated outcomes include an 89% reduction in effluent COD facilitated by the biogas recovery system, thereby enhancing overall treatment system efficiency. Comprehensive capture of greenhouse gasses resulting from the anaerobic breakdown of organic content in the wastewater significantly reduces emissions between the Baseline and Project Scenario. The treated wastewater complies with legal discharge limits and is released into a river, consistent with the Baseline Scenario.

Sludge removal in the Project Scenario is minimized, with any extracted sludge from lagoons or the anaerobic digester system disposed of on nearby land. Given uniformity in sludge disposal practices across Baseline and Project Scenarios, emissions from this process are not considered.

3.5 Additionality

According to the methodological tool *Positive lists of technologies Version 04.0* defines five conditions for automatic additionality (5.1.2, 12). These are provided in the table below and considered in relation to the Project.

Requirements for Additionality	***Project Scenario***
(a) The existing treatment system is an anaerobic lagoon and the wastewater discharged meets the host country regulation;	Yes The current treatment system consists of an anaerobic lagoon, and the discharged effluent complies with the regulations set by Malaysia.
(b) There is no regulation in the host country that requires the management of	Yes

biogas from domestic, industrial and agricultural sites;	There is currently no regulation in Malaysia mandating the management of biogas from a site similar to the project site.
(c) There is no capacity increase in the wastewater treatment system;	Yes There has been no expansion of capacity in the wastewater treatment system.
(d) No other alternative economic activity is expected to be undertaken on the land of the existing lagoon;	Yes No alternative economic activity is projected to be initiated on the land currently occupied by the existing lagoon.
(e) The biogas is used to generate electricity in one or more power plants, and the total nameplate capacity is below 5 MW.	Yes The biogas generated is utilized for electricity generation in a power plant with a total nameplate capacity below 5 megawatts (MW).

4 Quantification of GHG Emission Reduction/Removal

4.1 GHG emissions reduction/removal in the baseline scenario

The following formulae will be followed by PAIs in the Individual Project as the procedures set out in AMS-III.H.: Methane recovery in wastewater treatment - Version 19.0 to quantify the methane avoidance component.

Baseline emissions for instances in the Grouped Project are determined according to Equations 1 to 7 from AMS-III.H : Methane recovery in wastewater treatment - Version 19.0, as relevant to the PAI.

1) Wastewater and sludge treatment systems equipped with a biogas recovery facility in the baseline shall be excluded from the baseline emission calculations.

2) Baseline emissions for the systems affected by the project activity may consist of:
   - Emissions on account of electricity or fossil fuel used ($BE_{power,y}$);
   - Methane emissions from baseline wastewater treatment systems ($BE_{ww,treatment,y}$);
   - Methane emissions from baseline sludge treatment systems ($BE_{s,treatment,y}$);
   - Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea ($BE_{ww,discharge,y}$);
   - Methane emissions from the decay of the final sludge generated by the baseline treatment systems ($BE_{s,final,y}$).

$$BE_y = \{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\} \quad \textbf{E(1)}$$

Where,

BE_y	=	Baseline emissions in year y (t CO2e)
$BE_{power,y}$	=	Baseline emissions from electricity or fuel consumption in year y (t CO2e)
$BE_{ww,treatment,y}$	=	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (t CO2e)
$BE_{s,treatment,y}$	=	Baseline emissions of the sludge treatment systems affected by the project activity in year y (t CO2e)
$BE_{ww,discharge,y}$	=	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (t CO2e). The value of this term is zero for the case 1(b)
$BE_{s,final,y}$	=	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (t CO2e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected

3) Baseline emissions from electricity and fossil fuel consumption ($BE_{power,y}$) are determined as per the procedures described in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion", respectively. The energy consumption shall include all equipment/devices in the baseline wastewater and sludge treatment facility. If recovered biogas in the baseline is used to power auxiliary equipment it should be taken into account accordingly, using zero as its emission factor.

4) Methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww,treatment,y}$) are determined using the COD removal efficiency of the baseline plant:

$$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}) \times B_{o,ww} \times UF_{BL} \times GWP_{CH4}$$

E(2)

Where,

$Q_{ww,i,y}$	=	Volume of wastewater treated in baseline wastewater treatment system *i* in year y (m3). For ex ante estimation, forecasted wastewater generation volume or the designed capacity of the wastewater treatment facility can be used. However, the ex post emissions reduction calculation shall be based on the actual monitored volume of treated wastewater
$COD_{inflow,i,y}$	=	Chemical oxygen demand of the wastewater inflow to the baseline treatment system *i* in year y (t/m3). Average value may be used through sampling with the confidence/precision level 90/10
$\eta_{COD,BL,i}$	=	COD removal efficiency of the baseline treatment system i, determined as per the paragraphs 35, 36 or 37 below
$MCF_{ww,treatment,BL,i}$	=	Methane correction factor for baseline wastewater treatment systems *i* (MCF values as per Table 2 of AMS-III.H)

i	=	Index for baseline wastewater treatment system
$B_{o,ww}$	=	Methane producing capacity of the wastewater (IPCC value of 0.25 kg CH_4/kg COD)5
UF_{BL}	=	Model correction factor to account for model uncertainties (0.89)
GWP_{CH4}	=	Global Warming Potential for methane

5) If the baseline treatment system is different from the treatment system in the project scenario, the monitored values of the COD inflow during the crediting period will be used to calculate the baseline emissions ex post.

6) The Methane Correction Factor (MCF) shall be determined based on Table 2 of AMS-III.H.

7) Methane emissions from the baseline sludge treatment systems affected by the project activity are determined using the methane generation potential of the sludge treatment systems:

$$BE_{,treatment,s,y} = \sum_{j} S_{j,BL,y} \times MCF_{s,treatment,BL,j} \times DOC_{s} \times UF_{BL} \times DOC_{F} \times F \times 16j/12 \times GWP_{CH4}$$

E(3)

Where,

$S_{j,BL,y}$	=	Amount of dry matter in the sludge that would have been treated by the sludge treatment system j in the baseline scenario (t). For ex ante estimation, forecasted sludge generation volume or the designed capacity of the sludge

treatment facility can be used. However, the ex post emissions reduction calculation shall be based on the actual monitored volume of treated sludge

$MCF_{s,treatment,BL,j}$	=	Chemical oxygen demand of the wastewater inflow to the baseline treatment system *i* in year y (t/m3). Average value may be used through sampling with the confidence/precision level 90/10
DOC_s	=	Degradable organic content of the untreated sludge generated in the year y (fraction, dry basis). Default values of 0.5 for domestic sludge and 0.257 for industrial sludge shall be used
UF_{BL}	=	Model correction factor to account for model uncertainties (0.89)
j	=	Index for baseline sludge treatment system
DOC_F	=	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	=	Fraction of CH4 in biogas (IPCC default of 0.5)

8) If the sludge is composted, the following equation shall be applied:

$$BE_{s,treatment,y} = \sum_j S_{j,BL,y} \times EF_{composting} \times GWP_{CH4} \quad \textbf{E(4)}$$

Where,

$EF_{composting}$	=	Emission factor for composting organic waste (t CH4/t waste treated). Emission factors can be based on facility/site-specific measurements, country specific values or IPCC default values (Table 4.1, chapter 4, Volume 5, 2006 IPCC Guidelines for

National Greenhouse Gas Inventories). IPCC default value is 0.01 t CH_4/ t sludge treated on a dry weight basis

9) If the baseline wastewater treatment system is different from the treatment system in the project scenario, the sludge generation rate (amount of sludge generated per unit of COD removed) in the baseline may differ significantly from that of the project scenario. For example, it is known that the amount of sludge generated in aerobic wastewater systems is larger than in anaerobic systems, for the same COD removal efficiency. Therefore, for these cases, the monitored values of the amount of sludge generated during the crediting period will be used to estimate the amount of sludge generated in the baseline, as follows:

$$S_{j,BL,y} = S_{l,PJ,y} \times SGR_{BL} / SGR_{PJ} \quad \textbf{E(5)}$$

Where,

$S_{l,PJ,y}$	=	Amount of dry matter in the sludge treated by the sludge treatment system i in year y in the project scenario (t)
SGR_{BL}	=	Sludge generation ratio of the wastewater treatment plant in the baseline scenario (tonne of dry matter in sludge/t COD removed). This ratio will be determined as per paragraphs 35, 36 or 37 of AMS-III.H.
SGR_{PJ}	=	Sludge generation ratio of the wastewater treatment plant in the project scenario (tonne of dry matter in sludge/t COD removed). Calculated using the monitored values of COD removal (i.e. $COD_{inflow,i}$ minus $COD_{outflow,i}$) and sludge generation in the project scenario

10) Methane emissions from degradable organic carbon in treated wastewater discharged in e.g. a river, sea or lake in the baseline situation are determined as follows:

$$BE_{ww,discharge,y} = Q_{ww,y} \times GWP_{CH4} \times B_{o,ww} \times UF_{BL} \times COD_{ww,discharge,BL,y} \times MCF_{ww,BL,discharge} \quad \textbf{E(6)}$$

Where,

$Q_{ww,y}$	=	Volume of treated wastewater discharged in year y (m^3)
UF_{BL}	=	Model correction factor to account for model uncertainties (0.89)
$COD_{ww,discharge,BL,y}$	=	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year y (t/m3). If the baseline scenario is the discharge of untreated wastewater, the COD of untreated wastewater shall be used
$MCF_{ww,BL,discharge}$	=	Methane correction factor based on discharge pathway in the baseline situation (e.g. into sea, river or lake) of the wastewater (fraction) (MCF values as per Table 2 of AMS-III.H.)

11) To determine $COD_{ww,discharge,BL,y}$: if the baseline treatment system(s) is different from the treatment system(s) in the project scenario, the monitored values of the COD inflow during the crediting period will be used to calculate the baseline emissions ex post. The outflow COD of the baseline systems will be estimated using the removal efficiency of the baseline treatment systems, estimated as per paragraphs 35, 36 or 37 of AMS-III.H.

12) Methane emissions from anaerobic decay of the final sludge produced are determined as follows:

$$BE_{s,final,y} = S_{final,BL,y} \times DOC_s \times UF_{BL} \times MCF_{s,BL,final} \times DOC_F \times F \times 16/12 \times GWP_{CH4} \quad \textbf{E(7)}$$

Where,

$S_{final,BL,y}$	=	Amount of dry matter in the final sludge generated by the baseline wastewater treatment systems in the year y (t). If the baseline wastewater treatment system is different from the project system, it will be estimated using the monitored amount of dry matter in the final sludge generated by the project activity ($S_{final,PJ,y}$) corrected for the sludge generation ratios of the project and baseline systems as per equation (5) above
$MCF_{s,BL,final}$	=	Methane correction factor of the disposal site that receives the final sludge in the baseline situation, estimated as per the procedures described in the methodological tool "Emissions from solid waste disposal sites"
UF_{BL}	=	Model correction factor to account for model uncertainties (0.89)

The table below summarizes the baseline emissions that are considered in the PAI and their calculated values.

Source	Included/ Excluded	Calculated Value (tCO_2e)
Baseline emissions from electricity or fuel consumption in year y ($BE_{power,y}$)	<u>Excluded</u> The baseline scenario does not consume electricity or fuel (The system is gravity fed).	0
Baseline emissions of the wastewater treatment systems affected by the project activity in year y ($BE_{ww,treatment,y}$)	<u>Included</u> Main emissions source in the baseline from open lagoons.	77,231

Baseline emissions of the sludge treatment systems affected by the project activity in year y ($BE_{s,treatment,y}$)	<u>Excluded</u> There is no sludge treatment activity involved in PAI.	0
Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/ river/ lake in year y ($BE_{ww,discharge,y}$)	<u>Included</u> The treated effluent from open anaerobic lagoons is discharged into a river.	1,262
Baseline methane emissions from anaerobic decay of the final sludge produced in year y ($BE_{s,final,y}$)	<u>Excluded</u> There is no treatment of final sludge activity involved in PAI1. Sludge removal in the baseline is minimal. The amount of final sludge in the baseline, while minimal, is more than the amount of final sludge in the project scenario (due to superior mixing of the wastewater and further breakdown of the sludge). Therefore, it is conservative to ignore any emissions from final sludge in both scenarios.	0

In total, the baseline emissions in year y (BE_y) are calculated as 78,492 tCO2e. These baseline emissions are calculated as follows:

$$BE_y = \{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\}$$

$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}) \times B_{o,ww} \times UF_{BL} \times GWP_{CH4}$			
$Q_{ww,i,y}$	m^3	Derived from ratio of wastewater from mT of processed FFB, from study	173,244
$COD_{inflow,i,y}$	$tonnes/m^3$	From monitoring record data	0.1005
$\eta_{COD,BL,i}$	-	From monitoring record data	0.89
$MCF_{ww,treatment,BL,i}$	-	As per Anaerobic Deep Lagoon in Table 2 of AMS-III.H)	0.80
$B_{o,ww}$	kgCH4/kgCOD	IPCC default value (2006 IPCC Guideline)	0.25
UF_{BL}	-	Model correction factor	0.89
GWP_{CH4}	tCO2e/tCH4	IPCC default	28.00
$BE_{ww,treatment,y}$ = 77,231 tCO2e			

$BE_{ww,discharge,y} = Q_{ww,y} \times GWP_{CH4} \times B_{o,ww} \times UF_{BL} \times COD_{ww,discharge,BL,y} \times MCF_{ww,BL,discharge}$			
$Q_{ww,y}$	m^3	From monitoring record data	173,244

GWP_{CH4}	tCO2e/tCH4	IPCC default value	28.00
$B_{o,ww}$	kgCH4/kgCOD	IPCC default value (2006 IPCC Guideline)	0.25
UF_{BL}	-	Model correction factor	0.89
$COD_{ww,discharge,BL,y}$	tonnes/m³	From monitoring record data	0.01168
$MCF_{ww,BL,discharge}$	-	As per Anaerobic Deep Lagoon in Table 2 of AMS-III.H	0.10
$BE_{ww,discharge,y}$ = 1,261 tCO2e			

BE_y = $\{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\}$

BE_y = 0 + 77231 tCO2e + 0+ 1,261 tCO2e + 0

= 78,492 tCO2e

4.2 GHG emissions reduction/removal in the project scenario

PAIs will apply the procedures set out in AMS-III.H.: Methane recovery in wastewater treatment - Version 19.0 to quantify the project emissions:

Project emissions consist of:

- CO2 emissions from electricity and fuel used by the project facilities ($PE_{power,y}$);
- Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project scenario ($PE_{ww,treatment,y}$);

- Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{s,treatment,y}$);
- Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww,discharge,y}$);
- Methane emissions from the decay of the final sludge generated by the projectactivity treatment systems ($PE_{s,final,y}$);
- Methane fugitive emissions due to inefficiencies in capture systems ($PE_{fugitive,y}$);
- Methane emissions due to incomplete flaring ($PE_{flaring,y}$);
- Methane emissions from biomass stored under anaerobic conditions which would not have occurred in the baseline situation ($PE_{biomass,y}$)

$$PE_{,y} = \{PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{flaring,y} + PE_{biomass,y}\} \quad \textbf{E(8)}$$

Where,

PE_y	=	Project emissions in the year y (t CO2e)
$PE_{power,y}$	=	Emissions from electricity or fuel consumption in the year y (t CO2e). These emissions shall be calculated as per paragraph 26, for the situation of the project scenario, using energy consumption data of all equipment/devices used in the project activity wastewater and sludge treatment systems and systems for biogas recovery and flaring/gainful use
$PE_{ww,treatment,y}$	=	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (t CO2e). These emissions shall be calculated as per equation (2) in paragraph 27 of AMS-III.H, using an uncertainty factor of 1.12 and data applicable to the

project situation ($MCF_{ww,treatment,PJ,k}$ and $\eta_{,PJ,k,y}$) and with the following changed definition of parameters:

- $MCF_{ww,treatment,PJ,k}$: Methane correction factor for project wastewater treatment system k (MCF values as per Table 2)
- $\eta_{,PJ,k,y}$: Chemical oxygen demand removal efficiency of the project wastewater treatment system k in year y (t/m3), measured based on inflow COD and outflow COD in system k.

$PE_{s,treatment,y}$ = Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (t CO2e). These emissions shall be calculated as per equations (3) and (4) in paragraphs 30 and 31 of AMS-III.H, using an uncertainty factor of 1.12 and data applicable to the project situation ($S_{l,PJ,y}$, $MCF_{s,treatment,l}$) and with the following changed definition of parameters:

- $S_{l,PJ,y}$: Amount of dry matter in the sludge treated by the sludge treatment system l in the project scenario in year y (t)
- $MCF_{s,treatment,l}$: Methane correction factor for the project sludge treatment system l (MCF values as per Table 2 above)

$PE_{ww,discharge,y}$ = Methane emissions from degradable organic carbon in treated wastewater in year y (tCO_2e). These emissions shall be calculated as per equation (6) in paragraph 33 of AMS-III.H, using an uncertainty factor of 1.12 and data applicable to the project conditions ($COD_{ww,discharge,PJ,y}$, $MCF_{ww,PJ,discharge}$) and with the following changed definition of parameters:

- $COD_{ww,discharge,PJ,y}$: Chemical oxygen demand of the treated wastewater discharged into the sea, river or lake in the project scenario in year y (t/m3)

- $MCF_{ww,PJ,discharge}$: Methane correction factor based on the discharge pathway of the wastewater in the project scenario (e.g. into sea, river or lake) (MCF values as per Table 2)

$PE_{s,final,y}$ = Methane emissions from anaerobic decay of the final sludge produced in the year y (t CO_2e). These emissions shall be calculated as per equation (7) in paragraph 35, using an uncertainty factor of 1.12 and data applicable to the project conditions ($MCF_{s,PJ,final}$, $S_{final,PJ,y}$). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in aerobic conditions in the project activity, this term shall be neglected, and the sludge treatment and/or use and/or final disposal shall be monitored during the crediting period with the following revised definition of the parameters:

- $MCF_{s,PJ,final}$: Methane correction factor of the disposal site that receives the final sludge in the project situation, estimated as per the procedures described in the methodological tool "Emissions from solid waste disposal sites"

- $S_{final,PJ,y}$: Amount of dry matter in final sludge generated by the project wastewater treatment systems in the year y (t)

$PE_{fugitive,y}$	=	Methane emissions from biogas release in capture systems in year y, calculated as per paragraph 40 (t CO2e)
$PE_{flaring,y}$	=	Methane emissions due to incomplete flaring in year y (t CO2e). For ex ante estimation, baseline emission calculation for wastewater and/or sludge treatment (i.e. equation (2) and/or equation (3)) can be used but without the consideration of GWP for CH4. However, the ex post emission reduction shall be calculated as per methodological tool "Project emissions from flaring"
$PE_{biomass,y}$	=	Methane emissions from biomass stored under anaerobic conditions. If storage of biomass under anaerobic conditions takes place in the project and does not occur in the baseline, methane emissions due to anaerobic decay of this biomass shall be considered and be determined as per the procedure in the methodological tool "Emissions from solid waste disposal sites" (t CO2e)

Project emissions from methane release in capture systems are determined as follows:

Based on the methane emission potential of wastewater and/or sludge:

$$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y} \quad \textbf{E(9)}$$

Where,

$PE_{fugitive,ww,y}$	=	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y (t CO2e)
$PE_{fugitive,s,y}$	=	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y (t CO2e)

$$PE_{fugitive,ww,y} = (1 - CFE_{ww}) \times MEP_{ww,treatment,y} \times GWP_{CH4} \quad \textbf{E(10)}$$

Where,

CFE_{ww}	=	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)
$MEP_{ww,treatment,y}$	=	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y (t)

$$MEP_{ww,treatment,y} = Q_{ww,y} \times B_{o,ww} \times UF_{PJ} \times \sum_{k} COD_{removed,PJ,k,y} \times MCF_{ww,treatment,PJ,k} \qquad \textbf{E(11)}$$

Where,

$COD_{removed,PJ,k,y}$	=	The chemical oxygen demand removed10 by the treatment system k of the project activity equipped with biogas recovery in the year y (t/m3)
$MCF_{ww,treatment,PJ,k}$	=	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment (MCF values as per Table 2 above)
UF_{PJ}	=	Model correction factor to account for model uncertainties (1.12)

$$PE_{fugitive,s,y} = (1 - CFE_{s}) \times MEPs_{,treatment,y} \times GWP_{CH4} \qquad \textbf{E(12)}$$

Where,

CFE_s	=	Capture efficiency of the biogas recovery equipment in the sludge treatment systems (a default value of 0.9 shall be used)
$MEPs_{,treatment,y}$	=	Methane emission potential of the sludge treatment systems equipped with a biogas recovery system in year y (t)

$$MEPs_{,treatment,y} = \sum_{i}(S_{l,PJ,y} \times MCF_{s,treatment,PJ,l}) \times DOC_s \times UF_{PJ} \times DOC_F \times F \times 16/12 \quad \textbf{E(13)}$$

Where,

$S_{l,PJ,y}$	=	Capture efficiency of the biogas recovery equipment in the sludge treatment systems (a default value of 0.9 shall be used)
$MCF_{s,treatment,PJ,l}$	=	Methane emission potential of the sludge treatment systems equipped with a biogas recovery system in year y (t)
UF_{PJ}	=	Model correction factor to account for model uncertainties (1.12)

Optionally a default value of 0.05 m^3 biogas leaked/m^3 biogas produced may be used as an alternative to calculations per equation (9) to (13).

For project activity instance, the project emissions will be identified according to the procedures set out in AMS-III.H.: Methane recovery in wastewater treatment - Version 19.0. The table below summarizes the project emissions that will be considered for PAI:

Source	Included/ Excluded	Calculated Value (tCO_2e)

CO_2 emissions from electricity and fuel used by the project facilities *($PE_{power,y}$)*	Included The project activity may use electricity during start up.	0.20
Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project scenario *($PE_{ww,treatment,y}$)*	Included After passing through the treatment system that has been fitted with biogas recovery, the wastewater passes into the initial anaerobic ponds. Methane emissions result.	92,822
Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation *($PE_{s,treatment,y}$)*	Excluded There is not sludge treatment activity involved in this project activity	0
Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater *($PE_{ww,discharge,y}$)*	Included The treatment effluent from open anaerobic lagoons is discharged into a river.	12,143
Methane emissions on	Excluded There is no sludge treatment	0

account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{s,final,y}$)	activity involved in this project activity.	
Methane fugitive emissions due to inefficiencies in capture systems ($PE_{fugitive,y}$)	<u>Included</u> Project emissions due to potential inefficiencies of the biogas capture system.	9279
Methane emissions due to incomplete flaring ($PE_{flaring,y}$)	<u>Excluded</u> The flare is not anticipated to be used and, in any event, the amount would not be material.	0
Biomass stored under anaerobic conditions which would not have occurred in the baseline scenario ($PE_{biomass,y}$)	<u>Excluded</u> The project does not have biomass storage under anaerobic conditions.	0

In total, the project emissions in year y (PE_y) are calculated as 118,612.20 tCO2e. These emissions are calculated as follows:

$$PE_{,y} = \left\{ PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{flaring,y} + PE_{biomass,y} \right\}$$

$PE_{power,y} = PE_{EC,y}$ $PE_{EC,y} = \sum_{j} EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$			
$EC_{PJ,j,y}$	MWh/yr	Quantity of electricity consumed by the project electricity consumption	0.15
$EF_{EF,j,y}$	t CO_2/MWh	Conservative default value	1.3
$TDL_{j,y}$	-	Annual Average value of electric power transmission and distribution losses within host-country (Malaysia)	0.06
$PE_{power,y} = PE_{EC,y}$ $PE_{EC,y} = 0.2$			

$PE_{ww,treatment,y} = \sum_{i} (Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,PJ,i} \times MCF_{ww,treatment,PJ,i}) \times B_{o,ww} \times UF_{PJ} \times GWP_{CH4}$			
$Q_{ww,i,y}$	m^3	Derived from ratio of wastewater from mT of processed FFB, from study	173,244
$COD_{inflow,i,y}$	tonnes/m^3	COD at inflow to wastewater treatment systems not affected by biogas recovery system	0.1005

$\eta_{COD,PJ,i}$	-	From baseline monitoring campaign results	0.89
$MCF_{ww,treatment,PJ,i}$	-	As per Anaerobic Deep Lagoon in Table 2 of AMS-III.H)	0.80
$B_{o,ww}$	kgCH4/kgCOD	IPCC default value (2006 IPCC Guideline)	0.25
UF_{PJ}	-	Model correction factor	1.12
GWP_{CH4}	tCO2e/tCH4	IPCC default	28.00
$PE_{ww,treatment,y}$ = 97,190 tCO2e			

$PE_{ww,discharge,y} = Q_{ww,y} \times GWP_{CH4} \times B_{o,ww} \times UF_{BL} \times COD_{ww,discharge,PJ,y} \times MCF_{ww,PJ,discharge}$			
$Q_{ww,y}$	m^3	Volume of wastewater treated in baseline wastewater treatment system in year y	173,244
GWP_{CH4}	tCO2e/tCH4	IPCC default value	28.00
$B_{o,ww}$	kgCH4/kgCOD	IPCC default value (2006 IPCC Guideline)	0.25
UF_{PJ}	-	Model correction factor	1.12
$COD_{ww,discharge,PJ,y}$	tonnes/m^3	From monitoring record data	0.0894

$MCF_{ww,PJ,discharge}$	-	As per Anaerobic Deep Lagoon in Table 2 of AMS-III.H	0.10
$PE_{ww,discharge,y}$ = 12,143 tCO2e			

$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y}$			
$PE_{fugitive,ww,y}$	tCO2e/yr		9279
$PE_{fugitive,s,y}$	tCO2e/yr		0
$PE_{fugitive,ww,y} = (1 - CFE_{ww}) \times MEP_{ww,treatment,y} \times GWP_{CH4}$			
CFE_{w}	-	Default value for industrial sludge	0.90
$MEP_{ww,treatment,y}$	tonnes	From monitoring record data	3,314
GWP_{CH4}	tCO2e/tCH4	IPCC default value	28.0
$MEP_{ww,treatment,y} = Q_{ww,y} \times B_{o,ww} \times UF_{PJ} \times \sum_{k} COD_{removed,PJ,k,y} \times MCF_{ww,treatment,PJ,k}$			
$Q_{ww,y}$	m^3	Volume of wastewater treated in baseline wastewater treatment system in year y	173,244

$B_{o,ww}$	kgCH4/kgCOD	IPCC default value (2006 IPCC Guideline)	0.25
UF_{PJ}	-	As per AMS III-H	1.12
$COD_{removed,PJ,k,y}$	tonnes/m³	Calculated as $COD_{ww,inflow,y}$ x $\eta_{COD,PJ,i}$	0.0854
$MCF_{ww,treatment,PJ,k}$	-	As per Anaerobic Deep Lagoon in Table 2 of AMS-III.H)	0.80
$PE_{fugitive,y}$ = 9279 tCO2e			

$$PE_{,y} = \{PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + PE_{fugitive,y} + PE_{flaring,y} + PE_{biomass,y}\}$$

$$PE_{,y} = 0.2\ tCO2e + 97{,}190\ tCO2e + 0 + 12{,}143\ tCO2e + 0 + 9279\ tCO2e + 0 + 0$$

$$= 118{,}612\ tCO2e$$

4.3 Leakage

As per paragraph 41 of AMS III-H Version 19, if the technology is using equipment transferred from another activity, leakage effects at the site of the other activity are to be considered and estimated (LEy).

There are no relevant leakage effects to be considered. This is due to the design of the plant where the potential leakage areas are outside of the boundary.

4.4 Net GHG Emission Reductions and Removals

Individual Project

As per the AMS-III.H. methodology, Version 19.0, emission reductions for the Individual Project will be calculated as follows.

$$ER_{y,ex\ ante} = BE_{y,ex\ ante} - (PE_{y,ex\ ante} + LE_{y,ex\ ante}) \quad \textbf{(E14)}$$

Where,

$ER_{y,ex\ ante}$	=	Ex ante emission reduction in year y (t CO2e)
$BE_{y,ex\ ante}$	=	Ex ante leakage emissions in year y (t CO2e)
$PE_{y,ex\ ante}$	=	Ex ante project emissions in year y calculated as paragraph 39 (t CO2e)
$LE_{y,ex\ ante}$	=	Ex ante baseline emissions in year y calculated as per paragraph 25 (t CO2e)

The table below the ex-ante calculations, the estimated GHG emission reductions over the entire quantification period of the MY_TRG_BIOGAS_Q2/24 project:

Year	GHG emission reductions in the baseline scenario (tCO2e)	GHG emission reductions in the project scenario (tCO_{2e})	GHG emissions attributable to leakages (tCO_{2e})	Estimated Net GHG Reduction (tCO_{2e})
Year 1	78,493	118,612.20	-	40,119.20
Year 2	78,493	118,612.20	-	40,119.20

Year 3	78,493	118,612.20	-	40,119.20
Year 4	78,493	118,612.20	-	40,119.20
Year 5	78,493	118,612.20	-	40,119.20
Year 6	78,493	118,612.20	-	40,119.20
Year 7	78,493	118,612.20	-	40,119.20
Total	549,451	830,285.40	-	280,834.40

Total estimated of GHG emissions reductions (during the quantification period):

Project Activity : 280,834.40 tCO_2e

Estimated average annual amount of GHG emission reductions:

Project Activity : 40,119.20 tCO_2e/year

5 Monitoring Plan

5.1 Data and Parameters for Monitoring

Data/ Parameter	$Q_{ww,i,y}$
Data unit	m^3/ month
Description	The flow of wastewater to the anaerobic digester
Source of data	On site measurement
Description of measurement methods and procedures to be applied	Measured continuously by flow meters installed before entering the system.
Frequency of monitoring/recording	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained) Parameters aggregated monthly and annually for calculations.
Value applied	For PAI, the estimated value for the ex ante calculation is 173,244 m^3/year
Monitoring equipment	Flow meter(s)
QA/QC procedures to be applied	Flow meters will undergo maintenance and calibration in accordance with appropriate industry standards. In the absence of local/national standards or manufacturer specifications, international standards may be applied.
Purpose of data	Calculation of baseline and project emissions
Calculation method	-
Comments	-

Data/ Parameter	$COD_{ww,untreated,y}$ or $COD_{ww,inflow,y}$
Data unit	t COD/m^3
Description	The chemical oxygen demand of the wastewater before the treatment system is affected by the project activity.
Source of data	On site measurement
Description of measurement methods and procedures to be applied	Measured according to national or international standards. COD is measured through representative sampling.
Frequency of monitoring/recording	Samples and measurements shall ensure a 90/10 confidence/precision level Periodically, at least monthly.
Value applied	For PAI, the value for the ex-ante calculation is 0.1005
Monitoring equipment	Laboratory analysis
QA/QC procedures to be applied	Sampling and analysis procedures will adhere to internationally recognized standards, ensuring a confidence level of 90/10 for samples and measurements. Additionally, COD samples will undergo periodic testing by external laboratories to maintain quality assurance and quality control standards.
Purpose of data	Calculation of baseline and project emissions
Calculation method	-
Comments	-

Data / Parameter	$COD_{ww,treated,y}$ or $COD_{ww,outflow,y}$
Data unit	t COD/m³
Description	The chemical oxygen demand of the wastewater after the treatment system affected by the project activity.
Source of data	On site measurement
Description of measurement methods and procedures to be applied	Measure the COD according to national or international standards. COD is measured through representative sampling
Frequency of monitoring/recording	Samples and measurements shall ensure a 90/10 confidence/precision level Periodically, at least monthly.
Value applied	For PAI, the value for the ex-ante calculation is 0.01168
Monitoring equipment	Laboratory analysis
QA/QC procedures to be applied	Sampling and analysis will be carried out adhering to internationally recognized procedures. Samples and measurements shall ensure a 90/10 confidence level. COD samples will be periodically tested by external laboratories for QA/QC purposes.
Purpose of data	Calculation of baseline and project emissions
Calculation method	-
Comments	-

Data / Parameter	$S_{final,PJ,y}$
Data unit	t
Description	Method of disposal of the sludge
Source of data	Record of site and date of sludge disposal
Description of measurement methods and procedures to be applied	If methane emissions resulting from the anaerobic decay of the final sludge are negligible due to controlled disposal methods such as combustion, landfilling with methane recovery, or soil application, the end-use of the final sludge will be monitored throughout the crediting period. However, if baseline emissions encompass the anaerobic decay of final sludge deposited in a landfill without methane recovery, the specific baseline disposal site must be clearly identified and verified by the Designated Operational Entity (DOE).
Frequency of monitoring/recording	At each incidence of sludge disposal.
Value applied	For PAI, the estimated value for the ex-ante calculation is 0 due to no sludge treatment is involved in the PAI
Monitoring equipment	N/A
QA/QC procedures to be applied	Plant manager's signature is required on the record.
Purpose of data	Monitoring of sludge disposal.
Calculation method	-
Comments	-

Data / Parameter	$BG_{burnt,y}$
Data unit	m^3
Description	Biogas volume in year y
Source of data	Onsite measurement for $BG_{fuelled,y}$ .and $BG_{flared,y}$
Description of measurement methods and procedures to be applied	In all cases, the amount of biogas recovered, fuelled, flared or otherwise utilized (e.g. injected into a natural gas distribution grid or distributed via a dedicated piped network) shall be monitored ex post, using continuous flow meters. If the biogas streams flared and fuelled (or utilized) are monitored separately, the two fractions can be added together to determine the total biogas recovered, without the need to monitor the recovered biogas before the separation. As this is the case in PAI, PAI will use $BG_{fuelled,y}$ and $BG_{flared,y}$ as outlined below. The methane content measurement shall be carried out close to a location in the system where a biogas flow measurement takes place.
Frequency of monitoring/recording	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained)
Value applied	Value not used for ex ante estimates. Value to be monitored ex-post at $BG_{fuelled,y}$ and $BG_{flared,y}$
Monitoring equipment	Gas flow meter(s)
QA/QC procedures to be applied	Flowmeter to be maintained according to manufacturers specifications
Purpose of data	Calculation of project emissions
Calculation method	Add the values for $BG_{flared,y}$ and $BG_{fuelled,y}$ (if applicable)
Comments	-

Data / Parameter	$BG_{fuelled,y}$
Data unit	m^3
Description	Amount of biogas fuelled in year y
Source of data	Gas flowmeter
Description of measurement methods and procedures to be applied	In all cases, the amount of biogas fuelled shall be monitored ex post, using continuous flow meters. The methane content measurement shall be carried out close to a location in the system where a biogas flow measurement takes place
Frequency of monitoring/recording	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained)
Value applied	Value to be monitored ex-post
Monitoring equipment	Flowmeter
QA/QC procedures to be applied	Flowmeter to be maintained according to manufacturers specifications
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$BG_{flared,y}$
Data unit	m^3
Description	Amount of biogas fuelled in year y
Source of data	Gas flowmeter
Description of measurement methods and procedures to be applied	In all cases, the amount of biogas fuelled shall be monitored ex post, using continuous flow meters. The methane content measurement shall be carried out close to a location in the system where a biogas flow measurement takes place
Frequency of monitoring/recording	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained)
Value applied	Value to be monitored ex-post
Monitoring equipment	Flowmeter
QA/QC procedures to be applied	Flowmeter to be maintained according to manufacturers specifications
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$W_{CH4,y}$
Data unit	%
Description	Methane content in biogas in the year y
Source of data	On site measurement
Description of measurement methods and procedures to be applied	The methane fraction in the gas must be measured using a continuous analyzer or periodic measurements with a 90/10 confidence/precision level. Equipment capable of directly measuring methane content in biogas must be utilized; estimation of methane content based on other biogas constituents such as CO_2 is not allowed. The methane content measurement should be conducted near a location in the system where biogas flow is measured.
Frequency of monitoring/recording	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained)
Value applied	Value to be monitored ex-post
Monitoring equipment	Methane analyser
QA/QC procedures to be applied	Methane analyser to be maintained according to manufacturer's specifications
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	T
Data unit	°C
Description	Temperature of the biogas
Source of data	On site measurement
Description of measurement methods and procedures to be applied	If the biogas flow meter employed measures flow, pressure, and temperature, and provides normalized biogas flow data, separate monitoring of biogas pressure and temperature is not necessary. The temperature of the gas is essential for calculating the density of methane combustion.
Frequency of monitoring/recording	Shall be measured at the same time when methane content in biogas ($w_{CH4,y}$) is measured
Value applied	Value to be monitored ex-post
Monitoring equipment	Temperature transmitter
QA/QC procedures to be applied	Temperature transmitter to be maintained according to manufacturer's specifications
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	P
Data unit	Pa
Description	Pressure of the biogas
Source of data	On site measurement
Description of measurement methods and procedures to be applied	The pressure of the gas is required to determine the density of the methane combusted. If the biogas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of biogas, then there is no need for separate monitoring of pressure and temperature of the biogas
Frequency of monitoring/recording	Shall be measured at the same time when methane content in biogas ($w_{CH4,y}$) is measured
Value applied	Value to be monitored ex-post
Monitoring equipment	Pressure transmitter
QA/QC procedures to be applied	Pressure transmitter to be maintained according to manufacturer's specifications
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$Flame_m$
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute *m*
Source of data	On site measurement
Description of measurement methods and procedures to be applied	Measure using a fixed installation optical flame detector
Frequency of monitoring/recording	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
Value applied	Value to be monitored ex-post
Monitoring equipment	Optical flame detector: ultraviolet detector or infra-red or both
QA/QC procedures to be applied	Pressure transmitter to be maintained according to manufacturer's specificationsEquipment to be maintained and calibrated in accordance with manufacturer's specifications
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$fv_{i,h}$
Data unit	-
Description	Volumetric fraction of component *i* in the residual gas in the hour *h* where *i* = CH_4, CO, CO_2, O_2,H_2, N_2
Source of data	On site measurement
Description of measurement methods and procedures to be applied	Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60 °C
Frequency of monitoring/recording	Continuously. Values to be averaged hourly or at a shorter time interval.
Value applied	Value to be monitored ex-post
Monitoring equipment	Gas analyser
QA/QC procedures to be applied	Analysers must be periodically calibrated according to the manufactureris recommendation or industry standard. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	As a simplified approach, project participants may only measure the methane content of the residual gas and consider the remaining part as N_2.

Data / Parameter	$FV_{RG,h}$
Data unit	m^3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Source of data	On site measurement
Description of measurement methods and procedures to be applied	Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas ($fv_{i,h}$) when the residual gas temperature exceeds 60 °C
Frequency of monitoring/recording	Continuously. Values to be averaged hourly or at a shorter time interval
Value applied	Value to be monitored ex-post
Monitoring equipment	Flow meter
QA/QC procedures to be applied	Flow meters are to be periodically calibrated according to the manufacturer's recommendation or industry standard.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$t_{O2,h}$
Data unit	-
Description	Volumetric fraction of O2 in the exhaust gas of the flare in the hour *h*
Source of data	On site measurement
Description of measurement methods and procedures to be applied	For gas analysis, either extractive sampling analyzers equipped with water and particulates removal devices or in-situ analyzers shall be used for wet basis determination. The sampling point must be positioned in the upper section of the flare, at 80% of the total flare height. Sampling probes capable of withstanding high temperatures, such as inconel probes, shall be employed. An excessively high temperature at the sampling point (exceeding 700°C) may indicate inadequate flare operation or insufficient capacity for the actual flow.
Frequency of monitoring/recording	Continuously. Values to be averaged hourly or at a shorter time interval
Value applied	Value to be monitored ex-post
Monitoring equipment	Flow meter
QA/QC procedures to be applied	Flow meters are to be periodically calibrated according to the manufacturer's recommendation or industry standard.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$fv_{CH4,FG,h}$
Data unit	mg/m^3
Description	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
Source of data	Measurements by project participants using a continuous gas analyser
Description of measurement methods and procedures to be applied	For gas analysis, either extractive sampling analyzers equipped with water and particulates removal devices or in-situ analyzers shall be used for wet basis determination. The sampling point must be positioned in the upper section of the flare, at 80% of the total flare height. Sampling probes capable of withstanding high temperatures, such as inconel probes, shall be employed. An excessively high temperature at the sampling point (exceeding 700°C) may indicate inadequate flare operation or insufficient capacity for the actual flow.
Frequency of monitoring/recording	Continuously. Values to be averaged hourly or at a shorter time interval
Value applied	Value to be monitored ex-post
Monitoring equipment	Flow meter
QA/QC procedures to be applied	Flow meters must undergo periodic calibration as per the manufacturer's recommendations or industry standards.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	T_{flare}
Data unit	°C
Description	Temperature in the exhaust gas of the flare
Source of data	Measurements by project participants
Description of measurement methods and procedures to be applied	The temperature of the exhaust gas stream in the flare shall be measured using a Type N thermocouple. A temperature exceeding 500°C indicates that a substantial amount of gasses are still undergoing combustion, confirming the operational status of the flare.
Frequency of monitoring/recording	Continuously.
Value applied	Value to be monitored ex-post
Monitoring equipment	Flow meter
QA/QC procedures to be applied	Quality assurance and quality control (QA/QC) procedures dictate that flow meters must undergo periodic calibration in accordance with the manufacturer's recommendations or industry standards.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$EC_{PJ,j,y}$
Data unit	MWh / year
Description	Electricity consumption in the project scenario in the year y
Source of data	On site measurement
Description of measurement methods and procedures to be applied	Measurement by electricity meters on the electricity entering the Biogas Plant (from the Mill and/or directly from the national electricity grid).
Frequency of monitoring/recording	Continuous, ongoing
Value applied	Value to be monitored ex-post
Monitoring equipment	Electricity meter
QA/QC procedures to be applied	Meters will undergo maintenance and calibration in accordance with manufacturer recommendations, industry standards, or national grid operator requirements and standard practices. Meter data can be cross-checked against electricity sales invoices received by the Biogas Plant from electricity providers. During the Project Activity Instance (PAI), electricity will be supplied from the mill, and electricity consumption will be recorded using the mill's electricity meter.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

5.2 Monitoring Plan

The monitoring plan adheres to the recommended sections outlined in the PD instructions, encompassing methods for measuring, recording, storing, aggregating, collating, and reporting data and parameters. The monitoring system is structured in compliance with the stipulations of methodology AMS-III.H, with detailed definition of parameters provided in section 5.1. These parameters encompass:

- The flow of wastewater to the digester ($Q_{ww,i,y}$);
- The chemical oxygen demand of the wastewater before the treatment system affected by the project activity ($COD_{ww,inflow,y}$);
- The chemical oxygen demand of the wastewater after the treatment system affected by the project activity ($COD_{ww,treated,y}$ or $COD_{ww,outflow,y}$);
- The method of disposing the sludge ($S_{final,PJ,y}$);
- The amount of biogas recovered and utilized ($BG_{burnt,y}$), including biogas fuelled ($BG_{fuelled,y}$) and biogas flared ($BG_{flared,y}$);
- The methane content ($W_{CH4,y}$), temperature (T) and pressure (P) of the biogas;
- Parameters relevant to flaring ($Flare_m$); and
- Electricity consumption by the project ($EC_{PJ,j,y}$).

Measurements are recorded by well-maintained and appropriately calibrated monitoring equipment, ensuring adherence to manufacturer specifications or relevant national/international standards.

Regular inspections are conducted on monitoring equipment, with any damage or failure promptly reported for repairs or replacement.

Data collected by monitoring equipment is collated by a SCADA system and stored onsite, with backups stored in the cloud. Data accessibility is provided both onsite and remotely. All data, whether in hard copy or soft copy, will be archived for up to two years after the conclusion of the crediting period or the last issuance of Verified Carbon Units (VCUs) for this Project Activity Instance (PAI), whichever occurs later.

The organizational structure, responsibilities and competencies of the personnel that will be carrying out monitoring activities.

The following management structure summarizes the organizational structure of the monitoring team, responsibilities, monitoring practices, QA/QC procedures and archiving procedures. The monitoring plan will ensure that the emission reductions from the PAI are reported accurately and transparently. In detail, the data for the PAI is compiled by the operational and maintenance (O&M) team and subsequently stored by the PAI owner. The reporting and data flows as per the below structure of the monitoring group:

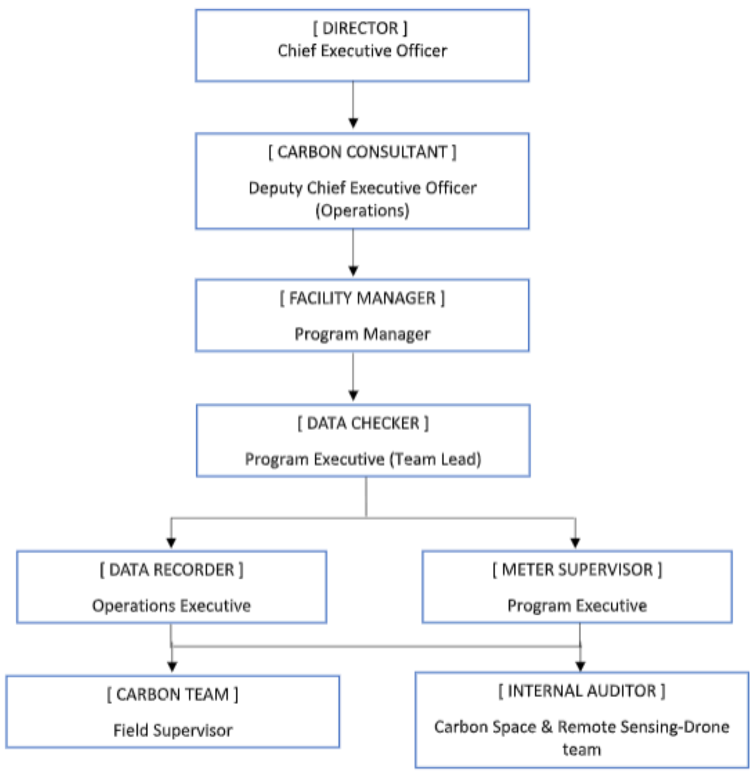


Figure 6: Structure of the Monitoring Group

The responsibilities of each persons involved in the monitoring are divided as follows:

Person in Charge	Responsibilities
CEO	Checking and signing the monitoring report annually.
Carbon Consultant	Providing training, technical support and oversight in relation to the carbon monitoring plan. Coordination and support for analysis of COD samples in external laboratories. Compilation of data, analysis of data and preparation of ER calculations, and preparing the verification report.
Facility Manager	Ensure day-to-day requirements of the plan are fulfilled.
Data Checker	Double checking the collected data measured by the power meter.
Meter Supervisor	Checking meters periodically according to relevant procedure/regulations.
Data Recorder	Collecting and recording data every month.
Carbon Team	Managing the carbon activities, guiding and supervising data recorders after being trained by carbon consultants.
Internal Auditor	Checking the monitoring procedure at least once in a year.

Onsite operators/technicians will assume the responsibilities of data recording, data verification, and meter supervision under the guidance of the facility manager.

All staff members will receive comprehensive training, covering aspects such as the setup of monitoring equipment and the protocols for calibration and maintenance.

All project personnel onsite undergo training in the code of conduct, occupational health and safety (OHS) standards, and other necessary procedures for ensuring the secure and efficient operation of the Biogas Plant.

The policies for oversight and accountability of monitoring activities.

The facility manager will oversee the daily implementation of the monitoring plan, while the carbon consultant will conduct annual reviews to ensure compliance with the plan.

The procedures for internal auditing and QA/QC.

Internal meter readings will be cross-checked against external sources, such as electricity invoices, to prevent discrepancies. Any inconsistencies will be promptly identified and resolved.

An emergency preparedness plan will be developed for the project activity to address potential emergencies, including earthquakes, explosions, fires, etc.

The procedures for handling non-conformances with the validated monitoring plan.

Data backups will be maintained, with manual hard-copy records utilized to estimate data in case of electronic data loss. Contingency plans will be established to address gaps in monitoring if data retrieval is not possible and manual measurements are unavailable.

In the event of malfunctions in the measurement of wastewater flow, biogas volume, or methane fraction, the following procedures will be implemented:

1. Manual measurement using backup flow meters/gas analyzers, with a 90% confidence interval calculated from the obtained data. The lower bound of the 90% confidence interval will be applied in calculations as a conservative approach.
2. Alternatively, if backup meters are unavailable, historical and future data (at least one month before and after the malfunction period) will be used to estimate quantities. A 90% confidence interval will be calculated from the data obtained, with the lower bound applied in calculations as a conservative approach.

In the case of COD measurement malfunctions, the amount of COD will be based on the most recent testing result.

Any sampling approaches used, including target precision levels, sample sizes, sample site locations, stratification, frequency of measurement and QA/QC procedures.

Regarding the measurement of COD, based on Raosoft, 11 samples need to be collected out of the total 12 months in a year to achieve a 90% confidence interval. No additional comments will be provided beyond the specific descriptions of sampling parameters (e.g., COD).

ANNEX

- INNIO JENBACHER biogas engine model Type 4: J 416 B

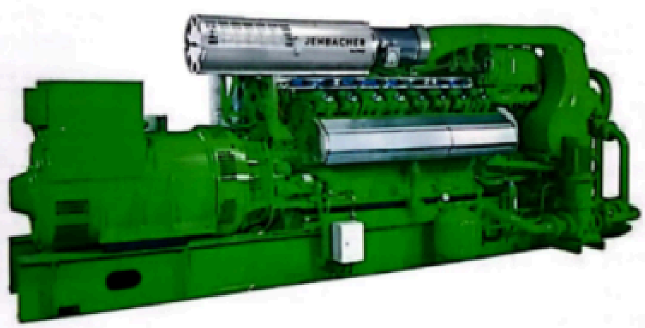
JENBACHER

1/2020

Technical Description

Genset
JGS 416 GS-B.L
Grid Parallel with Island Operation
static Grid Code

LADANG RAKYAT 1 & 2



Electrical output 1202 kW el.

Emission values
NOx < 500 mg/Nm³ (5% O2) | < 190 mg/Nm³ (15% O2)

1/40
INNIO

0.01 Technical Data (at genset)

			100%	75%	50%
Power input	[2]	kW	2,834	2,183	1,533
Gas volume	*)	Nm³/h	630	485	341
Mechanical output	[1]	kW	1,234	925	617
Electrical output	[4]	kW el.	1,202	901	599
Heat to be dissipated (calculated with Glykol 3%)	[5]				
~ Intercooler 1st stage (Engine jacket water cooling circuit)	[9]	kW	244	139	26
~ Intercooler 2nd stage (Low temperature circuit)		kW	57	42	27
~ Lube oil (Engine jacket water cooling circuit)		kW	169	151	132
~ Jacket water		kW	326	271	228
~ Surface heat	ca. [7]	kW	102	~	~
Spec. fuel consumption of engine electric	[2]	kWh/kWel.h	2.36	2.42	2.56
Spec. fuel consumption of engine	[2]	kWh/kWh	2.30	2.36	2.49
Lube oil consumption	ca. [3]	kg/h	0.25	~	~
Electrical efficiency			42.4%	41.3%	39.1%
Fuel gas LHV		kWh/Nm³	4.5		

*) approximate value for pipework dimensioning
[ ] Explanations: see 0.10 - Technical parameters

All heat data is based on standard conditions according to attachment 0.10. Deviations from the standard conditions can result in a change of values within the heat balance, and must be taken into consideration in the layout of the cooling circuit/equipment (intercooler; emergency cooling; ...). In the specifications in addition to the general tolerance of ±8 % on the thermal output a further reserve of +5 % is recommended for the dimensioning of the cooling requirements.

Main dimensions and weights (at genset)		
Length	mm	~ 6,200
Width	mm	~ 1,800
Height	mm	~ 2,200
Weight empty	kg	~ 12,800
Weight filled	kg	~ 13,400

Connections		
Jacket water inlet and outlet	DN/PN	80/10
Exhaust gas outlet [C]	DN/PN	300/10
Fuel Gas (at genset) [D]	DN/PN	125/16
Water drain ISO 228	G	½"
Condensate drain	mm	-
Safety valve - jacket water ISO 228 [G]	DN/PN	1½"/2,5
Lube oil replenishing (pipe) [I]	mm	28
Lube oil drain (pipe) [J]	mm	28
Jacket water - filling (flex pipe) [L]	mm	13
Intercooler water-Inlet/Outlet 1st stage	DN/PN	80/10
Intercooler water-Inlet/Outlet 2nd stage [M/N]	DN/PN	65/10

Output / fuel consumption		
ISO standard fuel stop power ICFN	kW	1,234
Mean effe. press. at stand. power and nom. speed	bar	20.20
Fuel gas type		Biogas
Based on methane number | Min. methane number	MZ	135 | 117 d)
Compression ratio	Epsilon	12.5
Min./Max. fuel gas pressure at inlet to gas train	mbar	80 - 200 c)
Max. rate of gas pressure fluctuation	mbar/sec	10
Maximum Intercooler 2nd stage inlet water temperature	°C	55
Spec. fuel consumption of engine	kWh/kWh	2.30
Specific lube oil consumption	g/kWh	0.20
Max. Oil temperature	°C	85
Jacket-water temperature max.	°C	95
Filling capacity lube oil (refill)	lit	~ 360

c) Lower gas pressures upon inquiry
d) based on methane number calculation software AVL 3.2

0.02 Technical data of engine

Manufacturer		JENBACHER
Engine type		J 416 GS-B25
Working principle		4-Stroke
Configuration		V 70°
No. of cylinders		16
Bore	mm	145
Stroke	mm	185
Piston displacement	lit	48,88
Nominal speed	rpm	1,500
Mean piston speed	m/s	9,25
Length	mm	3,660
Width	mm	1,495
Height	mm	2,085
Weight dry	kg	6,800
Weight filled	kg	7,435
Moment of inertia	kgm²	13,50
Direction of rotation (from flywheel view)		left
Radio interference level to VDE 0875		N
Starter motor output	kW	7
Starter motor voltage	V	24

Thermal energy balance

Power input	kW	2,834
Intercooler	kW	301
Lube oil	kW	169
Jacket water	kW	326
Exhaust gas cooled to 180 °C	kW	464
Exhaust gas cooled to 100 °C	kW	616
Surface heat	kW	59

Exhaust gas data

Exhaust gas temperature at full load [8]	°C	414
Exhaust gas temperature at bmep= 15.2 [bar]	°C	~ 436
Exhaust gas temperature at bmep= 10.1 [bar]	°C	~ 463
Exhaust gas mass flow rate, wet	kg/h	6,363
Exhaust gas mass flow rate, dry	kg/h	5,921
Exhaust gas volume, wet	Nm³/h	4,970
Exhaust gas volume, dry	Nm³/h	4,419
Max admissible exhaust back pressure after engine	mbar	60

Combustion air data

Combustion air mass flow rate	kg/h	5,875
Combustion air volume	Nm³/h	4,546
Max. admissible pressure drop at air-intake filter	mbar	10

Sound pressure level

Aggregate a)		dB(A) re 20μPa	97
31,5	Hz	dB	84
63	Hz	dB	88
125	Hz	dB	97
250	Hz	dB	95
500	Hz	dB	93
1000	Hz	dB	88
2000	Hz	dB	87
4000	Hz	dB	90
8000	Hz	dB	88
Exhaust gas b)		dB(A) re 20μPa	113
31,5	Hz	dB	101
63	Hz	dB	111
125	Hz	dB	116
250	Hz	dB	105
500	Hz	dB	102
1000	Hz	dB	96
2000	Hz	dB	108
4000	Hz	dB	107
8000	Hz	dB	104

Sound power level

Aggregate	dB(A) re 1pW	117
Measurement surface	m^2	105
Exhaust gas	dB(A) re 1pW	121
Measurement surface	m^2	6.28

a) average sound pressure level on measurement surface in a distance of 1m (converted to free field) according to DIN 45635, precision class 3.
b) average sound pressure level on measurement surface in a distance of 1m according to DIN 45635, precision class 2.
The spectra are valid for aggregates up to bmep=19 bar. (for higher bmep add safety margin of 1dB to all values per increase of 1 bar pressure).
Engine tolerance ± 3 dB

0.03 Technical data of generator

Manufacturer		STAMFORD e)
Type		PE 734 E e)
Type rating	kVA	1,625
Driving power	kW	1,234
Ratings at p.f. = 1,0	kW	1,202
Ratings at p.f. = 0.8	kW	1,191
Rated output at p.f. = 0.8	kVA	1,489
Rated reactive power at p.f. = 0.8	kVar	893
Rated current at p.f. = 0.8	A	2,149
Frequency	Hz	50
Voltage	V	400
Speed	rpm	1,500
Permissible overspeed	rpm	1,800
Power factor (lagging - leading)		0,8 - 0,95
Efficiency at p.f. = 1,0		97.4%
Efficiency at p.f. = 0,8		96.5%
Moment of inertia	kgm²	44.50
Mass	kg	3,506
Radio interference level to EN 55011 Class A (EN 61000-6-4)		N
Cable outlet		left
Ik" Initial symmetrical short-circuit current	kA	20.84
Is Peak current	kA	53.05
Insulation class		H
Temperature (rise at driving power)		F
Maximum ambient temperature	°C	40

Reactance and time constants (saturated) at rated output

xd direct axis synchronous reactance	p.u.	2.320
xd' direct axis transient reactance	p.u.	0.141
xd" direct axis sub transient reactance	p.u.	0.102
x2 negative sequence reactance	p.u.	0.149
Td" sub transient reactance time constant	ms	20
Ta Time constant direct-current	ms	20
Tdo' open circuit field time constant	s	2.50

e) JENBACHER reserves the right to change the generator supplier and the generator type. The contractual data of the generator may thereby change slightly. The contractual produced electrical power will not change.

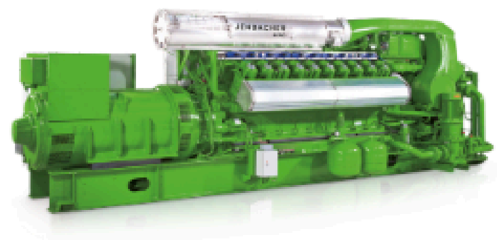
- MyHIJAU INNIO JENBACHER biogas engine model Type 4: J 416 B

JENBACHER
INNIO

JENBACHER TYPE 4

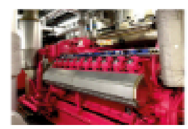
An efficiency milestone

Based on the proven design concepts of types 3 and 6, the modern Jenbacher type 4 engines in the 800 to 1,500 kW power range are characterized by a high-power density and outstanding efficiency. The enhanced control and monitoring provide easy preventive maintenance, high reliability and availability.



Reference installations

J420 St Bart's Hospital in London, United Kingdom



Energy Source	Engine type	Electrical output	Thermal output	Commissioning
Natural gas	1 x J420	1,480 kW	1,624 kW	2015

Since 2015, one of the oldest hospitals in the UK has obtained cooling, heat and power from a single J420 unit. The 1.4 MW cogeneration unit includes a 250 kW absorption chiller that delivers cooling water to the hospital. The J420 engine is the cornerstone of a new energy center that has provided the facility with financial savings by boosting its energy efficiency, reliability and durability.

J420 Ashford Power Peaking Plant in Kent, United Kingdom

Energy Source	Engine type	Electrical output	Commissioning
Natural gas	14 x J420	21 MW	2018

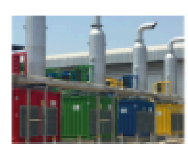
The electricity generating peaking plant at Ashford Power, Kings North Industrial Estate in Kent is operating 14 containerized Jenbacher J420 engines. When not in operation, the engines of this fully-automated plant wait on standby, prepared to be called upon and ramped up in less than two minutes.

J420 SV.CO Strijbisverbeek Greenhouse in Maasdijuk, the Netherlands

Energy Source	Engine type	Electrical output	Thermal output	Commissioning
Natural gas	1 x J420	1,501 kW	1,996 kW	2018

The Strijbisverbeek Greenhouse in Maasdijuk, Netherlands, is relying on a total greenhouse CHP solution consisting of a Jenbacher J420, a complete exhaust gas system incl. catalytic reactor for CO_2 and acoustical enclosure. The energy generated in this greenhouse is used to operate its grow lights. Additionally, they are using the heat of the CHP to heat up their greenhouse in colder periods and at night.

J420 Biogas Plant in Nakornrachasrima, Thailand



Energy Source	Engine type	Electrical output	Commissioning
Biogas	5 x J420	7,105 kW	2012

The Chok Yuen Yong facility profits from its five J420 engines that provide reliable on-site power while also reducing electrical and energy costs. The excess electricity produced is supplied to the public grid.

Technical features

Feature	Description	Advantages
Heat recovery	Flexible arrangement of heat exchanger, two stage oil plate heat exchanger on demand	- High thermal efficiency, even at high and fluctuating return temperatures
Gas dosing valve	Electronically controlled gas dosing valve with high degree of control accuracy	- Very quick response time - Rapid adjustment of air / gas ratio - Large adjustable calorific value range
Four-valve cylinder head	Enhanced swirl and channel geometry using advanced calculation and simulation methods (CFD)	- Reduced charge-exchange losses - Central spark-plug position resulting in optimal cooling and combustion conditions
Crack connecting rod	Applying a technology—tried and tested in the automotive industry—in our powerful stationary engines	- High dimensional stability and accuracy - Reduced connecting rod bearing wear - Easy to maintain

Technical data

Configuration	V 70°		
Bore (mm)	145		
Stroke (mm)	185		
Displacement / cylinder (lit)	3.06		
Speed (rpm)	1,800 / 1,200 (60 Hz) 1,500 (50 Hz)		
Mean piston speed (m/s)	7.4 (1,200 1/min) 9.3 (1,500 1/min) 11.2 (1,800 1/min)		
Scope of supply	Generator set, cogeneration system, generator set / cogeneration in container		
Applicable gas types	Natural gas, flare gas, biogas, landfill gas, sewage gas, special gases (e.g., coal mine gas, coke gas, wood gas, pyrolysis gas)		
Engine type	J412	J416	J420
No. of cylinders	12	16	20
Total displacement (lit)	36.7	48.9	61.1

		Dimensions l x w x h (mm)
Generator set	J412	5,400 x 1,800 x 2,200
	J416	6,200 x 1,800 x 2,200
	J420	7,100 x 1,900 x 2,200
Cogeneration system	J412	6,000 x 1,800 x 2,200
	J416	6,700 x 1,800 x 2,200
	J420	7,100 x 1,800 x 2,200
Container	J412	12,200 x 3,000 x 2,700
	J416	12,200 x 3,000 x 2,700
	J420	12,200 x 3,000 x 2,700

		Weights empty (kg)
Generator set	J412	11,200
	J416	13,500
	J420	17,200
Cogeneration system	J412	11,800
	J416	14,100
	J420	17,800

Outputs and efficiencies

Natural gas		1,500 1/min | 50 Hz					1,800 1/min | 60 Hz					1,200 1/min | 60 Hz				
NOx <	Type	Pel (kW)[1]	Pt (kW)[2]	ηel (%)[1]	ηth (%)[2]	ηtot (%)	Pel (kW)[1]	Pt (kW)[2]	ηel (%)[1]	ηth (%)[2]	ηtot (%)	Pel (kW)[1]	Pt (kW)[2]	ηel (%)[1]	ηth (%)[2]	ηtot (%)
500 mg/m³N	J412	901	928	43.4	44.6	88.0	851	960	41.6	46.9	88.5	630	618	42.8	41.9	84.7
	J416	1,202	1,244	43.4	44.9	88.3	1,141	1,281	41.8	46.9	88.7	846	824	43.0	41.9	85.0
	J416	1,000	1,029	43.3	44.6	87.9										
	J420	1,561	1,656	43.7	46.3	90.0	1,429	1,602	41.9	46.9	88.8	1,057	1,029	43.0	41.9	84.9
	J420	1,561	1,833	42.4	49.7	92.1										
250 mg/m³N	J412	901	967	42.1	45.2	87.4	851	1,003	40.6	47.9	88.5	630	641	41.8	42.5	84.4
	J416	1,202	1,285	42.3	45.2	87.5	1,141	1,338	40.8	47.9	88.7	846	858	42.1	42.6	84.7
	J416	1,000	1,046	42.7	44.7	87.4										
	J420	1,502	1,606	42.7	45.6	88.3	1,429	1,648	41.2	47.5	88.7	1,057	1,085	41.7	42.8	84.6
	J420	1,561	1,906	41.4	50.5	91.9										

Biogas		1,500 1/min | 50 Hz					1,800 1/min | 60 Hz				
NOx <	Type	Pel (kW)[1]	Pt (kW)[2]	ηel (%)[1]	ηth (%)[2]	ηtot (%)	Pel (kW)[1]	Pt (kW)[2]	ηel (%)[1]	ηth (%)[2]	ηtot (%)
500 mg/m³N	J412	749	750	42.1	42.2	84.3					
	J412	901	919	42.6	43.5	86.1	851	918	41.1	44.2	85.3
	J412	934	914	43.3	42.3	85.6					
	J416	999	993	42.3	42.1	84.4					
	J416	1,202	1,221	42.8	43.5	86.2	1,141	1,220	41.3	44.2	85.5
	J416	1,248	1,225	43.3	42.4	85.7					
	J420	1,498	1,524	42.7	43.4	86.2	1,429	1,527	41.4	44.2	85.7
	J420	1,561	1,548	43.3	42.9	86.2					
250 mg/m³N	J412	889	922	42.0	43.6	85.6	851	933	40.4	44.3	84.7
	J416	1,190	1,229	42.2	43.5	85.7	1,141	1,237	40.6	44.0	84.7
	J420	1,487	1,537	42.1	43.6	85.7	1,429	1,556	40.7	44.3	85.0

[1] Technical data according to ISO 3046
[2] Total heat output with a tolerance of +/- 8%, exhaust gas outlet temperature 120°C, for biogas gas outlet temperature 180°C

All data according to full load and subject to technical development and modification. Further engine versions available on request.

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- Dehumidifier and chiller brand Hyperchill model ICE150

Features and Benefits

- Special protective treatment of condensers and copper piping to ensure reliable operation in the most aggressive of ambient atmospheres at biogas plants and landfill sites.
- Pump and tank installed inside the chiller provides a compact and easy to install solution.
- Closed water temperature operation with high working limits and low running costs.
- Large built-in water tank that provides a large thermal mass / storage capacity thus reducing the number of refrigerant compressor stop/starts and short cycling and thereby increasing the compressor and chiller lifetime.
- Designed to provide cooling water where low temperature water is required as standard (Air Conditioning units do not normally need to provide water at less than 10 °C).
- Use of compliant scroll compressors designed specifically for high efficiency and long life in industrial applications.
- Low ambient speed-control on fan-motor ensures constant performances at different temperatures, long lifetime of the fans and a reduction in absorbed power when ambient temperature is low.
- Maximum working ambient temperature up to 48 °C for ICEP models, up to 45 °C for ICE models, prevents downtime even under extremely harsh conditions

Product-Specification

Hyperchill BioEnergy 007-360

Model		ICEP									ICE							
		007	010	014	020	024	030	040	050	060	076	090	116	150	183	230	310	360
Cooling Capacity[1]	kW	7,8	10,8	14,6	20,3	23,6	29,7	40,6	49,0	58,3	76,0	90,2	115,5	149,2	182,3	228	305,1	359,7
Compr. abs. power[1]	kW	1,7	2,5	3,2	4,4	5,4	5,7	7,5	10,0	12,3	15,4	20,3	24,9	30,8	40,1	51,4	64,2	81,5
Cooling Capacity[2]	kW	4,4	5,6	7,6	11,5	13,5	16,9	23	27,7	33,0	43,2	51,7	66,1	85,3	104,2	130,2	180,5	206,7
Compr. abs. power[2]	kW	1,4	1,9	2,7	3,5	4,3	6,4	8,2	10,7	13,1	16,4	20,8	26,4	32,5	41,4	55,1	63,4	83,2
Power supply	V/ph/Hz	400/3/50 no neutral																
Protection class		54																
Refrigerant		R407C																
Compressors																		
Type		scroll					hermetic compliant scroll											
Compressor / circuits		1/1									2/2			4/2				
Max. abs. power-1 compr.	kW	2,4	3,8	4,4	5,7	6,6	8,3	11,4	14,9	17,3	11,1	13,7	16,8	11,1	13,7	16,8	23,3	28,7
Axial fans																		
Quantity	N°	1			2						3			2		3	4	
Max. abs. power-1 fan	kW	0,3	0,3	0,4	0,4	0,4	0,45	0,69	0,69	0,69	0,78	0,78	0,78	2	2	2	2	2
Total air flow	m³/h	3437	3437	4337	6878	6159	9437	16029	15215	16875	25500	25000	26400	47000	46000	66000	88000	88000
PumpP15																		
Type		centrifugal																
Max. abs. power	kW	0,4	0,4	0,4	0,5	0,5	0,55	0,55	0,75	0,75	1,1	1,1	1,1	1,5	1,5	2,2	on request	
Water flow (nom/max)[1]	m³/h	1,3/4,2	1,8/4,2	2,6/4,2	3,4/7,2	4,1/7,2	5,1/11	6,9/11	8,4/18	10,1/18	12/25	15/825	19/44	25/44	30/44	39/48		
Head pressure (nom/min)[1]	mH_2O	19/9	15/9	17/9	18/7	17/7	16/12,5	14/12,5	16/10	13/10	15/8	15/8	13/6	12/6	10/6	14/8		
Water flow (nom/max)[2]	m³/h	0,9/4,2	1,2/4,2	1,6/4,2	2,4/7,2	2,8/7,2	3,7/11	5/11	6 /11	7,1/18	9,0/25	11/25	13/44	18/44	22/44	28/48		
Head pressure (nom/min)[2]	mH_2O	20/9	19/9	17/9	20/7	19/7	20/12,5	16/12,5	20/10	17/10	16/8	16/8	13/6	11/6	12/6	20/8		
Dimensions & Weight																		
Width	mm	756	756	756	756	756	756	856	856	856	898	898	898	1287	1287	1287	1500	1500
Depth	mm	806	806	806	1206	1206	1206	1956	1956	1956	2200	2200	2200	3000	3000	3260	4200	4200
Height	mm	1405	1405	1405	1405	1405	1405	1680	1680	1680	1984	1984	1984	2298	2298	2298	2240	2240
Connection in / out	in	3/4"	3/4"	3/4"	1"	1"	1"	1" 1/2	1" 1/2	1" 1/2	2"	2"	2"	2½"	2½"	2½"	4"	4"
Tank Capacity	l	65	65	65	100	100	130	250	250	250	500	500	500	1000	1000	1000	400	400
Weight (axial)[3]	kg	160	165	175	220	220	250	450	470	510	800	900	1000	1500	1800	2100	2900	2900
Noiselevel																		
Noise level[4]	dB(A)	53	53	50	50	50	51	52	52	53	58	58	58	62	62	64	65	65

[1] data refers to water inlet/outlet temperature = 20/15 °C, glycol 0 %, ambient temperature 25 °C.
[2] data refers to water inlet/outlet temperature = 5/1 °C, glycol 10 %, ambient temperature 35 °C.
[3] weights are inclusive of pallet and refrigerant charge.
[4] in free field conditions at a distance of 10 m from the unit, measured on condenser side, 1m from ground.
All models supplied with R407C and with power supply 400V / 3ph / 50Hz.

Correctionfactors

A) Ambient temp. (air-cooled models) correction factor (f1)	°C	5	10	15	20	25	30	35	40	45
		1,05	1,05	1,05	1,05	1	0,95	0,89	0,83	0,77

B) Water outlet temperature correction factor (f2)	°C	5	10	15	20	25
		0,72	0,86	1	1	1

C) Glycol correction factor (f3)	%	0	10	20	30	40	50
		1	0,99	0,98	0,97	0,96	0,94

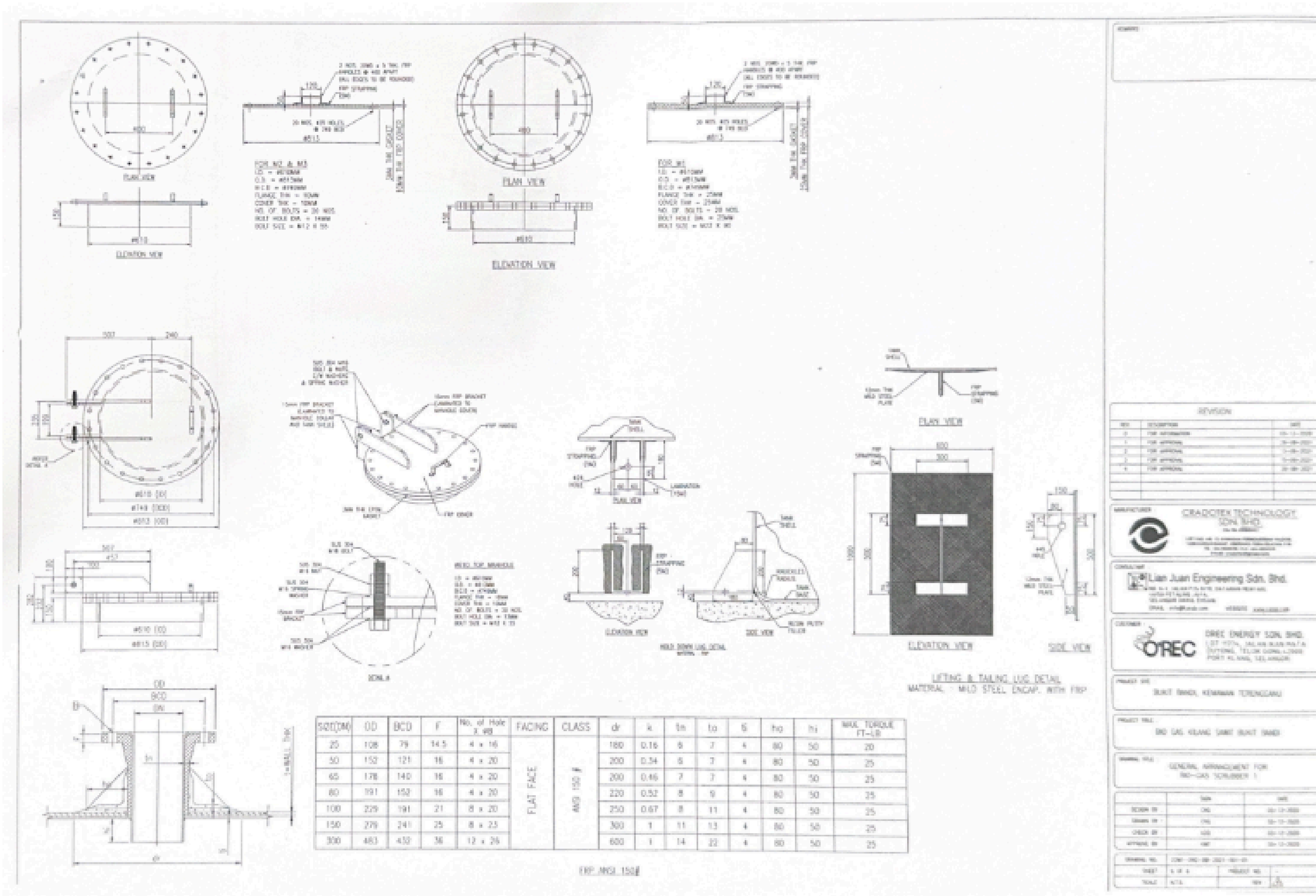
To obtain the required cooling capacity multiply the value at nominal conditions by the above correction factors (i.e. cooling capacity = Pxf1xf2xf3xf4, where P is the cooling capacity at conditions (1)). The above correction factors are approximative: for a precise selection always refer to the software selection program.

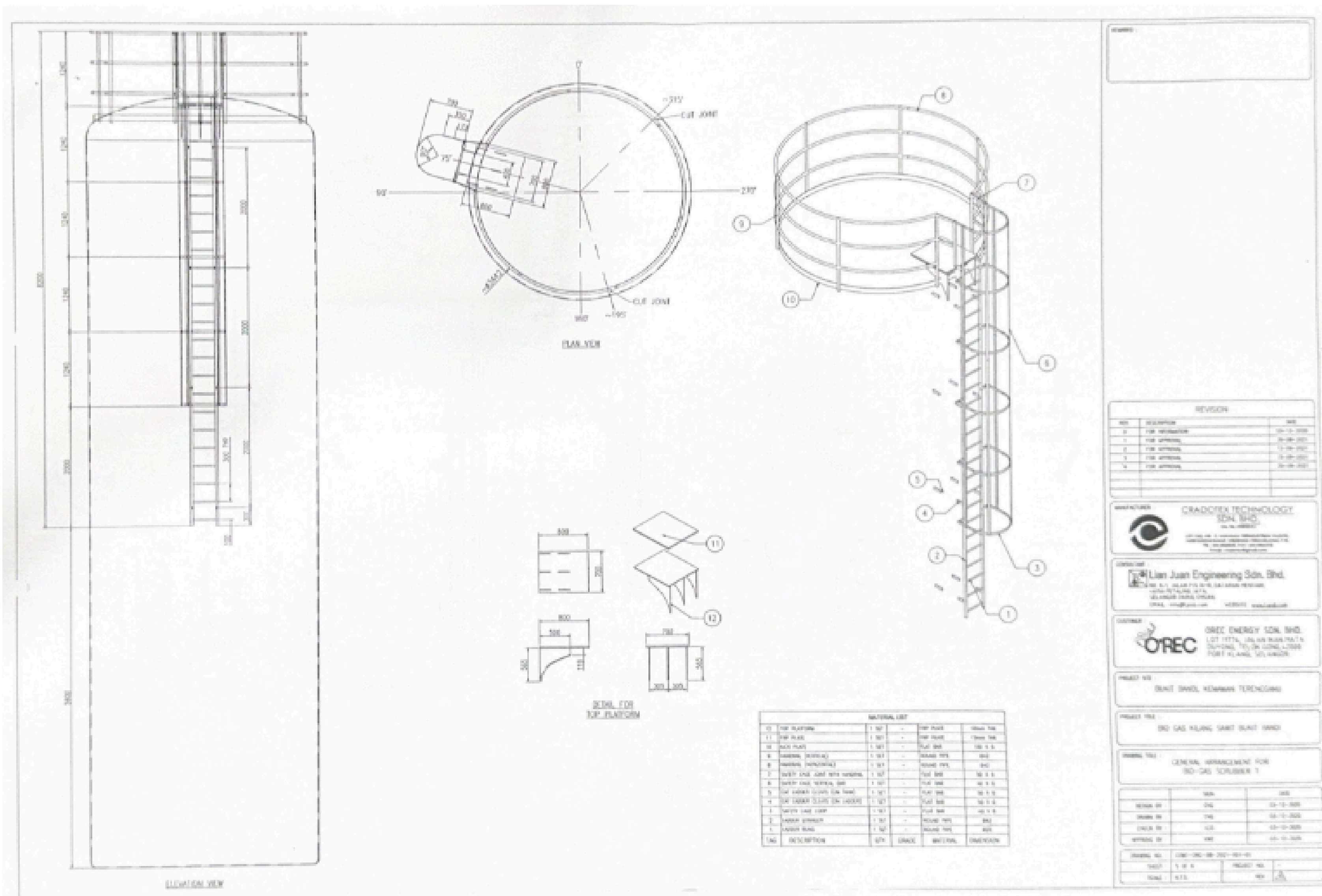
Reference: 1600Nm3/hr Bukit Bandi Biogas Dehumidification System

Chiller Performance Data

Model Chiller	MU	ICE 150
Cooling capacity	kW	88.80
Fridge compress. absorb. power	kW	32.80
Water flow	m3/h	15.40
Water pressure drop	kPa	8.20
Required power	kW	85.00
Required flow	m3/h	15.00
Water inlet temperature	°C	7.00
Water outlet temperature	°C	2.00
Ambient temperature	°C	35.00
Min. Ambient temperature	°C	28.00
Glycol percentage (by weight)	%	8.00
Condenser cooling fluid	-	AIR
Power supply	V/ph/Hz	400/3/50
N° Compressors / Circuits	-	4 / 2
Sound level	dB(A)	62.00
Max pressure of Hydraulic Circuit	bar g	6.00
Power discarge	%	0.05
Dimensions		
Width	mm	1290
Depth	mm	3000
Height	mm	2272
Weight	kg	1500

- Scrubbers model OREC GREEN02




PLAN VIEW
ELEVATION VIEW
DETAIL FOR
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MATERIAL LIST
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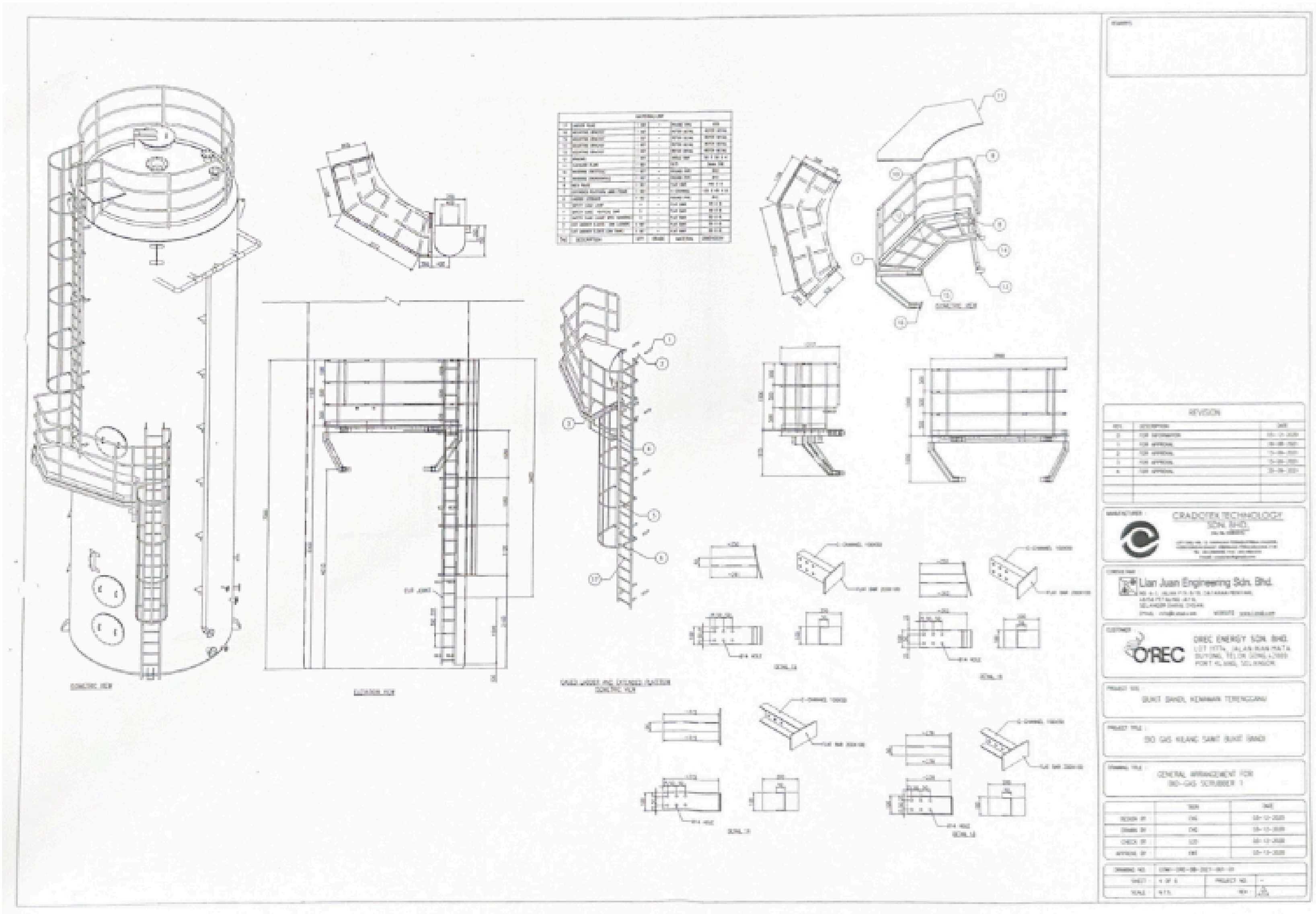
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BIO GAS KILANG SAWIT BUKIT BANDI
GENERAL ARRANGEMENT FOR
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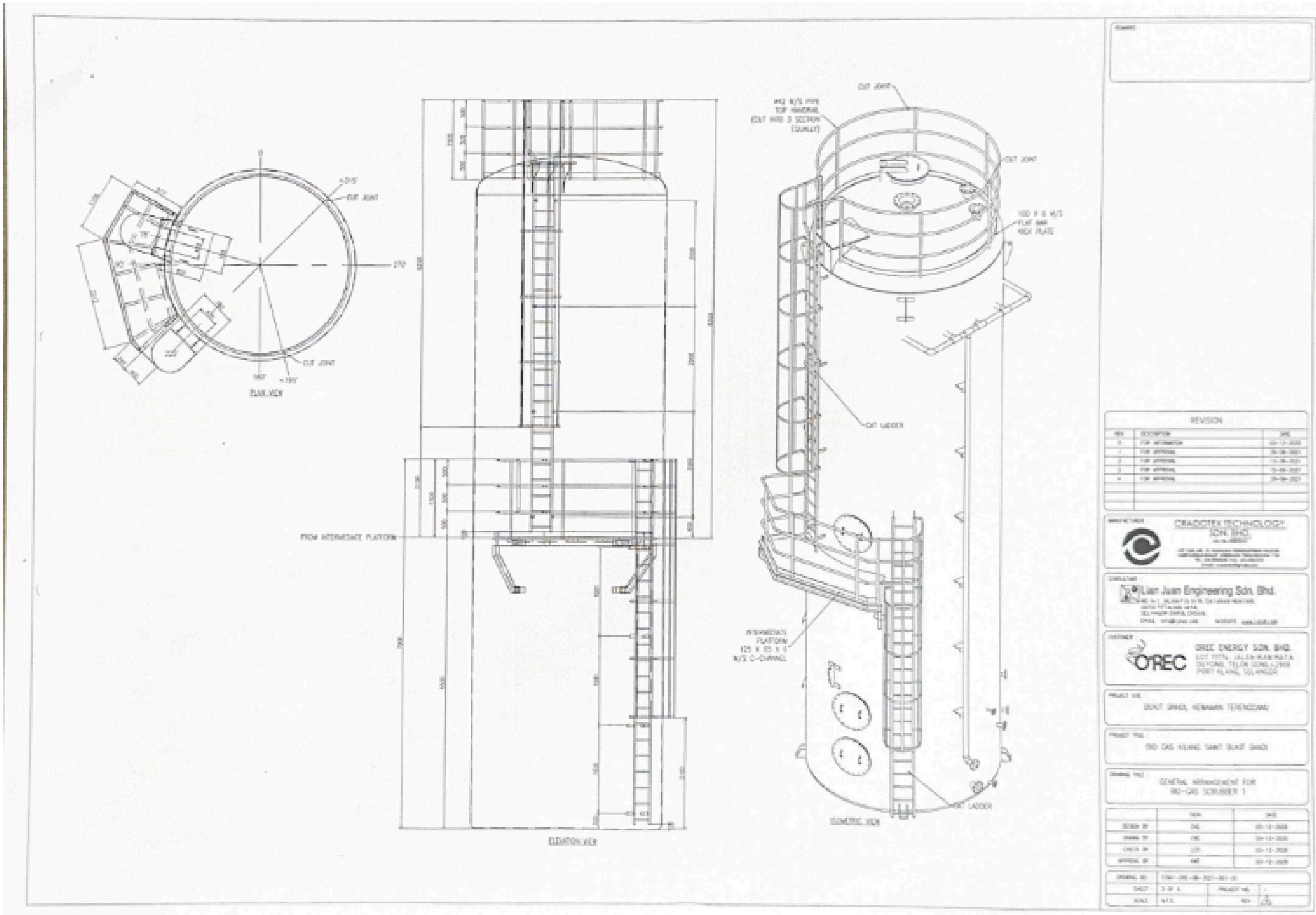

PLAN VIEW
ELEVATION VIEW
ISOMETRIC VIEW
CUT JOINT
CUT LADDER
INTERMEDIATE PLATFORM
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GENERAL ARRANGEMENT FOR
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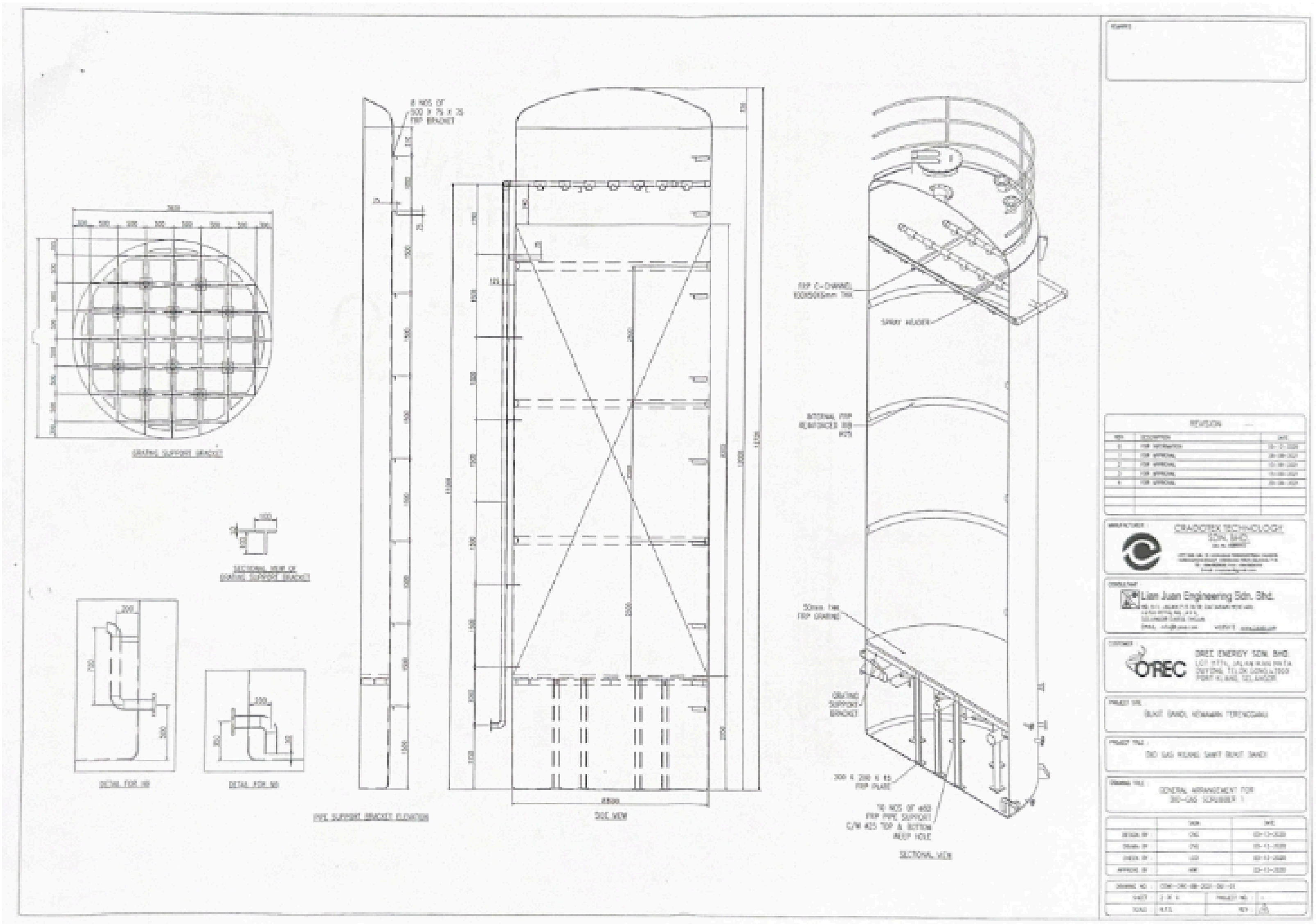
GRATING SUPPORT BRACKET
SPRAY HEADER
SIDE VIEW
SECTIONAL VIEW
PIPE SUPPORT BRACKET ELEVATION
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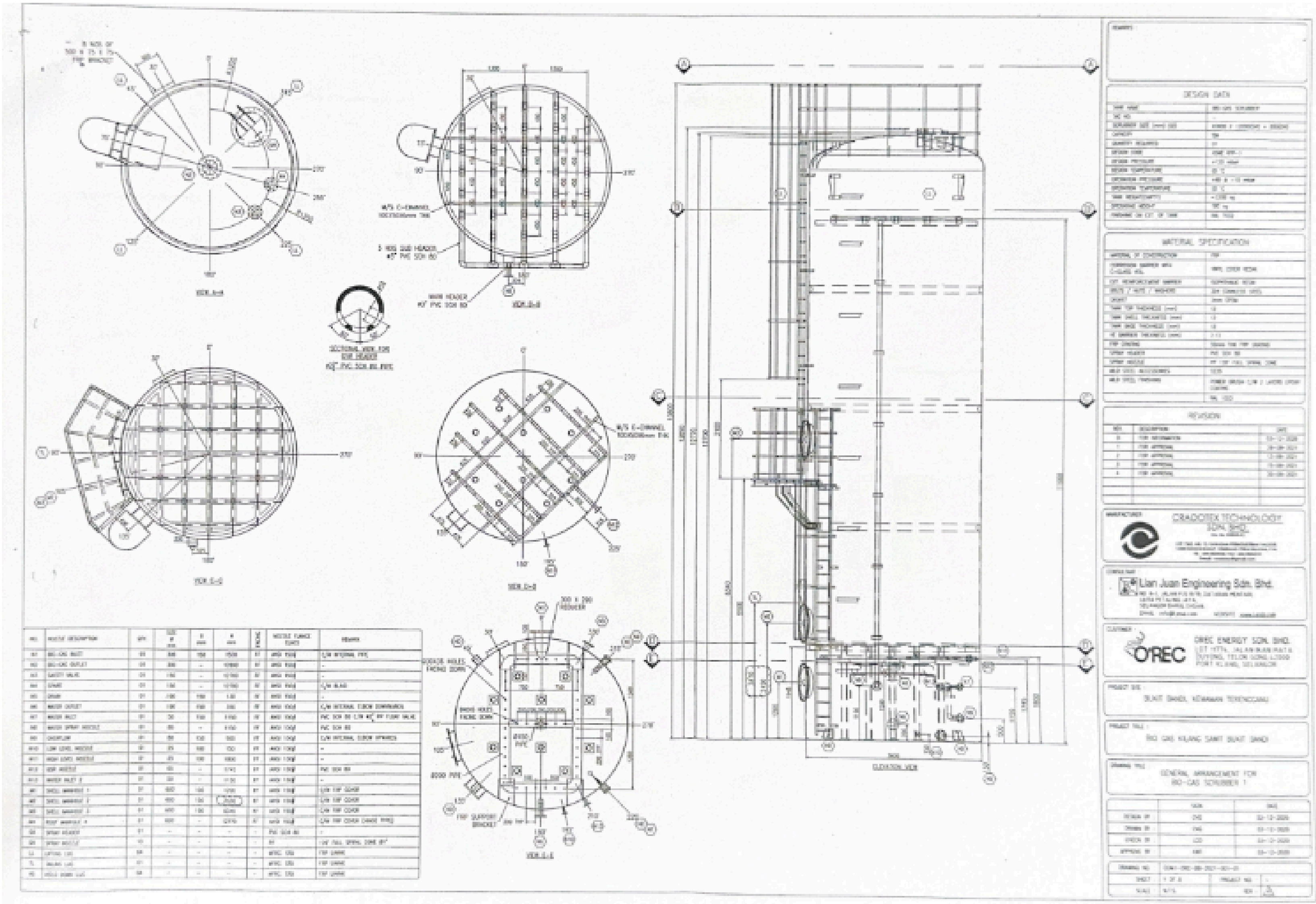
GENERAL ARRANGEMENT FOR
BIO-GAS SCRUBBER 1


DESIGN DATA
MATERIAL SPECIFICATION
REVISION
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ELEVATION VIEW

NOTE: This Project Document (PD) shall be completed following the instructions included. However, it is important to highlight that these instructions are complementary to the BCR Standard, and the Methodology applied by the project holder, in which more information on each section can be found.